Liverpool Bay CCS Ltd

HYNET CARBON DIOXIDE TRANSPORTATION AND STORAGE PROJECT - OFFSHORE

Environmental Statement
Volume 1 and 2: Chapters 1 - 14

EHE7228B
Liverpool Bay CCS Limited
Final
February 2024
Offshore ES

rpsgroup.com

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ENVIRONMENTAL STATEMENT DETAILS

Section A: Administrative Information

A1 – Project Reference Number

Please confirm the unique ES identification number for the project.

Number: **ES/2022/009**

A2 - Developer Contact Details

Company name: **LIVERPOOL BAY CCS LIMITED**

Contact name: **MR MARTIN CURRIE**

Contact title: **MANAGING DIRECTOR**

A3 - ES Contact Details (if different from above)

Company name: **Eni UK Limited**

Contact name: **Donald Smith**

Contact title: **HSE Manager**

A4 - ES Preparation

Please confirm the key expert staff involved in the preparation of the ES:

Name	Company	Title	Relevant Qualifications / Experience
Morag Wilson	RPS (a Tetra Tech company)	EIA Project Director	• RPS Associate Director with 20+ years' experience in the environmental sector. • BSc Joint Hons (2:1) Botany and Marine Biology, University of Wales, Bangor, • MSc Marine Resource Management, Heriot-Watt University, • Graduate Certificate, Environmental Studies, Strathclyde University. • Full Member, The Institution of Environmental Sciences (IES), Associate Member, Association for Project Management (APM), Affiliate Member, Institute of Environmental Management and Assessment (IEMA), Affiliate Member, Royal Town Planning Institute (RTPI).
Andrea Robinson	RPS (a Tetra Tech company)	EIA Project Manager	• RPS Principal Consultant with 20+ years' experience in the environmental sector. • M.Sc. Marine Resource Development and Protection, B.Sc. (Hons). Geology. • Full membership of IEMA, Chartered Environmentalist (CEnv).
Nathalie De Groot	RPS (a Tetra Tech company)	EIA Assistant Project Manager	• RPS Senior Consultant with 11+ years' experience in the energy sector. • MSc (Distinction) Environmental Partnership Management, University of Aberdeen, MSc Petroleum

Name	Company	Title	Relevant Qualifications / Experience
			Engineering, Delft University of Technology, BSc Applied Earth Sciences, Delft University of Technology.
Naomi Shannon	RPS (a Tetra Tech company)	Physical Processes	• RPS Senior Engineer - Water Environment and Flood Risk Management. • PhD Computational Fluid Dynamics, Queen's University of Belfast, MSc Engineering Computation, Queen's University of Belfast, PGCHET Queen's University of Belfast, BEng (2:1 Hons.) Civil Engineering, University of Brighton. • Graduate member Institution of Civil Engineers, Registered Practitioner for Higher Education Academy (ILTHE).
Lucy Shuff	RPS (a Tetra Tech company)	Marine Biodiversity	• RPS Principal Consultant with 12+ years' experience in the environmental sector. • BSc (Hons) Marine Biology and Oceanography.
Andrew Mather	RPS (a Tetra Tech company)	Ornithology	• RPS Senior Consultant with 4+ years' experience in the environmental sector. • BSc (Hons) in Zoology with Industrial Experience, University of Manchester, MPhil (Cantab) in Biological Science, University of Cambridge. • Associate Member of IMarEST.
John Beattie	Anatec Ltd	Shipping and Navigation	• Anatec Ltd Principal Risk Analyst with 20+ years' experience. • BEng (Hons) in Chemical Engineering and an MSc in Information Technology Systems from the University of Strathclyde.
Fiona Nimmo	Poseidon Aquatic Resources Management Ltd	Commercial Fisheries	• Poseidon Aquatic Resources Management Ltd Director with 13+ years' experience. • B.Sc. Marine Biology (First Class Hons), University of Newcastle upon Tyne, B.Eng. Chemical Engineering (2:1 Hons), Edinburgh University.
Mark James	MSDS Marine Ltd	Marine Archaeology	• MSDS Marine Ltd Director with 12+ years' experience in the maritime archaeology sector. • BSc (Hons) Marine Archaeology, Bournemouth University.
Stuart Sharp	RPS (a Tetra Tech company)	Infrastructure and Other Sea Users	• RPS Principal Consultant with 18+ years' experience. • MSc Environmental Science, BSc Ocean Sciences, Society for the Environment Cenv, Science Council Chartered Scientist (CSci), Energy Institute Member, IEMA Affiliate Member.
Andrew Tasker	RPS (a Tetra Tech company)	Climate Change	• RPS Associate Director – EIA and Sustainability. • BSc (Hons) Geography and Environmental Sciences, MSc Sustainable Cities, BREEAM UK NC Assessor. • Practitioner Member of IEMA.
Kathryn Barker	RPS (a Tetra Tech company)	Air Quality	• RPS Principal Air Quality Consultant. • BSc (Hons) Environmental Science, MSc Environmental Pollution Control. Member of the Institute of Air Quality Management (IAQM) and Associate Member of the Institute of Environmental Sciences.
John Beattie	Anatec Ltd	Aviation and Radar	• Anatec Ltd Principal Risk Analyst with 20+ years' experience.

Name	Company	Title	Relevant Qualifications / Experience
			• BEng (Hons) in Chemical Engineering and an MSc in Information Technology Systems from the University of Strathclyde.
Raymond Holbeach	RPS (a Tetra Tech company)	Seascape, Landscape and Visual Resources	• RPS Director - Planning and Environment with 30+ years' experience in urban and rural design, and planning. • BSc (Hons) Environmental Science, University of Ulster, Master of Landscape Architecture, University of Edinburgh. • Chartered Member of the Landscape Institute, Member of the Irish Landscape Institute, Practitioner Member of IEMA.
Simon Stephenson	Seiche	Underwater Noise	• Seiche Specialist Acoustic Consultant with 24+ years' experience. • BSc (Hons) Physics University of Bristol. • Chartered Engineer (CEng) Institute of Acoustics (IOA), Member of IOA, Associate of the Acoustical Society of America.

Please extend table if necessary.

A5 - Licence Details

a) Please confirm licence(s) covering proposed activity or activities

Licence number(s): **The Project will be undertaken within the carbon storage license area (CS004), including within Offshore Licensed Blocks 110/13a, 110/13b, 110/14a, 110/14c and 110/15a.**

b) Please confirm licensees and current equity

Licence Number: CS004	
Licensee	**Percentage Equity**
Eni UK Limited	**100%**

Licence Number: 110/13a, 110/13b, 110/14a, 110/14c and 110/15a	
Licensee	**Percentage Equity**
BHP BILLITON PETROLEUM GREAT BRITAIN LIMITED	**46.10%**
ENI AEP LIMITED	**8.90%**
ENI ULX LIMITED	**45.00%**

Please provide a separate table for each relevant licence and extend the table(s) if necessary.

Section B: Project Information

B1 - Nature of Project

a) Please specify the name of the project.

Name: **HYNET CARBON DIOXIDE TRANSPORTATION AND STORAGE PROJECT - OFFSHORE**

b) Please specify the name of the ES (if different from the project name).

Name: **AS ABOVE**

c) Please provide a brief description of the project.

The Project involves the repurposing of the existing offshore natural gas import pipeline from Point of Ayr (PoA) Gas Terminal to become an export pipeline to transport CO_2 to the newly constructed Douglas Carbon Capture and Storage (CCS) platform, and onwards to the Hamilton Main, Hamilton North, and Lennox platforms for injection into the depleted oil and gas reservoirs. The Project is located entirely within the 12 nm limit of both Welsh and English territorial waters and will include:

- installation of a new Douglas CCS platform to replace the existing Douglas Process platform to receive CO_2 from the onshore PoA Terminal and distribute CO_2 to the Hamilton Main, Hamilton North, and Lennox wellhead platforms;
- utilisation of the existing Hamilton Main, Hamilton North, and Lennox reservoirs for the injection of 109 Mt of CO_2 for permanent geological storage.
- drilling and re-completion of injection and monitoring wells by side-tracking existing production wells.
- installation of new sections of pipeline to connect the new Douglas CCS platform and the existing subsea natural gas pipelines.
- installation of new topsides on the Hamilton Main, Hamilton North, and Lennox wellhead platforms.
- installation of two submarine 33kV power cables, with integrated fibre-optic cable connections from PoA Terminal onshore to the modified Douglas platform, and onward connections to the three satellite platforms.

B2 - Project Location

a) Please indicate the offshore location(s) of the main project elements (for pipeline projects please provide information for both the start and end locations).

Quadrant number(s): **110**

Block number(s): **The Project will be undertaken within the carbon dioxide storage license area CS004, including within Offshore Licensed Blocks 110/13a, 110/13b, 110/14a, 110/14c, and 110/15a.**

Latitude: Longitude (W / E):

Point	Latitude (DDM)	Longitude (DDM)
A	53° 41' 00" N	3° 37' 00" W
B	53° 41' 00" N	3° 07' 00" W
C	53° 35' 00" N	3° 07' 00" W
D	53° 35' 00" N	3° 21' 00" W

E	53° 33' 00" N	3° 21' 00" W
F	53° 33' 00" N	3° 23' 00" W
G	53° 28' 00" N	3° 23' 00" W
H	53° 28' 00" N	3° 37 00" W
I	53° 41' 00" N	3° 37 00" W

Distance to nearest UK coastline (km): **2**

Which coast? **England**

Distance to nearest international median line (km) **111**

Which line? **UK/Ireland**

B3 - Previous Applications

If the project, or an element of the project, was the subject of a previous consent application supported by an ES, please provide details of the original project.

Name of project: **None**

Date of submission of ES: **None**

Identification number of ES: **None**

Document status					
Version	**Purpose of document**	**Authored by**	**Reviewed by**	**Approved by**	**Date**
FINAL	Final	RPS	Eni UK Ltd	Eni UK Ltd	February 2024

Prepared by:

RPS

Prepared for:

Liverpool Bay CCS Limited

Liverpool Bay CCS Ltd

HYNET CARBON DIOXIDE TRANSPORTATION AND STORAGE PROJECT - OFFSHORE

Environmental Statement
Volume 1, chapters 1 to 5: Introductory Chapters

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Glossary

Term	Meaning
"Do Nothing" Scenario	The environment as it would be in the future should the proposed project not be developed.
Baseline	The existing conditions as represented by the latest available survey and other data which is used as a benchmark for making comparisons to assess the impact of the Proposed Development.
CCS	Integrated process of three stages: capture of CO_2 from power stations and large industrial sources; transporting CO_2 to a storage site; and permanent storage of CO_2 in deep geological features.
Climate Change	A change in global or regional climate patterns, in particular a change apparent from the mid to late 20th century onwards and attributed largely to the increased levels of atmospheric CO_2 produced by the use of fossil fuels.
Climate Emergency	A situation in which urgent action is required to reduce or halt climate change and avoid potentially irreversible environmental damage resulting from it.
Cumulative Effect Assessment	Assessment of the likely effects arising from the offshore components of the HyNet CO_2 Transportation and Storage Project ('Proposed Development') alongside the likely effects of other development activities in the vicinity of the Proposed Development.
Effect	The consequence of an impact.
EIA Directive	European Union Directive 2011/92/EU of 13 December 2011 (as amended in 2014 by Directive 2014/52/EU).
EIA Regulations	Collectively the term used to refer to The Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020; and The Marine Works (Environmental Impact Assessment Regulations) 2007 (as amended).
Embedded Mitigation Measures	Mitigation measures to avoid or reduce environmental effects that are directly incorporated into the design of the Proposed Development.
Emissions	An amount of a substance that is produced and sent out into the air that is harmful to the environment, especially CO_2.
English Inshore Waters	English waters within 12 nm from the English coast.
English Offshore Waters	English waters beyond 12 nm from the English coast.
Environmental Impact Assessment	A statutory process by which certain planned projects must be assessed before a formal decision to proceed can be made. It involves the collection and consideration of environmental information, which fulfils the assessment requirements of the Environmental Impact Assessment Directive and Environmental Impact Assessment Regulations, including the publication of an Environmental Statement.
Environmental Statement	The document presenting the results of the Environmental Impact Assessment process for the Proposed Development.
European Protected Species	European Protected Species (such as cetaceans, marine turtles and otters) receive full protection under The Conservation of Species and Habitats Regulations 2010.
Favourable Conservation Status	Describes the situation in which a habitat or species is thriving throughout its natural range and is expected to continue to thrive in the future.
Fossil Fuel	A hydrocarbon containing material formed naturally in the earth's crust from the remains of dead plants and animals.
Greenhouse Effect	The trapping of the sun's warmth in a planet's lower atmosphere, due to the greater transparency of the atmosphere to visible radiation from the sun than to infrared radiation emitted from the planet's surface.
Greenhouse Gas	A gas that absorbs and emits radiant energy within the thermal infrared range, causing the greenhouse effect. Examples include carbon dioxide and methane.
Habitat	The environment that a plant or animal lives in.
Impact	A change that is caused by an action.

Term	Meaning
International Commitments	Commitments made publicly on the international level.
Inter-related Effects	Interrelationships between ES topics that may lead to environmental effects.
Magnitude	A combination of the extent, duration, frequency and reversibility of an impact.
Major Significance	These beneficial or adverse effects are considered to be important considerations and are likely to be material in the decision-making process.
Marine Licence	The Marine and Coastal Access Act 2009 requires a marine licence to be obtained for licensable marine activities. In addition, licensable activities within 12 nm of the Welsh coast require a separate marine licence from Natural Resource Wales.
Marine Spatial Planning	A public process of analysing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic and social objectives that have been specified through a political process.
Maximum Design Scenario	The maximum design parameters of the Proposed Development considered to be a worst case for any given assessment but within the range of the Project Description Envelope.
Mean High Water Spring	The highest level reached by the sea at high tide during mean high water spring tide. This is defined as the average throughout the year, of two successive high waters, during a 24-hour period in each month when the range of the tide is at its greatest.
Mean Low Water Spring	The lowest level reached by the sea at low tide during mean low water spring tide. This is defined as the average throughout the year, of two successive low waters, during a 24-hour period in each month when the range of the tide is at its greatest.
Minor Significance	These beneficial or adverse effects are generally, but not exclusively, raised as local factors. They are unlikely to be critical in the decision making process, but are important in enhancing the subsequent design of the project.
Mitigation Measure	Measure which would avoid, reduce, or remediate an impact.
National Policy Statement	A document setting out national policy for the energy infrastructure against which proposals are assessed and decided upon.
Net Zero	A target of completely negating the amount of greenhouse gases produced by human activity either worldwide or by a country or organisation, to be achieved by reducing emissions and implementing methods of absorbing carbon dioxide from the atmosphere.
Policy	A set of decisions by governments and other political actors to influence, change, or frame a problem or issue that has been recognized as in the political realm by policy makers and/or the wider public.
Project	The HyNet Carbon Dioxide Transportation and Storage Project.
Project Design Envelope	Also known as the Rochdale Envelope, the Project Design Envelope concept is routinely utilised in both onshore and offshore planning applications to allow for some flexibility in design options, particularly offshore, and more particularly for foundations and turbine type, where the full details of the project are not known at application submission but where sufficient detail is available to enable all environmental impacts to be appropriately considered during the Environmental Impact Assessment.
Project Lifetime Effects	Effects that occur throughout more than one phase of the project (construction, operations and maintenance, and decommissioning) interacting to potentially create a more significant effect upon a receptor than if just assessed in isolation in a single phase.
Proposed Development	The offshore components of the Project which are subject of this Environmental Statement, as described in volume 1, chapter 3.
Protected Species	A species of animal or plant which it is forbidden by law to harm or destroy.
Receptor	A component of the natural or man-made environment that is potentially affected by an impact.
Receptor-led Effects	Effects that interact spatially and/or temporally resulting in inter-related effects upon a single receptor.

Term	Meaning
Residual Impact	Residual impacts are the final impacts that occur after the proposed mitigation measures have been put into place, as planned.
Scoping Opinion	Sets out the Secretary of State's response to the Applicants Scoping Report and contains the range of issues that the Secretary of State, in consultation with statutory stakeholders, has identified should be considered within the Environmental Impact Assessment.
Special Protection Area	A site designation specified in the Conservation of Habitats and Species Regulations 2017, classified for rare and vulnerable birds, and for regularly occurring migratory species. Special Protection Areas contribute to the national site network.
The Applicant	This is Liverpool Bay CCS Ltd.
Topsides	Surface structures and equipment placed on a supporting structure to provide some or all of a platform's functions.
Transboundary Effects	Impacts from a project within one state affect the environment of another state(s).
Welsh Inshore Waters	Welsh waters within 12 nm of the Welsh coast.
Welsh Offshore Waters	Welsh waters beyond 12 nm from the Welsh coast.

Acronyms and Initialisations

Acronym/Initialisation	Description
3D	Three-Dimensional
4D	Four-Dimensional
ADD	Acoustic Deterrent Device
AfL	Agreement For Lease
APM	Association For Project Management
BEIS	The Department For Business, Energy and Industrial Strategy, Now Replaced By The Department For Energy Security And Net Zero.
BSI	British Standards Institute
CCC	Climate Change Committee
CCS	Carbon Capture and Storage
CCUS	Carbon Capture, Usage and Storage
CEA	Cumulative Effect Assessment
CEFAS	Centre For Environment, Fisheries And Aquaculture Science
CEng	Chartered Engineer
CEnv	Chartered Environmentalist
CIEEM	Chartered Institute Of Ecology And Environmental Management
CLV	Cable Lay Vessel
CM	Corrective Measures
CO_2	Carbon Dioxide
CoCP	Code of Construction Practice
COP	Conference of the Parties
CP	Chemical Permit
CSci	Chartered Scientist
CS-SSGS	CO_2 Sequestration In Sub-Seabed Geological Structures
CtL	Consent To Locate

Acronym/Initialisation	Description
DA	Douglas Accommodation
DAERA	Department Of Agriculture, Environment And Rural Affairs Of Northern Ireland
DCO	Development Consent Order
DD	Douglas Deck
DECC	The Department Of Energy And Climate Change, Merged With The Department For Business, Innovation And Skills, To Form The Department For Business, Energy And Industrial Strategy
DEFRA	Department For Environment, Food And Rural Affairs
DESNZ	The Department For Energy Security And Net Zero, Preceded By The Department For Business, Energy, And Industrial Strategy (2016 To 2023) And The Department Of Energy And Climate Change (2008 To 2016)
DMRB	Design Manual For Roads And Bridges
DP	Decommissioning Programme
DR	Drilling Operations
DW	Douglas Wellhead
EA	Environmental Appraisal
EAJ	Environmental Assessment Justification
EBS	Environmental Baseline Survey
EC	European Commission
EcIA	Ecological Impact Assessment
EEA	European Economic Area
EIA	Environmental Impact Assessment
EMF	Electromagnetic Field
EMP	Environmental Management Plan
Eni	Eni UK Limited
EPC	Engineering Procurement Construction
EPS	European Protected Species
ES	Environmental Statement
ESD	Emergency Shut Down
EU	European Union
FEED	Front End Engineering Design
FO	Fibre Optic
FSL	Floating Shear Legs
G&G	Geophysical and Geotechnical
GHG	Greenhouse Gas
GISZ	Gas Importation And Storage Zone
H_2S	Hydrogen Sulphide
HazMat	Hazardous Materials
HDD	Horizontal Directional Drilling
HLV	Heavy Lift Vessel
HRA	Habitats Regulations Assessment
HVAC	Heating, Ventilation, And Air Conditioning

Acronym/Initialisation	Description
IEMA	Institute Of Environmental Management And Assessment
IES	Institution Of Environmental Sciences
INNS	Invasive Non-Native Species
IOA	Institute Of Acoustics
IPCC	Intergovernmental Panel On Climate Change
IROPI	Imperative Reasons Of Overriding Public Interest
ISP	Irish Sea Pioneer
JNCC	Joint Nature Conservation Committee
JT	Joule-Thompson
LAT	Lowest Astronomical Tide
LBA	Liverpool Bay Area
LCA/SCA	Landscape And Seascape Character Assessment
LDAR	Leak Detection And Repair
LSE	Likely Significant Effects
MAT	Master Application Template
MCAA	Marine And Coastal Access Act
MD	Measured Depth
MDS	Maximum Design Scenario
MHWS	Mean High Water Spring
MLWS	Mean Low Water Spring
MMMP	Marine Mammal Mitigation Protocol
MMO	Marine Management Organisation
MMV	Monitoring, Measuring And Verification
MPS	Marine Policy Statement
MSV	Multi-Purpose Supporting Vessels
NDCs	Nationally Determined Contributions
NE	Natural England
NORM	Naturally Occurring Radioactive Material
NPS	National Policy Statement
NRA	Navigational Risk Assessment
NRP	Natural Resources Policy
NRW	Natural Resources Wales
NRW-MLT	Natural Resources Wales – Marine Licencing Team
NSTA	North Sea Transition Authority, Known As The Oil And Gas Authority Until March 2022.
NUI	Normally Unmanned Installation
OGA	Oil And Gas Authority, Replaced By The North Sea Transition Authority In March 2022
OP	Offshore Platform
OPRED	Offshore Petroleum Regulator For Environment and Decommissioning
P&A	Plugged And Abandoned
PAD	Protocol For Archaeological Discoveries
PDE	Project Design Envelope

Acronym/Initialisation	Description
PINS	The Planning Inspectorate
PoA	Point Of Ayr
POB	People On Board
PWA	Pipeline Works Authorisation
RBMP	River Basin Management Plan
RIAA	Report To Inform Appropriate Assessment
RTPI	Royal Town Planning Institute
SAT	Subsidiary Application Template
SMP	Shoreline Management Plan
SPA	Special Protection Area
SSC	Suspended Sediment Concentrations
T&I	Transportation And Installation
TCPA	Town And Country Planning Act
TDP	Touch Down Point
TVD	True Vertical Depth
UK	United Kingdom
UK ETS	UK Emissions Trading Scheme
UNECE	United Nations Economic Commission For Europe
UNFCCC	United Nations Framework Convention On Climate Change
UXO	Unexploded Ordnance
VSP	Vertical Seismic Profile
WAG	Welsh Assembly Government
WCA	Wildlife And Countryside Act
WFD	Water Framework Directive
WNMP	Welsh National Marine Plan
WSI	Written Scheme Of Investigation
WSW	West South West
ZOD	Zone Of Disturbance
ZOI	Zone Of Influence

Units

Unit	Description
%	Percent
“	Inch (distance; equal to 0.0254 m)
°C	Degrees Celsius (temperature)
Hz	Hertz (frequency)
km	Kilometres (distance)
km^2	Kilometres squared (area)
kV	Kilovolt (electrical potential)
kW	Kilowatt (power)
m	Metres (distance)

Unit	Description
m^2	Metres squared (area)
m^3	Metres cubed (volume)
Mt	Million tonnes (weight)
MW	Megawatt (power)
nm	Nautical Mile (distance; equal to 1.852 km)

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1 INTRODUCTION

1.1 Overview

Eni UK Limited (Eni), whose ultimate parent company is Eni SpA, is a leading partner of the Consortium delivering the HyNet North West Project, through their Eni group affiliate Liverpool Bay CCS Limited ('the Applicant'). The Applicant is developing the HyNet Carbon Dioxide Transportation and Storage Project (hereafter referred to as 'the Project'). The aim of the Project is to reduce carbon dioxide (CO_2) emissions from industry, homes, and transport and support economic growth in the North West of England and North Wales. The Project will include infrastructure to produce and distribute low carbon hydrogen. The hydrogen is produced using natural gas, with the resultant CO_2 emissions captured and stored. A schematic of the HyNet CO_2 Transportation and Storage Project (orange line), within the HyNet North West Project, is illustrated in Figure 1.1.

As part of the offshore components of the Project (hereafter referred to as the 'Proposed Development'), the existing offshore natural gas import pipeline from Point of Ayr (PoA) Gas Terminal will be repurposed to become a CO_2 export pipeline and will transport the CO_2 to the newly constructed Douglas Carbon Capture and Storage (CCS) platform. From the Douglas CCS platform, CO_2 will be transported along re-purposed natural gas pipelines to the Hamilton Main platform for injection into the Hamilton Main reservoir, to the Hamilton North platform for injection into the Hamilton North reservoir, and to the Lennox platform for injection into the Lennox reservoir. The Proposed Development will also require new electrical and fibre optic (FO) transmission infrastructure seawards of Mean High Water Spring (MHWS), connecting the PoA Terminal to the offshore infrastructure. The concept of the Proposed Development is illustrated in Figure 1.2.

This Offshore Environmental Statement (ES) supports the following permit, and licence applications being sought by the Applicant for the Proposed Development:

- a Marine Licence under the Marine and Coastal Access Act (MCAA) 2009 (administered by Natural Resources Wales Marine Licensing Team (NRW-MLT) for licensable activities in Welsh Waters (between 0 and 12 nautical miles (nm) from MHWS) (i.e. all licensable activities associated with installation of the new Douglas CCS platform, associated pipeline connections, new electrical and fibre optic cables, and related works within Territorial Waters); and
- a Storage Permit from the North Sea Transition Authority (NSTA), in accordance with the Storage of Carbon Dioxide (Licensing etc.) Regulations 2010 (SI 2010/2221) for the storage of carbon dioxide at a storage site in the licensed area (licence reference CS004). Prior to the issue of a Storage Licence the Offshore Petroleum Regulator for Environment & Decommissioning (OPRED) must approve the ES.

The Environmental Impact Assessment (EIA) Directive (2011/92/EU, as amended by Directive 2014/52/EU) has traditionally directed the assessment of effects of certain public and private projects on the environment in the United Kingdom (UK). Following the UK's departure from the European Union (EU), EU-derived legislation continues to have effect in domestic law under the European Union (Withdrawal) Act 2018. For this chapter (and throughout this offshore Environmental Statement), where legislation has been amended (for example, by EU Exit Amendment Regulations), following an initial acknowledgement of the amending legislation, the legislation is not referred to as amended.

This ES documents the EIA process and conclusions as carried out in support of applications for consent to develop the proposed HyNet Carbon Dioxide Transportation and Storage Project.

This chapter introduces the Proposed Development, summarises the consents and licences that are required for the proposed works, and outlines the content of the Offshore ES.

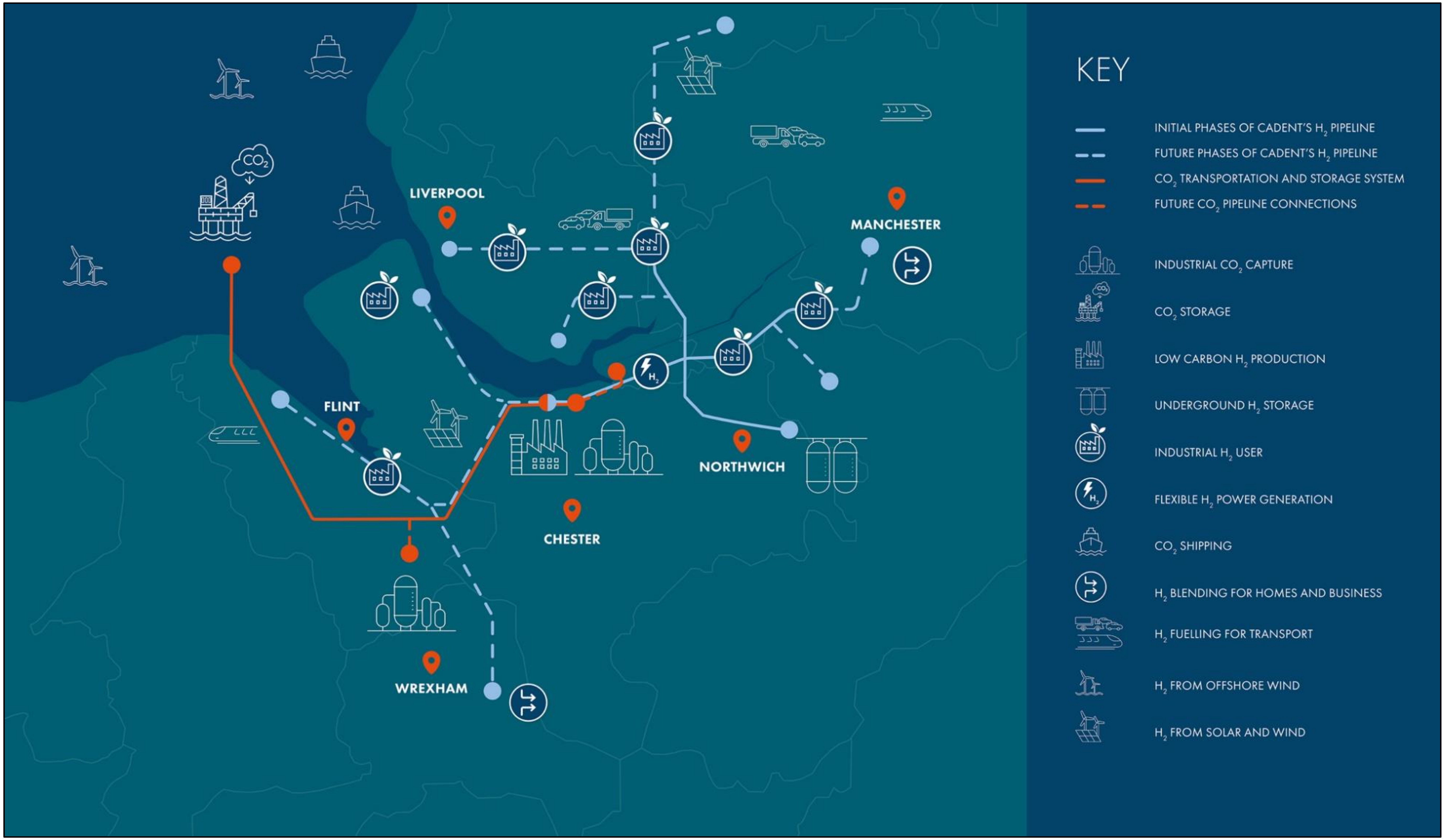

Figure 1.1: Illustrates The HyNet Carbon Dioxide Transportation And Storage Project Within The HyNet North West Project

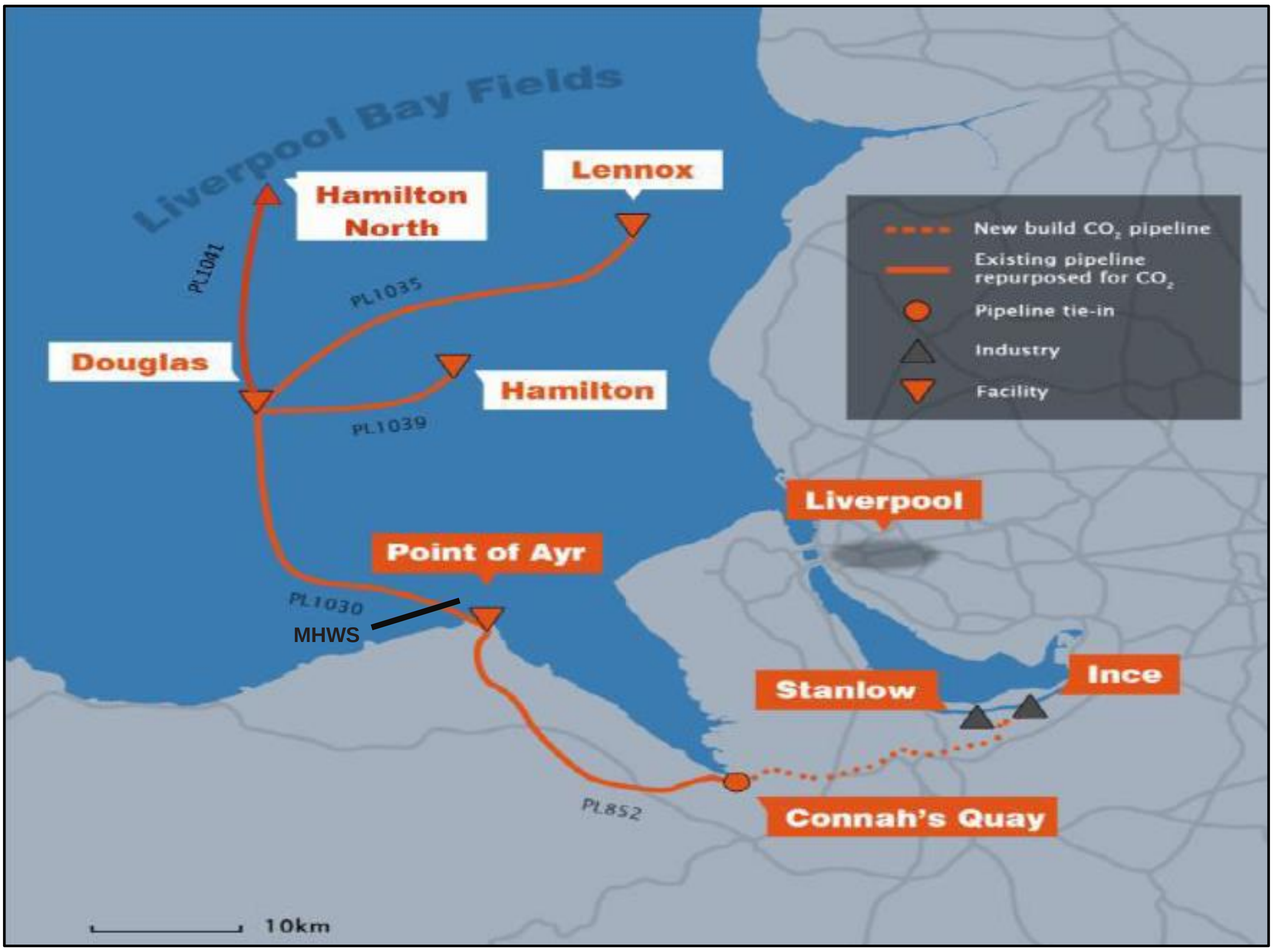

Figure 1.2: Illustrates The Concept Of The Proposed Development (Infrastructure Seawards MHWS)

1.2 The Proposed Development

An overview of the Project is outlined in the paragraphs below, the full Proposed Development description is provided in volume 1, chapter 3.

The Proposed Development is located entirely within the 12 nm limit of both Welsh and English territorial waters and will include:

- installation of a new Douglas CCS platform to replace the existing Douglas Process platform to receive CO_2 from the onshore PoA Terminal and distribute CO_2 to the Hamilton Main, Hamilton North, and Lennox wellhead platforms and when necessary, provide heating. Installation of the new Douglas CCS platform will include up to eight driven piles;
- installation of new topsides on the Hamilton Main, Hamilton North, and Lennox wellhead platforms to receive and inject CO_2 into the depleted hydrocarbon reservoirs;
- repurposing of the existing subsea natural gas pipelines for their change of use from hydrocarbon to CO_2 service;
- installation of new sections of pipeline to connect the new Douglas CCS platform to the existing subsea natural gas pipelines;
- development of the Hamilton Main, Hamilton North, and Lennox reservoirs for the injection of around 109 Mt of CO_2 over a 25-year period for permanent geological storage. The storage would be divided between the three reservoirs, as follows: Hamilton Main, 53 Mt; Hamilton North, 18 Mt; and Lennox 38 Mt.

This will be done through up to eight injection wells created by side tracking of existing production wells. This includes drilling and recompletion operations, all of which will be within the existing footprint (template) of each platform;

- implementation of a programme of Monitoring ,Measurement and Verification (MMV) activities; the Monitoring Plan. This includes the drilling of two new monitoring wells, one at Hamilton North and one at Hamilton Main. Additional monitoring wells will be created from the recompletion of existing wells within the existing footprint (template) of each platform: one monitoring well created by side-tracking an existing well in Lennox; and two sentinel wells, one in Hamilton North and one in Lennox;
- installation, including cable burial, and some dredging, of two submarine 33 kV armoured cables, with integrated FO cable connections (35 km from PoA Terminal onshore to the new Douglas CCS platform, including within the intertidal/foreshore area up to MHWS, within Welsh waters only);
- installation, including cable burial, of new power cables with integrated FO connecting the new Douglas CCS platform with the Hamilton Main (12 km; 33 kV), Hamilton North (15 km; 33 kV) and Lennox (35 km; 33 kV) platforms; and
- installation of concrete mattresses and external cable protection at crossings of existing cables, and in areas where cable burial is not deemed feasible, or as a remedial secondary protection measure if the target cable depth of lowering cannot be achieved.

A ‘Project Design Envelope’ (PDE) approach has been adopted that takes into account Planning Inspectorate Advice Note Nine: Rochdale Envelope, July 2018 (PINS, 2018). The provision of a PDE is intended to identify key parameters to enable the environmental assessment to be carried out whilst retaining enough flexibility to accommodate further refinement during detailed design, and installation. Further details on the use of the PDE parameters for each of the project elements described above are presented in volume 1, chapter 3.

To support the Proposed Development, several site surveys were caried out between October 2022 and May 2023, including:

- Environmental Baseline Survey (EBS) to inform the Offshore EIA;
- Geophysical and Geotechnical (G&G) survey to inform the Offshore cable routes design;
- surveys to inform the Monitoring Plan, including seismic, bathy-morphological surveys and environmental monitoring; and
- pipeline inspection and facilities integrity surveys.

The site surveys were consented with separate permits (Marine Licenses), accompanied by an Environmental Assessment Justification (EAJ) proportionate to the works within the scope of the surveys, where required.

To support the Proposed Development, the existing offshore infrastructure that will no longer be required for the transport and storage of CO_2, will be decommissioned. This will include removal of the existing Douglas offshore platforms (OPs), and the plugging and abandonment (P&A) of existing wells. These decommissioning activities will be consented with separate permits, upon submission of a Decommissioning Programme (DP), including an Environmental Appraisal (EA) proportionate to the works within the scope of the DP.

The proposed activities will be undertaken within the carbon storage license area (CS004), including within Offshore Licensed Blocks 110/13a, 110/13b, 110/14a, 110/14c and 110/15a. The location overview of the Proposed Development is provided in Figure 1.3.

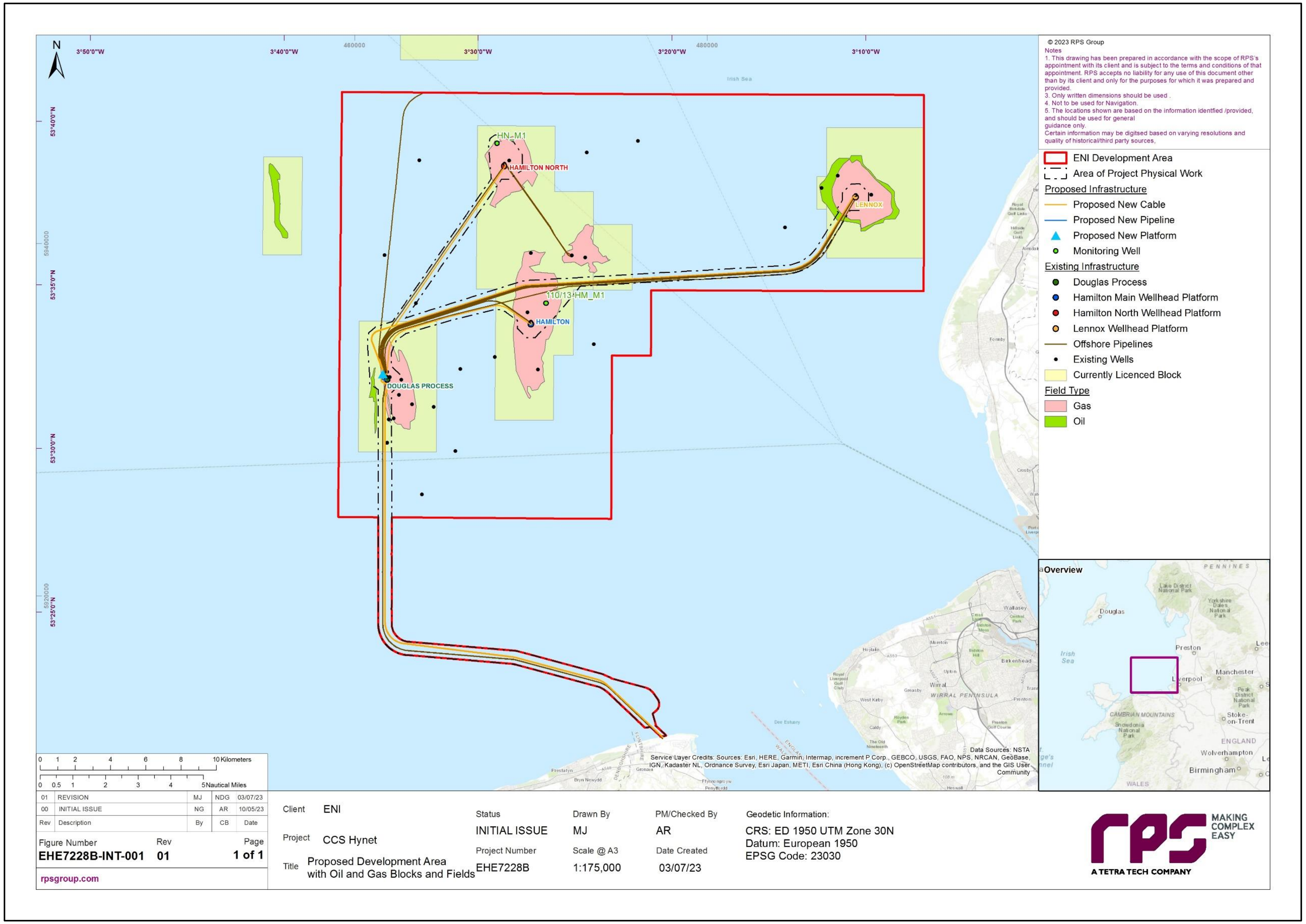

Figure 1.3: Location of the Proposed Development and Eni Development Area overview

1.3 Environmental Impact Assessment

1.3.1 Offshore and onshore EIA

The HyNet Carbon Dioxide Transportation and Storage Project has both Onshore and Offshore elements.

The Onshore elements were supported by two separate ESs:

- an ES to support the Development Consent Order (DCO) application for the HyNet Carbon Dioxide Pipeline DCO. The ES for the HyNet Carbon Dioxide Pipeline DCO application was submitted in October 2022. National Infrastructure Planning Examination of the application started on the 20 March 2023 and closed on the 20 September 2023. The decision from the relevant Secretary of State (SoS) is expected in Q1/Q2 2024; and
- an ES to support the Town and Country Planning Act (TCPA) applications for the HyNet Carbon Dioxide Pipeline TCPA, these covering the elements located in Wales only. An EIA Scoping Report for the HyNet Carbon Dioxide Pipeline TCPA applications was submitted in July 2021 and the EIA Scoping Opinion received in August 2021. Consultation on the ES closed in December 2022 and the planning applications were submitted on the 10 March 2023. The TCPA applications were approved by Flintshire County Council (FCC) on 10^{th} January 2024.

The Onshore elements of the HyNet Carbon Dioxide Transportation and Storage Project are outside the scope of this Offshore ES, which relates to those impacts from the infrastructure seawards of MHWS. The onshore ES for the TCPA application relates to those impacts from infrastructure landwards of Mean Low Water Spring (MLWS) and therefore there is an overlap in assessment within the intertidal area (between MHWS and MLWS).

Where there is an overlap in jurisdiction in the intertidal area between MHWS and MLWS of the Offshore and Onshore consenting and regulatory regimes, both the Offshore ES and the Onshore ES present the relevant technical assessments. Within this Offshore ES, 'Offshore' generally refers to the receptors on the seaward side of MHWS and 'Onshore' refers to the receptors on the landward side of MHWS.

1.3.2 Purpose of the offshore EIA

This report is intended as a single overarching Offshore ES that serves the requirements of all consenting authorities for the Offshore elements, to support the following applications:

- **Storage Permit application**, following requirements defined in License CS004, for the use of the depleted hydrocarbon reservoirs within the Liverpool Bay area for the storage of CO_2, including the carbon dioxide pipeline/transportation and injection facilities offshore. The Storage Permit application includes a Carbon Storage Development Plan, which also contains a detailed description of each storage site and complex, and associated injection facilities.
- **Marine Licence application**, for all licensable activities associated with installation of the new Douglas CCS platform, associated pipeline spool connections, new electrical and FO cables, and related works, located in Welsh waters.

The Offshore ES provides a description of the Proposed Development and presents the environmental information that has been gathered to carry out an assessment of the likely significant environmental effects of the Proposed Development (seaward of MHWS) on the receiving environment.

The Offshore ES specifically:

- provides statutory and non-statutory consultees with technical information to facilitate understanding of the Proposed Development;
- presents the existing environmental baseline information, established from desktop studies, site-specific surveys, and/or consultation;

- describes the EIA methodology used for the assessments;
- presents the likely significant environmental effects arising from the Proposed Development, based on baseline information and data gathered, and the analysis and impact assessments completed as part of the EIA process;
- outlines any limitations encountered during the compilation of the environmental information, including where any data gaps or deficiencies exist, and the level of confidence in the information gathered;
- suggests designed in mitigation measures to avoid, prevent, reduce or, where possible, offset any identified significant adverse effects on the environment, and where appropriate, proposed monitoring arrangements to validate findings of the EIA (see also Section 3.5.1.2). Where additional mitigation measures have been identified, the residual significance of effect has also been presented; and
- provides a description of the reasonable alternatives considered for the Proposed Development, and an indication of the main reasons for site, route, and concept selection.

The Non-Technical Summary (NTS) provides an overview, in non-technical language, of the findings of the Offshore ES.

1.3.3 Scope of the assessment

On 30 September 2022, the Applicant submitted a HyNet Carbon Dioxide Transportation and Storage Project – Offshore EIA Scoping Report to OPRED to support a request for a formal Scoping Opinion from in relation to HyNet Carbon Dioxide Transportation and Storage Project – Offshore EIA Scoping Report (Liverpool Bay CCS Limited, 2022). The intention at this time was that the Douglas OP would be repurposed, but this concept has been replaced by the proposed installation of a new Douglas CCS platform. The Scoping Opinion for HyNet Carbon Dioxide Transportation and Storage Project – Offshore project was received on 27 January 2023, which helped inform the proposed scope of the current assessment for the Proposed Development and guided the Applicant in progressing with the Offshore EIA.

The Scoping Opinion for the HyNet Carbon Dioxide Transportation and Storage Project – Offshore (OPRED, 2023) set out the proposed scope of the assessment and guided the Applicant in progressing with this Offshore ES. As far as responses provided are relevant to the Proposed Development, or the Applicant has been directed to refer to them, the Applicant has relied on these responses to guide the scope of this Offshore ES. Such responses are categorised within the term ‘relevant consultation undertaken to date’.

Based on the Scoping Opinion (OPRED, 2023) received and discussions with stakeholders, as well as consideration of the proposed new Douglas CCS platform, this Offshore ES focuses on the following topic areas:

- Physical Processes;
- Marine Biodiversity (Benthic Subtidal and Intertidal Ecology; Fish and Shellfish Ecology; and Marine Mammals);
- Ornithology;
- Shipping and Navigation;
- Commercial Fisheries;
- Marine Archaeology;
- Infrastructure and Other Sea Users;
- Climate Change; and
- Inter-Related Effects.

The topics Seascape, Landscape and Visual Resources, Aviation and Radar, and Air Quality have been scoped out of the EIA due to no likely significant effect in EIA terms or no effect-receptor pathways identified.

Justification for scoping out these topics is provided in RPS Group (2023a), Anatec and RPS Group, (2023a) and RPS Group (2023b). Major accidents and disasters have also been scoped out of the assessment because the Proposed Development is not seen as vulnerable to, or introducing, risks of major accidents and/or disasters. Furthermore, all possible major accidents and/or disasters are covered by design measures and compliance with legislation and best practice.

1.4 Need for the Proposed Development

Climate change is a global issue, resulting from greenhouse gas (GHG) emissions released into the atmosphere, largely due to human activity. Evidence of the effects of climate change include widespread and rapid changes in the atmosphere, ocean, cryosphere, and biosphere (IPCC, 2021).

The United Kingdom (UK) Parliament announced a climate change emergency in May 2019, publicly declaring concern over the findings around climate change and its consequences. The Climate Change Act 2008 (2050 Target Amendment) Order 2019 introduced a legally binding commitment that the net UK carbon account for the year 2050 must be at least 100% lower than the 1990 baseline i.e. 'net zero'. The Committee on Climate Change (CCC10) concluded that net zero is (CCC, 2019):

- **necessary** to respond to the overwhelming evidence of the role of GHGs in driving global climate change;
- **feasible** as the technologies and approaches to deliver net zero are understood and can be implemented with strong government leadership; and
- **cost-effective** given the falls in the costs of key technologies that permit net zero.

To achieve the UK Net Zero target, it is thought that industrial emissions in the UK will need to reduce by at least two thirds by 2035, and at least 90% by 2050, and to achieve this, the deployment of carbon capture and storage (CCS) is essential (CCC, 2019). CCS refers to a set of processes that capture CO_2 from waste gases produced at industrial or power generation facilities and permanently store it in offshore geological storage sites. CCS is proven technology and is already in use around the world (Global CCS Institute, 2021).

Forecasts of the UK's future energy scenarios require CCS to be utilised with industrial processes where there are limited available alternatives to fossil fuels e.g. producing steel, concrete, and chemicals (BEIS, 2022a; IEA, 2020). Power plants with CCS provide reliable lower carbon generation capacity and are intended to reduce emissions compared to unabated plants by 90% or more. Power plants equipped with post-combustion CCS could provide flexible generation that is able to ramp up or down to meet demand and balance variable generation from renewable electricity sources (National Grid, 2020).

In November 2020, the UK Government published the Ten Point Plan for a Green Industrial Revolution, to decarbonise the economy with commitments focused on driving innovation, boosting export opportunities, and generating green jobs and growth across the country to level up regions of the UK. Included in the Plan was the first UK commitment to deploy CCS in two industrial clusters by the mid-2020s, and a further two clusters by 2030 with an ambition to capture 10 million tonnes per annum (MtPA) CO_2 by 2030 (UK Government, 2020). The UK Government is committed to investing up to £1 billion to support the establishment of CCS in four industrial clusters in areas such as the North West, Wales, the Humber, North East, and Scotland (UK Government, 2021). CCS infrastructure is needed to decarbonise the industrial areas of the North West proposed by HyNet.

As part of encouraging CCS cluster development, the Government established a cluster sequencing process in February 2021, which seeks to provide industry with the certainty to deploy the technology at pace and at scale (BEIS, 2021a). In October 2021, the UK Government published the UK Net Zero Strategy, which set out to at least double the commitments from the UK Government's Ten Point Plan by aiming to capture between 20 and 30 MtPA of CO_2. In the same month, the Department for Business, Energy and Industrial Strategy (BEIS) (now the Department for Energy Security and Net Zero (DESNZ)) confirmed two Track-1 clusters, i.e. clusters expected to be operational by mid-2020s and having the first opportunity to receive support from the government's CCS Programme.

HyNet is one of the two selected Track-1 clusters and includes the Proposed Development (Section 1.2). The Proposed Development aims to transport and store around 4.5 MtPA CO_2, and 109 Mt by the end of the 25-year life of the Proposed Development. Achieving these aims bolsters the UK's leadership in the energy transition and the emerging global low-carbon and hydrogen market and plays a major role in the desire to level up across the country. The Development is critical to delivery of the wider HyNet Project by providing the onshore and offshore infrastructure for transporting CO_2 from the industrial emitters in the North West of England to the Liverpool Bay storage sites.

1.5 Statutory Consents and Permissions

The Project is located within the jurisdictions of England and Wales; therefore, the Offshore ES will be submitted to two regulators: NRW-MLT for the Marine Licence Application in Wales; and OPRED, who will approve the ES for the Storage Permit Application to the NSTA covering England and Wales.

Further details of the other consents that will be required, consenting process, and legislation that the Project will comply with is provided in volume 1, chapter 2.

1.6 The Applicant

The Applicant is an integrated energy company committed to developing a fully decarbonised portfolio of products and services by 2050, creating value for their stakeholders and contributing to a socially just energy transition (Eni, 2021). As a global energy company, Eni is active at every stage of the value chain, from natural gas and oil to co-generated electricity and renewables.

1.7 The EIA Team

Eni UK Limited (Eni) has engaged the services of RPS ('the Environmental Consultants'), who are competent and experienced experts in the field of offshore EIA, to carry out an EIA in respect of the Proposed Scheme and to prepare this ES. In accordance with the Regulation 12(2)(f), (g) of The Marine Works (EIA (England and Wales) Regulations 2007 (as amended) (the '2007 EIA Regulations'), Eni confirms that to the best of their knowledge and belief, the Environmental Consultants are competent experts within the meaning of the 2007 EIA Regulations. This belief is based on the Environmental Consultants' relevant expertise, qualifications, and level of experience in preparing environmental statements. The evidence of the Environmental Consultants' competence is demonstrated in Table 1.1.

Table 1.1: Qualifications And Experience Of The Offshore EIA Competent Experts Responsible For The Preparation Of The ES

Role	Qualifications
EIA Project Director	• RPS Associate Director with 20+ years' experience in the environmental sector. • BSc Joint Hons (2:1) Botany and Marine Biology, University of Wales, Bangor, MSc Marine Resource Management, Heriot-Watt University, Graduate Certificate, Environmental Studies, Strathclyde University. • Full Member, The Institution of Environmental Sciences (IES), Associate Member, Association for Project Management (APM), Affiliate Member, Institute of Environmental Management and Assessment (IEMA), Affiliate Member, Royal Town Planning Institute (RTPI).
EIA Project Manager	• RPS Principal Consultant with 20+ years' experience in the environmental sector. • M.Sc. Marine Resource Development and Protection, B.Sc. (Hons). Geology. • Full membership of IEMA, Chartered Environmentalist (Cenv).
EIA Assistant Project Manager	• RPS Senior Consultant with 11+ years' experience in the energy sector.

Role	Qualifications
	• MSc (Distinction) Environmental Partnership Management, University of Aberdeen, MSc Petroleum Engineering, Delft University of Technology, BSc Applied Earth Sciences, Delft University of Technology.
Physical Processes	• RPS Senior Engineer - Water Environment and Flood Risk Management. • PhD Computational Fluid Dynamics, Queen's University of Belfast, MSc Engineering Computation, Queen's University of Belfast, PGCHET Queen's University of Belfast, BEng (2:1 Hons.) Civil Engineering, University of Brighton. • Graduate member Institution of Civil Engineers, Registered Practitioner for Higher Education Academy (ILTHE).
Marine Biodiversity	• RPS Principal Consultant with 12+ years' experience in the environmental sector. • BSc (Hons) Marine Biology and Oceanography.
Ornithology	• RPS Senior Consultant with 4+ years' experience in the environmental sector. • BSc (Hons) in Zoology with Industrial Experience, University of Manchester, MPhil (Cantab) in Biological Science, University of Cambridge. • Associate Member of IMarEST.
Shipping and Navigation	• Anatec Ltd Principal Risk Analyst with 20+ years' experience. • BEng (Hons) in Chemical Engineering and an MSc in Information Technology Systems from the University of Strathclyde.
Commercial Fisheries	• Poseidon Aquatic Resources Management Ltd Director with 13+ years' experience. • B.Sc. Marine Biology (First Class Hons), University of Newcastle upon Tyne, B.Eng. Chemical Engineering (2:1 Hons), Edinburgh University.
Marine Archaeology	• MSDS Marine Ltd Director with 12+ years' experience in the maritime archaeology sector. • BSc (Hons) Marine Archaeology, Bournemouth University.
Infrastructure and Other Sea Users	• RPS Principal Consultant with 18+ years' experience. • MSc Environmental Science, BSc Ocean Sciences, Society for the Environment Cenv, Science Council Chartered Scientist (CSci), Energy Institute Member, IEMA Affiliate Member.
Climate Change	• RPS Associate Director – EIA and Sustainability. • BSc (Hons) Geography and Environmental Sciences, MSc Sustainable Cities, BREEAM UK NC Assessor. • Practitioner Member of IEMA.
Air Quality	• RPS Principal Air Quality Consultant. • BSc (Hons) Environmental Science, MSc Environmental Pollution Control. • Member of the Institute of Air Quality Management (IAQM) and Associate Member of the Institute of Environmental Sciences.
Aviation and Radar	• Anatec Ltd Principal Risk Analyst with 20+ years' experience. • BEng (Hons) in Chemical Engineering and an MSc in Information Technology Systems from the University of Strathclyde.
Seascape, Landscape and Visual Resources	• RPS Director - Planning and Environment with 30+ years' experience in urban and rural design, and planning. • BSc (Hons) Environmental Science, University of Ulster, Master of Landscape Architecture, University of Edinburgh. • Chartered Member of the Landscape Institute, Member of the Irish Landscape Institute, Practitioner Member of IEMA.
Underwater Noise	• Seiche Specialist Acoustic Consultant with 24+ years' experience. • BSc (Hons) Physics University of Bristol. • Chartered Engineer (CEng) Institute of Acoustics (IOA), Member of IOA, Associate of the Acoustical Society of America.

1.8 Structure of the Offshore ES

The Offshore ES relates to those impacts and receptors associated with the offshore environment (seaward of MHWS), including potential impacts of offshore infrastructure on onshore and offshore receptors (i.e. impacts from infrastructure seaward of MHWS).

The Offshore ES is divided into four volumes:

- volume 1 – Introductory Chapters;
- volume 2 – Offshore ES Main Report; and
- volume 3 – Offshore ES Technical Reports; and

Table 1.2 provides a breakdown of the contents of each of the Offshore ES Report volumes and the organisations that have contributed to them. Topics are discussed in full within each chapter in a consistent and sequential manner (i.e. each environmental receptor chapter describes the baseline, impact assessment, mitigation measures, and conclusions for the receptor).

Table 1.2: Structure Of The Offshore ES

Chapter Number	Chapter Title	Lead Author
Non-Technical Summary		
-	Non-Technical Summary	RPS and The Applicant
Volume 1 – Introductory Chapters		
-	Glossary	RPS
-	Acronyms and Initialisations	RPS
-	Units	RPS
1	Introduction	RPS and The Applicant
2	Policy and Legislative Context	RPS and The Applicant
3	Proposed Development Description	RPS and The Applicant
4	Site Selection and Consideration of Alternatives	RPS and The Applicant
5	Environmental Impact Assessment Methodology	RPS
Volume 2 – Offshore ES Main Report		
6	Physical Processes	RPS
7	Marine Biodiversity	RPS
8	Ornithology	RPS
9	Shipping and Navigation	Anatec Ltd.
10	Commercial Fisheries	Poseidon Aquatic Resource Management Ltd.
11	Marine Archaeology	MSDS Marine Ltd.
12	Infrastructure and Other Sea Users	RPS
13	Climate Change	RPS
14	Inter-Related Effects	RPS
Volume 3 – Technical reports		
-	Enhancement, Mitigation and Monitoring Commitments	RPS and The Applicant
-	Navigational Risk Assessment (NRA) Report	Anatec Ltd.
-	Report to Inform Appropriate Assessment (RIAA)	RPS
-	Water Framework Directive (WFD) Assessment Report	RPS

In addition to the ES documents listed in Table 1.2, the following reports have been prepared by the Applicant while carrying out the EIA, all of which are referenced in the ES.

- EIA Scoping Report
- EIA Scoping Opinion
- Topics scoped out of assessment
- Marine Plan policies
- Cumulative Effects
- Transboundary Impacts Screening
- Physical Processes Technical Report
- Underwater Noise Technical Report
- Ornithology Baseline Report
- Ornithology Displacement Report
- Intertidal Ornithology Report
- Commercial Fisheries Technical Report
- Marine Archaeology Technical Report
- Greenhouse Gas Assessment
- Marine Biodiversity Technical Report
- Marine Biodiversity Subtidal Survey
- Marine Biodiversity Intertidal Survey

The following outline management plans have also been prepared by the Applicant while carrying out the EIA. These too are referenced in the ES.

- Environmental Management Plan (EMP)
- Marine Mammal Mitigation Protocol (MMMP)
- Invasive Non-Native Species (INNS) Plan
- Written Scheme of Investigation (WSI) and Protocol for Archaeological Discoveries (PAD)

1.9 Availability of the Offshore ES

The documents described in Table 1.2, and above, have been made publicly available online, giving all interested parties an opportunity to engage with the Proposed Development. The Offshore ES, including the non-technical summary, is available in English language in digital format at:

- **website:** https://hynethub.co.uk/.

1.9 References

Eni (2021) *Eni for 2021 – Carbon neutrality by 2050*. Available at: https://www.eni.com/assets/documents/eng/just-transition/2021/eni-for-2021-carbon-neutrality-2050-eng.pdf Accessed on September 2023.

Liverpool Bay CCS Limited (2022) *HyNet Carbon Dioxide Transportation and Storage Project - Offshore EIA Scoping Report*.

Liverpool Bay CCS Limited (2023) *HyNet Carbon Dioxide Pipeline TCPA - Onshore Environmental Statement*.

Offshore Petroleum Regulator for Environment and Decommissioning (OPRED) (2023). *Scoping Opinion for HyNet Carbon Dioxide Transportation and Storage Project - Offshore*.

The Planning Inspectorate (PINS) (2018) *Advice Note Nine: Rochdale Envelope.*

RPS Group (2023a) *Liverpool Bay CCS Ltd, HyNet Carbon Dioxide Transportation and Storage Project – Offshore Environmental Statement Volume 3, Air Quality Technical Report.*

Anatec and RPS Group (2023a) *Liverpool Bay CCS Ltd, HyNet Carbon Dioxide Transportation and Storage Project – Offshore Environmental Statement Volume 3, Aviation and Radar Technical Report.*

RPS Group (2023b) *Liverpool Bay CCS Ltd, HyNet Carbon Dioxide Transportation and Storage Project – Offshore Environmental Statement Volume 3, Seascape, Landscape and Visual Impact Assessment Technical Report.*

2 POLICY AND LEGISLATIVE CONTEXT

2.1 Introduction

This chapter of the Offshore Environmental Statement (ES) provides a summary of the policy and legislative context for the Proposed Development, specifically in relation to:

- international obligations and policy, including those derived from European legislation, relating to climate change, reducing Greenhouse Gas (GHG) emissions and the role of Hydrogen, and Carbon Capture and Storage (CCS);
- United Kingdom (UK) and Welsh climate change and energy policy and legislation;
- planning consents and environmental legislation, including the consent applications required for the construction, operation and maintenance, and decommissioning of the Proposed Development; and
- other legislation that may be relevant to the Proposed Development.

Policy and legislation relating to specific topics, particularly in respect to the impact assessment, is discussed in the relevant topic chapters of this Offshore ES.

The consents required are dictated by the location, nature and scale of the Proposed Development and the consenting requirements are explained with reference to different legislative requirements within inshore/offshore waters. Section 2.4 describes the consents and legislation relevant to the Proposed Development.

Throughout this Offshore ES, where legislation has been amended (for example, by European Union (EU) Exit Amendment Regulations), following an initial acknowledgement of the amending legislation, the legislation is referred to 'as amended'.

2.2 Climate change and energy policy and legislation

This section provides a summary of policy, legislation, and strategy in relation to the climate crisis and the role of CCS and low carbon hydrogen.

2.2.1 International commitments

Climate change and energy policy in the UK is underpinned by international commitments, which are summarised below.

2.2.1.1 United Nations Framework Convention on Climate Change

The United Nations Framework Convention on Climate Change (UNFCCC) came into force on 21 March 1994. Its objective was to achieve:

'*Stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system*' (United Nations, 1992).

To date, the UNFCCC has been ratified by 197 signatories, including the UK.

2.2.1.2 Kyoto Protocol

The UK is a signatory to the Kyoto Protocol, an international agreement for the implementation of the UNFCCC. The Kyoto Protocol commits industrialised countries and economies to limit and reduce GHG emissions in accordance with agreed individual targets. The protocol came into effect in 2005 and its commitments are transposed into UK law by the Climate Change Act 2008 (as amended).

The protocol initially placed a duty on the UK to ensure that the net UK carbon account for the year 2050 was 80% lower than the 1990 baseline. Due to increasing awareness of the need for more urgent action, this was revised to a '*net zero target*' of GHG emissions for the year 2050 to be 100% lower than the 1990 levels by the Climate Change Act 2008 (2050 Target Amendment) Order 2019.

2.2.1.3 The United Nations adoption of the Paris Agreement COP21

In December 2015, 195 countries adopted the first ever universal, legally binding global climate deal at the Paris climate conference (21st Conference of the Parties (COP)). The Paris Agreement (United Nations, 2015) seeks to reduce global GHG emissions and to limit the global temperature increase in this century to 2°C, while pursuing the means to limit this further to 1.5°C. This was ratified by the UK Government in November 2016 and now forms part of UK Government Policy.

2.2.1.4 The Glasgow Pact COP26

At the COP26 summit in November 2021, nearly 200 parties voted to adopt the Glasgow Climate Pact (UNFCCC, 2021). This included commitments to phase down the use of coal and supports a common timeframe and methodology for national commitments on emissions reductions. Countries were tasked to return in 2022 with more ambitious 2030 emissions reductions targets.

2.2.2 European legislation

2.2.2.1 EU exit

On 31 January 2020, the UK formally left the EU after triggering article 50 of the Lisbon Treaty (EU Exit). After leaving the EU, the UK Government has committed, as a minimum, to implement international environmental obligations in accordance with the EU (Withdrawal) Act 2018 and to maintain environmental commitments made and legislation enacted following the departure of the UK from the EU (HM Government, 2018).

On this basis, the existing EU Climate Change Act 2008 will remain applicable. However, new EU legislation or updates to existing directives will not be required to be transposed into UK law.

Where specific EU Exit legislation has been implemented to ensure legislative instruments continue to operate in a similar way after EU Exit Day, these are discussed in this chapter.

2.2.3 UK climate change and energy policy and legislation

The UK has several policies relating to climate change and energy, a summary of which is provided below.

2.2.3.1 The Climate Change Act 2008 (as amended)

Under the Climate Change Act 2008, the UK committed to a net reduction in GHG emissions of 80% by 2050 against the 1990 baseline in line with the commitments of the Kyoto Protocol. In June 2019, secondary legislation (the Climate Change Act 2008 (2050 Target Amendment) Order 2019) was passed that extended that target to at least 100% against 1990 baseline by 2050, with Scotland committing to a net zero by 2045.

The Climate Change Act 2008 also established the Climate Change Committee (CCC), which advises the UK and devolved governments on emissions targets and reports to Parliament on progress made in reducing GHG emissions and preparing for and adapting to the impacts of climate change.

The CCC has produced six four yearly carbon budgets, covering 2008-2037. The UK has so far outperformed on its carbon budget targets, but progress is slowing, and the UK is not on track to meet its future budgets or the overall reduction target, according to the most recent Progress Report to Parliament by the Committee on Climate Change (CCC, 2021). Low carbon and hydrogen energy proposed developments, such as the HyNet North West Project, are an important part in aiding the whole of the UK to meet its future environmental budgets.

2.2.3.2 Carbon capture and storage

The CCC have stated that CCS is a necessity, not an option (CCC, 2021). CCS is fundamental to the decarbonisation of energy intensive industries, such as chemical and cement plants and refineries, and will enable domestic production of low carbon hydrogen from natural gas.

Through updates to National Policy Statement (NPS) EN-1 (DESNZ, 2023), the UK Government recognises that new CCS infrastructure will be essential to ensuring the transition to a net zero economy and that any realistic alternatives to new CCS infrastructure for delivering net zero by 2050 are limited.

To meet the UK's sixth carbon budget, the Government has outlined an ambition to capture 20-30 $MtCO_2$ per year by 2030 and the CCC have recommended that the first cluster should be operational by 2025, with at least one cluster involving low-carbon hydrogen. A cluster is a collection of businesses and applications working in unison to create a new hydrogen network.

The HyNet North West Project is an innovative low carbon and hydrogen energy project that will provide infrastructure to unlock a low carbon economy for the North West of England and North Wales and put the region at the forefront of the UK's drive to Net-Zero. The importance of the Project has been recognised in the Government's choice in taking forward the Project in Track 1 of its Cluster Sequencing process, which provides support to begin decarbonising industry from 2025.

The Proposed Development, being part of the HyNet North West Project, will contribute to the reduction of CO_2 in the atmosphere and make a significant contribution to the international, national, and local effort against the climate emergency. The HyNet North West Project overall will capture 10 $MtCO_2$ per year by 2030, the equivalent of taking four million cars off the road or the equivalent of heating 5 million households with natural gas boilers for a year. The transportation and offshore storage of CO_2 via the Proposed Development, in combination with the onshore elements of the CCS infrastructure, means that industry in the region will be able to reduce their emissions and new low-carbon hydrogen plant can be built with the CO_2 captured.

2.2.3.3 The Energy Act 2008

The Energy Act 2008 provides for a licensing regime that governs the offshore storage of carbon dioxide. It forms part of the transposition into UK law of EU Directive 2009/31/EC on the geological storage of carbon dioxide. In 2011, the Storage of Carbon Dioxide (Amendment of the Energy Act 2008 etc.) Regulations 2011 extended the licensing regime to onshore and the adjacent internal waters in the United Kingdom. Carrying out regulated CCUS operations without a license is prohibited. The Storage of Carbon Dioxide (Licensing etc.) Regulations 2010 (SI 2010/2221), which transpose many other requirements of the Directive, came into force in 1 October 2010.

The regime applies to storage in the offshore area comprising both UK territorial sea and beyond designated as a Gas Importation and Storage Zone (GISZ) under Section 1(5) of the Act. The North Sea Transition Authority (NSTA), formerly known as the Oil and Gas Authority, is the licensing authority for offshore storage within the territorial sea adjacent to England and Wales. In addition to applying for a license, developers must obtain a grant of the appropriate rights from the Crown Estate.

2.2.3.4 The Clean Growth Strategy 2017

In October 2017, the government announced its new approach to Carbon Capture, Usage and Storage (CCUS) in the Clean Growth Strategy (HM Government, 2017). The approach is designed to enable the UK to become a global technology leader for CCUS and ensure that government has the option of deploying CCUS at scale during the 2030s, subject to costs coming down sufficiently. To progress this ambition, the government has set out action under three themes:

- reaffirming our commitment to deploying CCUS in the UK subject to cost reduction;
- international collaboration on CCUS; and
- CCUS innovation.

Additionally, in 2018, the UK Government published "*The UK Carbon Capture Usage and Storage Deployment Pathway: An Action Plan*" (HM Government, 2018). This document further illustrated and details the commitment to CCS as part of the UK's Energy Strategy. Furthermore, the Action Plan identifies the East Irish Sea Basin as a key location to develop CCS projects.

2.2.3.5 The Ten Point Plan for a Green Industrial Revolution 2020

The UK's Ten Point Plan (HM Government, 2020a) intends to set the foundations for a Green Industrial Revolution, creating jobs through harnessing British science and technology to create and use clean energy. Point 1 of the Ten Point Plan is '*Driving the Growth of Low Carbon Hydrogen*' and Point 8 is '*Investing in Carbon Capture, Usage and Storage*'.

The Plan notes that producing low carbon hydrogen at scale will be made possible by carbon capture and storage and that developing CCS infrastructure will contribute to the economic transformation of the UK's industrial regions, enhancing the long-term competitiveness of UK industry in a global net zero economy.

It confirms the ambition to capture and store 10 Mt of CO_2 per year by 2030 and sets out a proposed £1 billion CCUS Infrastructure Fund to invest in the new carbon capture industry at pace and scale.

2.2.3.6 The HM Government Energy White Paper - Powering our Net Zero Future 2020

Following the Prime Minister's ten-point plan for a green revolution (HM Government, 2020a), the White Paper (HM Government, 2020b) marked a significant milestone in the UK's net-zero transition, setting a net-zero target by 2050 and outlining how this may be achieved. It relates to the generation, supply and use of energy with the drive towards net zero by 2050 at its core, along with energy-efficient buildings and lower household bills. It signalled a decisive move away from fossil fuel generation and highlights how planned Government investment has the potential to leverage billions of pounds more in private sector funding and support for over 250,000 jobs in the green economy by 2030.

In particular, the White Paper set out a commitment to invest £1 billion up to 2025 to facilitate the deployment of CCUS in two industrial clusters (HyNet and East Coast Clusters) by the mid-2020s, and a further two clusters by 2030, supporting the aim to capture 10 $MtCO_2$ per year by the end of the decade.

2.2.3.7 UK Net Zero Strategy 2021

Building on the Ten Point Plan, the Energy White Paper, the requirements of the Climate Change Act 2008 (2050 Target Amendment) Order 2019 and the commitments made at COP26, the Government published its Net Zero Strategy in 2021 (HM Government, 2021). This sets out the long-term plan to end the UK's contribution to man-made climate change by 2050. The key policies in the net zero strategy include:

- by 2035 the UK will fully decarbonise the power system; and
- deliver six $MtCO_2$ per year of industrial CCUS by 2030, and nine $MtCO_2$ per year by 2035.

The Strategy proposed that the UK lead the way in meeting the commitments made at COP26.

2.2.4 Welsh policy and legislation

2.2.4.1 Climate policy Wales

The Welsh Government declared a climate emergency in April 2019 (Welsh Government, 2019a). Following this, Wales has set interim carbon targets for 2030 and 2040, and a series of carbon budgets. The second carbon budget for 2021 to 2025 sets out the plan for Net Zero Wales (Welsh Government, 2021a).

Further details of the approach to achieving net zero are set out in the Working Together to Reach Net Zero document (Welsh Government, 2022) and in Prosperity for All: A Low Carbon Wales (Welsh Government, 2019b).

2.2.4.2 The Well-being of Future Generations (Wales) Act 2015

The Well-being of Future Generations (Wales) Act 2015 places the duty on public bodies to place the principles of sustainability and sustainable development at the heart of its decision-making processes. The Act is centred in improving the social, economic, environmental, and cultural well-being of Wales. The relevant objectives of the Well-being of Future Generations (Wales) Act 2015 include:

- A Resilient Wales – contributing to the protection and improvement of the environment, to improve the quality of life and protect local and global ecosystems;
- A Healthier Wales – contribute to the protection and, where possible, the improvement of people's health and well-being as a core component of achieving the well-being goals and responding to climate change; and
- A Globally Responsive Wales – support the need to tackle the causes of climate change by moving towards a low carbon economy.

2.2.4.3 The Environment (Wales) Act 2016

The Environment (Wales) Act 2016 puts in place the legislation needed to plan and manage Wales's natural resources in a more proactive, sustainable and collective way. A key part of the Environment (Wales) Act 2016 focuses on climate change with the aim to reduce emissions by at least 80% by 2050 and sets a clear path for decarbonisation in the future.

The Environment (Wales) Act 2016 is supported by the Natural Resources Policy (NRP) which focuses on the sustainable management of Wales's natural resources to maximise their contribution to achieving goals within the Well-being of Future Generations (Wales) Act. The NRP sets out three National Priorities including '*increasing renewable energy and resource efficiency*'.

The act will provide an iterative framework that ensures sustainable management of natural resources, provide Natural Resources Wales (NRW) with tools to manage natural resources more sustainably, and include a biodiversity duty to help in reversing decline and securing the long-term resilience of biodiversity in Wales.

2.2.4.4 Future Wales: The National Plan 2040

Future Wales (Welsh Government, 2021b) is the national development framework, setting the direction for development in Wales to 2040. It addresses key national priorities, including sustaining and developing a vibrant economy, achieving decarbonisation and climate-resilience, developing strong ecosystems and improving the health and well-being of communities.

In terms of climate change, Future Wales recognises that changes to climate and weather patterns will have a significant impact on well-being for both current and future generations. Therefore, climate change is identified as an equality issue as it will disproportionately affect the most vulnerable communities in Wales and throughout the world.

Furthermore, the plan realises that it is vital that emissions are reduced to protect well-being and to demonstrate global responsibility. Future Wales together with Planning Policy Wales will ensure the planning system focuses on delivering a decarbonised and resilient Wales. Future Wales identifies that Wales can become a world leader in renewable energy technologies. Wales's support for both large and community scaled projects and commitment to ensuring the planning system provides a strong lead for renewable energy development means it is well placed to support the renewable sector, attract new investment and reduce carbon emissions.

2.3 Marine policy

2.3.1 UK Marine Policy Statement

Published in 2011, the UK Marine Policy Statement (MPS), under Section 44 of the Marine and Coastal Access Act (MCAA) 2009, provides the framework for marine spatial planning, specifically for the preparation of Marine Plans and to ensure marine resources are utilised in a sustainable way (Defra, 2011). The MPS was jointly adopted by the Secretary of State, Welsh Minister, Scottish Ministers, and the Department of the Environment in Northern Ireland to promote successful collaboration opportunities.

The MPS states that Marine Plans should consider and identify the specific areas of potential related to the deployment of various renewable energy technologies, to help improve the UK's energy security. Additionally, the MCAA 2009 requires that all public authorities taking authorisation and/or enforcement decisions that affect or have the potential to affect the UK marine area, to do so in accordance with the MPS and relevant Marine Plans.

2.3.2 North West Marine Plan

Part of the Eni development area overlaps with English offshore waters, and is covered by the North West Inshore and North West Offshore Marine Plan (Figure 2.1). The North West Inshore and North West Offshore Marine Plan was published in June 2021 (HM Government, 2021) and introduces a strategic approach to marine planning within the marine plan area. It is intended to inform decision-making by marine users and regulators on where, when or how activities may take place within the marine plan area.

The North West Inshore and North West Offshore Marine Plan sets out the following four objectives in relation to achieving a sustainable marine economy:

- infrastructure is in place to support and promote safe, profitable, and efficient marine businesses;
- the marine environment and its resources are used to maximise sustainable activity, prosperity and opportunities for all, now and in the future;
- marine businesses are taking long-term strategic decisions and managing risks effectively. They are competitive and operating efficiently; and
- marine businesses are acting in a way which respects environmental limits and is socially responsible. This is rewarded in the market place.

The policy provisions within the North West Inshore and North West Offshore Marine Plan relevant to each physical, biological and human environment topic of the Environmental Impact Assessment (EIA) will be presented and addressed in the individual technical topic chapters of the ES.

When assessing applications in England (see section 2.4) the Regulator, in this case, the NSTA, must determine whether the activities of the proposed project are compatible with the objectives of the relevant marine plan. The key policies relevant to the Proposed Development and how the policy objectives have been addressed are presented in Compliance with Marine Plan Policies (RPS Group, 2023).

2.3.3 Welsh National Marine Plan

The Welsh National Marine Plan (WNMP) was published in November 2019 (Welsh Government, 2019c), introducing a framework to support sustainable decision making within the marine environment. Policies within the WNMP are specific to the renewable energy sector.

The WNMP represents the planning process to shape Wales's seas to support economic, social, environmental, and cultural objectives. The purpose of the WNMP is to guide the sustainable development of Wales's marine area by setting out how proposals will be considered to decision makers. Pertaining to the Welsh inshore region (out to 12 nautical miles (nm)) and the offshore region (12 nm to 200 nm), the WNMP sets out four key objectives in achieving an increasingly sustainable marine economy, including:

- contribute to a thriving Welsh economy by encouraging economically productive activities and profitable and sustainable businesses that create long-term employment at all skill levels;
- support the opportunity to sustainably develop marine renewable energy resources with the right development in the right place, helping to achieve the UK's energy security and carbon reduction objectives, whilst fully considering other's interests, and ecosystem resilience;
- provide space to support existing and future sustainable economic activity through managing multiple uses, encouraging the coexistence of compatible activities, the mitigation of conflicts between users and, where possible, by reducing the displacement of existing activities; and
- recognise the significant value of coastal tourism and recreation to the Welsh economy and well-being and ensure such activity and potential for future growth are appropriately safeguarded.

When assessing Marine Licence applications in Wales (see section 2.4) the Regulator, NRW, must determine whether the activities of the proposed project are compatible with the objectives of the relevant marine plan. The key policies relevant to the Proposed Development and how the policy objectives have been addressed are presented in Compliance with Marine Plan Policies (RPS Group, 2023).

2.3.4 North West Shoreline Management Plan

The Shoreline Management Plan (SMP) is a non-statutory policy document for coastal defence management planning that was formally adopted in August 2016. It takes account of other existing planning initiatives and legislative requirements and is intended to inform wider strategic planning. The SMP identifies the most sustainable management policies over three main timescales – the present day (0 years to 20 years), the medium-term (20 years to 50 years) and the long-term (50 years to 100 years). There are four policy options: Hold the Line, Advance the Line, Managed Realignment, No Active Intervention. SMPs form an important part of the Department for Environment, Food and Rural Affairs (Defra) and Welsh Assembly Government (WAG) strategy for managing risks due to flooding and coastal erosion. The North West SMP extends between Great Orme's Head in North Wales and the Scottish Border. This area is also known as Cell 11.

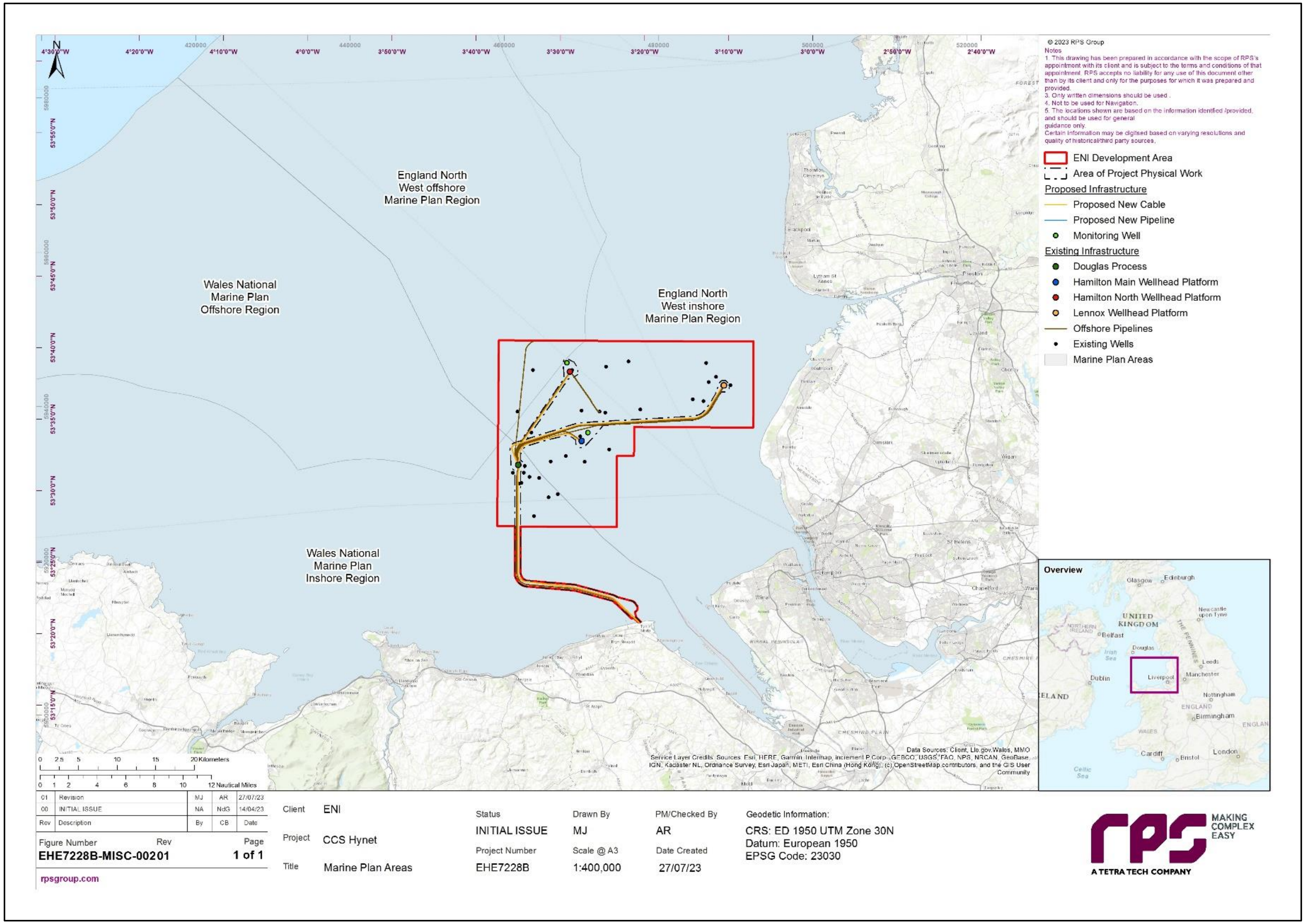

Figure 2.1: Eni Development Area in relation to the Marine Plan Regions (*The 12 nm limit represents the boundary of the inshore and offshore Marine Plan Regions. The boundary between the England and Wales Marine Plan Regions is represented by the territorial boundary of the two nations*).

2.4 Consenting regime

2.4.1 Introduction

This section provides a summary of the consenting process and associated legislative requirements being followed for the Proposed Development.

Table 2.1 sets out the permits and licences pertinent to the Proposed Development and to which the following legislation applies. The applications are supported by this ES, as well as a Water Framework Directive (WFD) assessment, and a Report to Inform Appropriate Assessment (RIAA).

Should additional pre-construction licences be required, these will be discussed and agreed with the relevant consent authority during the pre-construction phase of the Proposed Development.

Table 2.1: Proposed Development Planning And Consenting Requirements

Activity	Permit/Licence/Requirement	Key Legislation
Benthic ecology baseline surveys: • intertidal benthic survey; and • subtidal benthic survey.	• Marine Licence (Band 1) from **NRW-MLT** (MMO exemption). • **OPRED** Survey Notification. • **Crown Estate** seabed survey licence.	• Marine and Coastal Access Act (MCAA) 2009.
Pipeline repurposing/Installation of new pipeline spools to new platform	• Pipeline Works Authorisation (PWA) updates/renewals for the repurposed pipeline from **NSTA**. • Marine Licence Band 3 from **NRW-MLT**.	• The Petroleum Act 1988. • The Pipeline Safety Regulations 1996. • The Offshore Chemicals Regulations 2002 (as amended). • MCAA 2009.
New platform installation	• Marine Licence Band 3 from **NRW-MLT**. • Consent to Locate (CtL) for fixed installation from **OPRED**.	• MCAA 2009. • Energy Act 2008.
Drilling	• Master Application Templates (MATs) and Subsidiary Application Templates (SATs) from **OPRED** for new wells, side-track drilling and well intervention.	• Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020. • The Offshore Chemicals Regulations 2002 (as amended). • Part 4A of The Energy Act 2008 (as amended). • The Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005 (as amended). • Consent for a Marine Geological Survey or Investigation under The Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 (as amended).
Environmental Impact Assessment and Environmental Statement	• Scoping. • ES production. • HRA screening and appropriate assessment. • WFD assessment. • Submission and Public Notice. • ES approval for Storage Permit – **OPRED**	• The Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020. • The Offshore Environmental Impact Assessment (The Marine Works (Environmental Impact Assessment) Regulations 2007 (as amended).

Activity	Permit/Licence/Requirement	Key Legislation
	• ES approval for Marine Licence – **NRW-MLT**	• HRA (Conservation of Habitats and Species Regulations 2017 (as amended); Conservation of Offshore Marine Habitats and Species Regulations 2017 (as amended)). • Water Framework Directive. • The Habitats and Birds Directive.
Carbon Storage	• Carbon Dioxide Appraisal and Storage Licence already awarded by **NSTA**. Licence No. CS004. • **Crown Estate** Lease. • Carbon Storage Permit from **NSTA**.	• Energy Act 2008. • The Storage of Carbon Dioxide (Licensing etc.) Regulations 2010.
Cable laying and associated activities	• Marine Licence Band 3 (Welsh waters.) from **NRW-MLT**. • PWA (English waters) from **NSTA**.	• MCAA 2009 Marine Licence. • The Petroleum Act 1988.

2.4.2 The Carbon Appraisal and Storage Licensing

In October 2020, the UK Oil and Gas Authority (OGA), currently NSTA, awarded Eni UK Limited a Carbon Dioxide Appraisal and Storage Licence (CS004) under the Energy Act 2008, Section 18.

The CS004 license includes terms and conditions for the application of a Storage Permit, in accordance with the Storage of Carbon Dioxide (Licensing etc.) Regulations 2010 (SI 2010/2221), in respect of a storage site situated in the licensed area. In addition, the CS004 license includes the general conditions applicable to a storage site authorised under a Storage Permit, addressing the closure of storage site, the post-closure plan and post-closure obligations.

A draft Storage Permit application has been made to the NSTA, which comprises a suite of prescribed documents, supported by this ES. The application documents draw upon a number of those previously developed during the Assess and Define Phases of the CS Permit application process. These documents provide a summary of the essential features of the proposed storage site and storage complex; the containment risk analysis undertaken; and the planned operational strategy associated with the proposed undersea carbon storage facility located within Liverpool Bay and described by Carbon Dioxide Appraisal and Storage Licence CS004. Once the process set out in the "Guidance on Applications for a Carbon Storage Permit " is complete and the Applicant has formally taken FID and OPRED 'approved' the ES, the NSTA will notify the Applicant to submit the finalised Storage Permit Application. The Storage Permit will authorise the use of a place as a storage site for CO_2. This will grant authorisation for the Applicant to proceed with both the construction of facilities and other infrastructure, and the injection of CO_2 into the storage sites.A Monitoring Plan, Corrective Measures Plan, Provisional closure and post-closure Plan, and proposals for Financial Security are also included with the Storage Permit application.

To inform the Storage Permit application and its accompanying plans, the EIA has been undertaken, and ES prepared, with reference to the following guidelines:

- OSPAR. Guidelines for Risk Assessment and Management of Storage of CO_2 Streams in Geological Formations (Reference Number: 2007-12);
- London Protocol. Risk Assessment and Management Framework for CO_2 Sequestration in Sub-Seabed Geological Structures (CS-SSGS), LC/SG-CO2 1/7, Annex 3. 2006; and
- London Protocol. Specific Guidelines for the Assessment of Carbon Dioxide for Disposal into Sub-seabed Geological Formations.LP.7. LC 34/15, Annex 8. 2012.

2.4.3 Marine and Coastal Access Act (MCAA) Marine Licence

Within the UK offshore waters (between 12 nm and up to 200 nm offshore), the MCAA 2009 applies. Under the MCAA 2009 (as amended) there is the requirement for a marine licence to be obtained prior to the construction, alteration or improvement of any works or deposit any object in or over the sea, or on or under the seabed. Similarly, under the Marine MCAA 2009 which applies to both Welsh and English Territorial Waters (between 0 nm and 12 nm seaward from Mean High Water Springs (MHWS)), there is also the requirement for a marine licence prior to the construction, alteration or improvement of any works or deposit any object in or over the sea, or on or under the seabed. Marine Licensable areas in Welsh waters are defined in the MCAA 2009 (Section 42), while those in English waters are assessed by the MMO in Part 4 of the MCAA 2009.

The MCAA 2009 (administered by NRW-MLT and MMO), make it a licensable activity to:

- deposit any substance or object in the sea or on or under the seabed from:
  - any vehicle, vessel, aircraft or marine structure;
  - any container floating in the sea; and
  - any structure on land constructed for depositing solids in the sea;
- construct, alter or improve any works either in or over the sea or under the seabed;
- use a vehicle, vessel, aircraft or marine structure to remove any substance or object from the seabed; and
- carry out any form of dredging, whether or not involving the removal of any material from the sea or seabed.

As proposed, the Applicant's activities include the potential to remove substrate from the seabed and to deposit infrastructure in the sea or on or under the seabed, Marine Licences may be required for certain activities.

Section 77 of the Act specifically excludes offshore energy activities relating to oil and gas exploration and production, gas unloading and storage, and carbon dioxide storage from the marine licensing provisions, where the activities fall into the following categories:

- anything done in the course of carrying on an activity for which a licence under Section 3 of the Petroleum Act 1998 (c. 17) or Section 2 of the Petroleum (Production) Act 1934 (c. 36) (licences to search for and get petroleum) is required;
- anything done for the purpose of constructing or maintaining a pipeline as respects any part of which an authorisation (within the meaning of Part 3 of the Petroleum Act 1998) is in force;
- anything done for the purpose of establishing or maintaining an offshore installation (within the meaning of Part 4 of the Petroleum Act 1998 (c. 17)); and
- anything done in the course of carrying on an activity for which a licence under Section 4 or 18 of the Energy Act 2008 (c. 32) is required (gas unloading, storage and recovery, and carbon dioxide storage), with the exception of activities where there is devolved competence.

Additional exemptions from the marine licensing provisions are contained in the Marine Licensing (Exempted Activities) Order 2011 (as amended).

As a consequence of the exclusions and exemptions, most offshore energy activities that are the responsibility of OPRED are not subject to the MCAA marine licensing regime. However, the exclusions do not apply to activities that do not fall into the categories detailed above, and the most significant activities that are not excluded are any licensable activities relating to decommissioning operations and the use of explosives for either ordnance clearance or decommissioning.

Where there is a licensing requirement, OPRED is the licensing authority for reserved offshore energy activities, acting on behalf of the Secretary of State.

2.4.4 Marine licensing in England

In England, depositing any object in the sea, on, or under the seabed, may require a marine licence. The MMO licences most activities in English inshore and offshore waters. However, for the Proposed Development, the activities in English waters are associated with a CCS project and are therefore understood to be exempt from Marine Licencing under Section 77 of the MCAA. A Pipeline Works Authorisation (PWA) will instead be required from the NSTA for such activities. A marine wildlife licence or a European Protected Species (EPS) licence may also be required if deployment of an Acoustic Deterrent Device (ADD) may cause an offence in relation to seals (UK protected species) or cetaceans (EPS species).

The English and Welsh guidance *"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"*, can be referred to for further information.

The location of planned infrastructure is shown in Figure 2.1.

2.4.5 Marine licensing in Wales

NRW licences activities in Welsh inshore and offshore waters. In Wales, depositing any object in the sea or on or under the seabed may require a marine licence. A Marine Licence application has therefore been made for the marine licensable activities in Welsh waters, which is supported by this ES.

A marine wildlife licence or an EPS licence may also be required if deployment of an ADD may cause an offence in relation to seals (UK protected species) or cetaceans (EPS species). From 31 March 2017 species licensing becomes the responsibility of Welsh Ministers and licences will be issued by NRW.

The English and Welsh guidance *"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"*, can be referred to for further information.

The location of planned infrastructure is shown in Figure 2.1.

2.4.6 Environmental Impact Assessment Regulations

EIA is the process of identifying and assessing the significant effects likely to arise from a project. This requires consideration of the likely changes to the environment, where these arise because of a project, through comparison with the existing and projected future baseline conditions.

In compliance with the EU Directive on the assessment of the effects of certain public and private projects on the environment (EIA Directive) (2011/92/EU, as amended by Directive 2014/52/EU), when applying for a marine licence or carbon dioxide storage permit, an ES is required to be prepared and submitted to support these applications if they are likely to have a significant effect on the environment due to factors such as their size nature or location. The Proposed Development is classified as a band 3 project under NRW's Marine Licensing bands, defined as having a complex application process that has estimated costs pertaining to marine works exceeding £1 million and/or requiring an EIA and/or undertaking activities involving construction works.

The Proposed Development falls within the descriptions of projects that fall within Schedule 1 of The Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020 (The '2020 EIA Regulations'), and for which EIA is mandatory:

"*3. Activities captured by section 17(2)(a) or (b) of the Energy Act 2008 (activities related to the geological storage of carbon dioxide).*"

The Proposed Development also falls within the descriptions of projects that fall within Schedule A1 of The Marine Works (Environmental Impact Assessment) (Amendment) Regulations 2017 (The '2017 EIA Regulations'), and for which EIA is mandatory:

"*29. Storage sites pursuant to Directive 2009/31/EC(a) of the European Parliament and of the Council on the geological storage of carbon dioxide.*"

The Proposed Development also includes marine licensable activities as defined in Section 66 of the Marine and Coastal Access Act 2009. As per Schedule A2 of the 2017 EIA Regulations, it is considered that these activities are likely to have significant effects on the environment due to factors such as their "*size, nature or location*", as follows:

- any deposit or removal of material or substance, using a vehicle or vessel;
- construction, alteration or improvement works (including works hanging/suspended over the marine licensable area and works beneath the seabed);
- dredging; and
- deposit and use of explosives.

The EIA for the Proposed Development will therefore be undertaken in accordance with the 2020 EIA Regulations, and the 2017 EIA Regulations.

Schedule 6 of the 2020 EIA Regulations, and Schedule 3 of the 2017 EIA Regulations, specify the requirements of the information for inclusion in an environmental statement.

In addition to this, the Offshore ES must consider the following factors during the assessment:

- population and human health;
- biodiversity, in particular species and habitats protected under the Habitats Directive;
- land, soil, water, air and climate; and
- material assets, cultural heritage and the landscape.

The main stages of the EIA process include the following:

- decision to undertake an EIA (screening);
- scoping to determine the subject matter of the EIA and to identify potentially significant effects;
- data review involving compiling and reviewing available baseline data and/or undertaking of baseline surveys to generate site-specific data;
- assessment and design iterations, whereby the potential impacts of the development during the construction, operation and maintenance, and decommissioning stages of its life are assessed. Feedback is provided to the design and engineering team(s) to modify the design of the development where possible in order to avoid, prevent, reduce and/or offset any significant adverse effects on the environment;
- identifying any further mitigation or compensation requirements;
- identifying residual effects;
- preparing the Offshore ES (i.e. reporting on the EIA process and continuing with design iteration and consultation);
- consultation with the consultation bodies, stakeholders, and the community, in accordance with all relevant requirements (the MCAA 2009, EIA Regulations and the associated regulations and guidance);
- consideration of the Offshore ES by NRW, and OPRED; and
- controlling and where necessary monitoring the effects of the project during construction, operation and maintenance, and decommissioning in accordance with the mitigation measures identified in the Offshore ES and/or the requirements identified in the relevant licences which have been drawn from the findings of the EIA.

2.5 Additional consents and legislation

2.5.1 Drilling operations

MAT and SAT permits will be required from OPRED to undertake drilling operations.

- Drilling Operations (DR) MAT: this will cover the proposed monitoring wells, sentinel wells, and side-track drilling operations. SATs falling under the DR MAT will include:
  - EIA Screening Direction SAT (Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020);
  - Chemical Permit (CP) SAT (The Offshore Chemicals Regulations 2002 (as amended);
  - Consent to Locate (CtL) (Part 4A of The Energy Act 2008 (as amended) SAT; and
  - Marine Licensing, OPEP/TOOPEP.

2.5.2 New offshore pipeline

Pipeline Works Authorisation from NSTA, which includes application for Consent to Locate and application for Consent to Deposit Materials for any material deposits required for pipeline stabilisation, will be required for pipeline repurposing and the installation of new pipeline.

Should any chemicals be used and discharged during pipeline commissioning, a CP application will be required.

2.5.3 The WFD Regulations

In the UK, coastal waters are protected under the WFD which requires that "*the project or activity does not cause or contribute to deterioration in water body status or jeopardise the water body achieving good status*" (UK Government, 2014).

The Welsh Ministers, in exercise of the powers conferred by Article 11 of the Natural Resources Body for Wales (Establishment) Order 2012(a) and having consulted the Secretary of State to the extent that there is any effect in those parts of England that are within the catchment areas of the rivers Dee, Wye and Severn, and having also consulted the Natural Resources Body for Wales, give the following Directions to the Natural Resources Body for Wales.

The Directions are given for the implementation of:

- Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for community action in the field of water policy;
- Directive 2008/105/EC of the European Parliament and of the Council on environmental quality standards in the field of water policy; and
- Directive 2013/39/EU of the European Parliament and of the Council amending Directives 2000/60/EC and 2008/105/EC as regards priority substances in the field of water policy.

The WFD guidance is for compliance assessment of activities in the marine environment up to one nautical mile out to sea for ecological status, and 12 nm for chemical status. A WFD assessment must be provided as part of the application to the public body tasked with regulating and granting permission for the Proposed Development activity. Additionally, a WFD assessment helps all parties understand:

- the impact the proposed activity may have on the immediate water body and any linked water bodies; and
- whether the proposed activity complies with the River Basin Management Plan (RBMP).

For the Proposed Development, one WFD assessment has been carried out to cover all activities (described in section 3).

2.5.4 The Habitats and Birds Directive

The Council Directive 92/43/EEC (the Habitats Directive) was adopted in 1992, providing a means for the EU to meet its obligations under the Bern Convention. The aim of the Directive is to maintain or restore natural habitats and wild species listed on the Annexes at a favourable conservation status. This protection is granted through the designation of European Sites and EPS. The European Directive (2009/147/EC) on the conservation of wild birds (The Birds Directive) provides a framework for the conservation and management of wild birds within Europe. The Directive affords rare and vulnerable species listed under Annex I of the Directive, and regularly occurring migratory species, protection through the identification and designation of Special Protection Areas (SPAs).

The Habitat Regulations require that where a plan or project that is not directly connected with, or necessary to the management of a Natura 2000 site, but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives. NRW-MLT, and OPRED must therefore consider whether the Proposed Development is likely to have significant effects on the conservation objectives of the sites considered in the HRA, and, where Likely Significant Effects (LSE) cannot be excluded at the screening stage, and in the absence of mitigation measures, an 'Appropriate Assessment' of the implication of the plan or project must be undertaken by the competent authority before consent may be given for the proposed project.

The HRA process is a multi-stage process aligned with European Commission (EC) guidance documents '*Assessment of plans and projects significantly affecting Natura 2000 sites*' (EC, 2001) and 'Managing Natura 2000 sites: The Provisions of Article 6 of the '*Habitats*' Directive 92/43/EEC' (EC, 2019). In accordance with this guidance from the Commission, the obligations arising under Article 6 establish a stepwise procedure, as set out below:

1. The first part of this procedure consists of a preliminary '*screening*' stage to determine whether, firstly, the plan or project is directly connected with or necessary to the management of the site, and secondly, whether it is likely to have a significant effect on the site; it is governed by the first sentence of Article 6(3).
2. The second part of the procedure, governed by the second sentence of Article 6(3), relates to the appropriate assessment and the decision of the competent national authorities.
3. A third part of the procedure (governed by Article 6(4)) comes into play if, despite a negative assessment, it is proposed not to reject a plan or project but to give it further consideration. In this case Article 6(4) allows for derogations from Article 6(3) under certain conditions.

The stepwise procedure has the aim of determining LSEs and, where necessary, assesses the implications of the Proposed Development for their potential to adversely affect the integrity of a European site or sites in accordance with Article 6(3) of the Habitats Directive. If a determination of adverse effect on site integrity is made despite the application of mitigation measures intended to avoid or reduce the harmful effects of the project(s) on the sites concerned, the stepwise procedure then provides for a derogation procedure under Article 6(4). Such a derogation is available to the competent authorities concerned following three tests to be met in sequential order:

1. There are no feasible alternative solutions to the project which are less damaging.
2. There are "imperative reasons of overriding public interest" (IROPI) for the project to proceed.
3. Compensatory measures are secured to ensure that the overall coherence of the network of European sites is maintained.

Some of the existing and Proposed Development infrastructure lies within the Liverpool Bay/Bae Lerpwl SPA (UK designated site and Natura 2000 site), namely, the existing pipeline and proposed cables route between

PoA and Douglas platforms, the existing Douglas, Hamilton North, Hamilton Main, and Lennox platforms, and the existing pipelines and proposed cables between Douglas and Hamilton North, Hamilton Main, and Lennox platforms. The location of planned infrastructure is described in volume 1, chapter 3, and shown in Figure 3.1.

The aim of the Directive 2009/147/EC of 30 November 2009 on the conservation of wild birds (The Birds Directive) (Ref 2.5) is to protect, manage and control all species of naturally occurring wild birds in the Member States. Member States are required to take the requisite measures to maintain the population of the species at a level which corresponds to ecological, scientific, and cultural requirements, while taking account of economic and recreational requirements, or to adapt the population of these species to that level. The Birds Directive is implemented in England and Wales through the Wildlife & Countryside Act 1981 (as amended) and the Habitats Regulations.

For the Proposed Development, a Report to Inform Appropriate Assessment (RIAA) has been prepared by the Applicant to cover all activities described in section 3.

2.5.5 EPS licensing

The Conservation of Habitats and Species Regulations 2017, known as the '*Habitats Regulations*' transposes requirements of the European Habitats Directive (92/43/EEC) on the conservation of natural habitats and of wild flora and fauna into UK law. This includes animals whose natural range includes any area of the UK, and animals which are included in Annex IV of the Directive, and which are species of European Community interest and in need of strict protection (EPS). Within Welsh and English waters, the following EPS are known to occur:

- Cetaceans (whales, dolphins, and porpoises);
- marine turtles;
- otter; and
- common sturgeon.

Of the cetacean species occurring within UK waters, the following species are known to occur in Welsh waters:

- Harbour porpoise *Phocoena phocoena*;
- Bottlenose dolphin *Tursiops truncates*;
- Short-beaked common dolphin *Delphinus delphis*;
- Risso's dolphin *Grampus griseus*; and
- Minke whale *Balaenoptera acutorostrata*.

Under the Conservation of Habitats and Species Regulations 2017, it is an offence to deliberately or recklessly capture, injure or kill an EPS, or deliberately disturb wild animals of EPS. As of 1 April 2018, the responsibility for the administration of EPS licence applications has transferred to NRW-MLT, who act on behalf of the Welsh Ministers. NRW-MLT issues licences under Regulation 55 of the Conservation of Habitats and Species Regulations 2017 and the Conservation of Offshore Marine Habitats and Species Regulations 2017, to allow activities that would otherwise constitute an offence under the Conservation of Habitats and Species Regulations 2017, to be carried out.

Underwater noise associated with the Proposed Development activities (e.g. seismic activity) has the potential to cause an offence under the Regulations, therefore there may be a requirement to obtain a licence to disturb marine EPS from the Department for Energy Security and Net Zero (DESNZ), formerly the Department for Business, Energy, and Industrial Strategy (BEIS). EPS licences are obtained from Natural England (NE) and NRW, depending on the reason for the licence application. Although the grant of EPS licences is separate to the Section 36 and marine licence application process, it can be considered in parallel by NE and NRW to constrict timelines.

Should an EPS licence be required, DESNZ aims to process applications within 6 to 8 weeks from receipt of a completed application, with all associated supporting information provided.

Should additional pre-construction licences be required, these will be discussed and agreed with the relevant consenting authority during the pre-construction phase of the Proposed Development.

2.5.6 Basking shark licence

Basking sharks are protected under Schedule 5 of the Wildlife and Countryside Act (WCA) 1981 (as amended). Under this Act it is an offence to intentionally kill, injure or take; damage or destroy a place of shelter or protection, or disturb them whilst occupying such a place; or obstruct access to such a place. In addition, it is an offence to disturb a basking shark intentionally or recklessly.

NRW can issue a licence under Section 16(3) of the WCA (if required) to allow an activity to be carried out that would otherwise constitute an offence. NRW aim to process applications with 30 working days from receipt of a completed application, with all associated supporting information provided.

2.5.7 UK Emissions Trading Scheme

The UK Emissions Trading Scheme (UK ETS) was established on 1 January 2021 by the UK ETS Authority (UK Government, Scottish Government, Welsh Government and the Department of Agriculture, Environment and Rural Affairs of Northern Ireland (DAERA)), replacing the UK's participation in the EU ETS.

The UK ETS is established through The Greenhouse Gas Emissions Trading Scheme Order 2020. This guidance includes CO_2 capture, transport by pipelines and geological storage of CO_2 in its scope of activities (Schedule 2). This means that the installations that are covered by the UK ETS wouldn't need to surrender credits for the CO_2 they have captured for subsequent transportation by pipelines and geological storage.

At the time of writing, proceedings for the development of the UK ETS are ongoing, including proposals on aligning the scheme's cap with UK Net Zero Target. It is expected the new legislation will come to force in due course, ahead of the 2024 scheme year.

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3 PROPOSED DEVELOPMENT DESCRIPTION

3.1 Introduction

The HyNet Carbon Dioxide Transportation and Storage Project - Offshore (hereafter the "Proposed Development") is being developed in parallel with and as a key part of the HyNet North West full-chain hydrogen and Carbon Capture and Storage (CCS) industrial decarbonisation project (the HyNet Project), which is designed to transform a region of the UK into the world's first low carbon industrial cluster by 2030.

This chapter provides an outline description of the Proposed Development and describes the activities likely to be associated with the construction, operation, and maintenance, and decommissioning of the Proposed Development. It summarises the design and components of the Proposed Development infrastructure. These are based on evolving design information and refinement of the Proposed Development parameters following receipt of the Offshore EIA Scoping Opinion (OPRED, 2023), and understanding of the environment from site specific surveys and desk-top analysis.

The Project Design Envelope (PDE) approach (also known as the Rochdale Envelope approach) has been adopted for the assessment of the Proposed Development, in accordance with current good practice (National Infrastructure Planning, 2018) and the 'Rochdale Envelope Principle'. The PDE concept allows for some flexibility in project design options, for example, cable installation and protection, where the full details of the project are not known at application submission but will be confirmed in detail once the installation contractor is appointed.

3.2 Proposed development location

The Proposed Development is in the CS004 CO_2 Appraisal and Storage Licence area (NSTA, 2020), approximately 12 km to the north of the Welsh coastline and 2 km west of the English coastline (Figure 3.1). The licence area covers approximately 576.82 km^2 and encompasses the depleted hydrocarbon reservoirs of the Hamilton, Hamilton North, and Lennox fields. The Proposed Development infrastructure will be located within the 'Eni development area' defined by both the Licence area (CS004), and the pipeline and cable corridor connecting the Point of Ayr (PoA) Terminal to Douglas Offshore Platform (OP) (up to Mean High Water Springs (MHWS)), as shown by the red line in Figure 3.1. The corridor shore approach is located to the north of Talacre in Flintshire, Wales, near the mouth of the Dee Estuary. Within the Eni Development Area, Figure 3.1 also shows a black, dotted, and dashed line, which identifies the 'area of project physical works'. It is within this area that the works required for the Proposed Development will be carried out.

The Eni development area is in water depths that range from 0.72 m below Lowest Astronomical Tide (LAT) to 35 m LAT, with average water depths across the Eni development area approximately 20 m LAT. The Lennox OP is in 7.2 m depth of water, while the Douglas OP complex is in 29.2 m depth of water.

The Eni development area encompasses the existing OPs, depleted oil and gas reservoirs, and connecting submarine pipelines and cables (Figure 3.1). These OPs are:

- The Douglas OP Complex comprises three-bridge linked platforms comprising a wellhead platform, a central process platform and an accommodation platform. These will be decommissioned, subject to the approval by Offshore Petroleum Regulator for Environment & Decommissioning (OPRED) of a separate decommissioning plan and environmental appraisal;
- Lennox OP is an unmanned oil and gas Wellhead platform to be repurposed for CO_2 service;
- Hamilton Main OP is an unmanned oil and gas Wellhead platform to be repurposed for CO_2 service; and
- Hamilton North OP is an unmanned Wellhead gas platform to be repurposed for CO_2 service.

Eni's offshore infrastructure is just one element of many other existing and proposed offshore activities and infrastructure elements situated within Liverpool Bay. These are discussed further in volume 2, chapter 12 and include:

- Burbo Bank, Burbo Bank Extension, North Hoyle, Gwynt y Môr, and Rhyl Flats wind farms;
- electrical export cables and landfalls associated with offshore wind developments;
- proposed wind farms and electrical export cables and landfalls, including Awel y Môr (in planning), OWL's Project 5 (in pre-planning) and a proposed 1,500 MW project by an EnBW/BP consortium;
- active aggregate dredging areas south of Douglas and northwest of Hamilton;
- active dredge spoil dumping areas to the west of Douglas, to the northeast of Hamilton, to the southwest of Lennox and north of Lennox; and
- shipping lanes to the south, and through the development area.

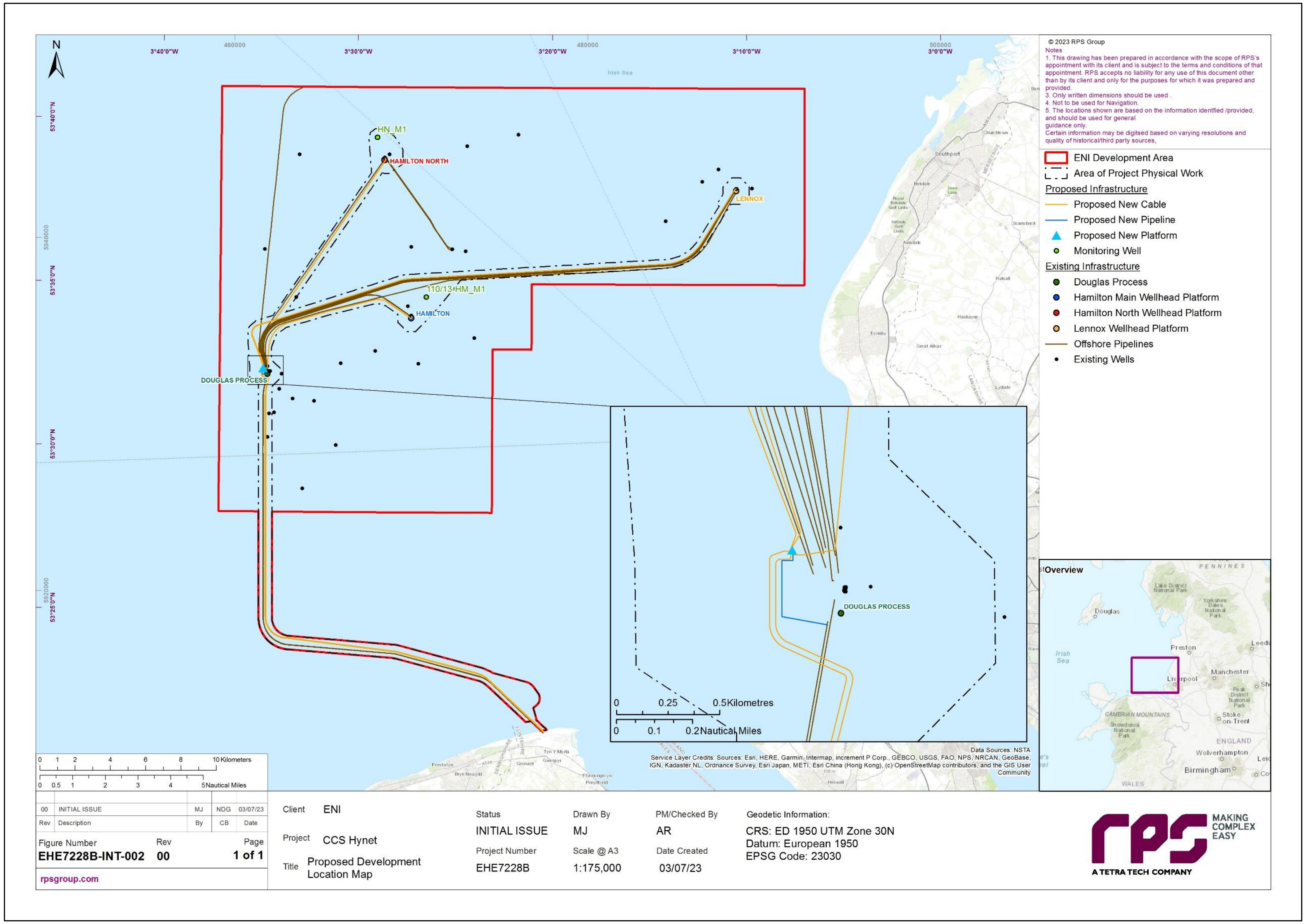


Figure 3.1: Location overview of Proposed Development

3.3 Offshore infrastructure

3.3.1 Overview

The key offshore infrastructure of the Proposed Development will include both new and re-purposed existing infrastructure.

The elements of offshore infrastructure that comprise the Proposed Development will include:

- Utilisation of the existing Hamilton Main, Hamilton North, and Lennox reservoirs for the injection of 109 Mt of CO_2 over a 25-year period for permanent geological storage. The storage would be divided between the three reservoirs, as follows: Hamilton Main, 53 Mt; Hamilton North, 18 Mt; and Lennox 38 Mt.
- Drilling and re-completion of injection wells by side-tracking existing production wells. This includes drilling and recompletion operations, all of which will be within the existing footprint (template) of each platform.
- Installation of a new Douglas CCS platform to replace the existing Douglas Process platform to receive CO_2 from the onshore PoA Terminal and distribute CO_2 to the Hamilton Main, Hamilton North, and Lennox wellhead platforms and when necessary, provide heating to the CO_2 stream. Installation of the new Douglas CCS platform will include up to eight driven piles.
- Installation of new sections of pipeline, concrete mattresses, and external rock protection to connect the new Douglas CCS platform and the existing subsea natural gas pipelines.
- Installation of new topsides on the Hamilton Main, Hamilton North, and Lennox wellhead platforms to receive and inject CO_2 into the depleted hydrocarbon reservoirs.
- Repurposing of the existing subsea natural gas pipelines for their change of use from hydrocarbon to CO_2 service.
- Implementation of a Monitoring Plan. This includes the drilling of two new monitoring wells, one at Hamilton North and one at Hamilton Main. Additional monitoring wells will be created from the recompletion of existing wells within the existing footprint (template) of each platform: one monitoring well created by side-tracking an existing well in Lennox; and two sentinel wells, one in Hamilton North and one in Lennox.
- Installation of two submarine 33 kilovolt (kV) power cables, with integrated fibre-optic cable connections (35 km from PoA Terminal onshore to the modified Douglas platform, including within the intertidal/foreshore area up to MHWS, within Welsh waters only).
- Installation of new submarine 33 kV power cables with integrated fibre-optic connecting the modified Douglas platform with the Hamilton Main (12 km; 33 kV), Hamilton North (15 km; 33 kV) and Lennox (35 km; 33 kV) platforms.
- Installation of concrete mattresses and external cable protection, at crossings of existing cables, and in areas where cable burial is not deemed feasible, or as a remedial secondary protection measure if the target cable depth of lowering cannot be achieved.

All the above infrastructure will be confined within the Eni Development Area shown in Figure 3.1, and is also described in detail in each of the Carbon Storage Development Plans, submitted with the Storage Permit applications.

3.3.2 Partial decommissioning programme

3.3.2.1 Programme overview

Prior to the commencement of the Proposed Development there will be a partial decommissioning programme (PDP) that will make ready the Liverpool Bay assets that will be repurposed for CO_2 transportation and storage. The partial decommissioning will comprise the following:

- Removal of the satellite platform topsides at Lennox, Hamilton, and Hamilton Main;
- Plugging and abandonment (P&A) of wells at Douglas, Hamilton, Hamilton North, and Lennox; and
- Removal of expansion spools, umbilicals, and exposed stabilisation features (mattresses and grout bags) in the near platform area (at Douglas, Hamilton, Hamilton North, and Lennox), which do not meet the 0.6m depth of burial criterion and therefore cannot be left in-situ.

The draft PDP and supporting Environmental Appraisal (EA) have been submitted to OPRED for review. The PDP will be finalised for approval once review comments have been addressed to OPRED's satisfaction.

Further separate Decommissioning Programmes (and respective EAs, environmental permits and consents, as required) that are out of scope of the PDP, will cover the following remaining facilities as part of Liverpool Bay Asset: Offshore Storage Installation (OSI) (unless alternative re-use options are found to be viable and more appropriate); Conwy platform (jacket, topsides, wells, and pipelines); Douglas production platform; Douglas accommodation platform; Douglas wellhead platform; Hamilton East subsea field (subsea well and integral protection structure); offshore pipelines; subsea umbilicals; subsea flexible lines; and subsea valves and components.

3.3.2.2 Well 110/15-6z abandonment at Lennox

The proposed P&A programme included in the PDP requires an immediate abandonment activity at well 110/15-6z in the Lennox field (Figure 3.2). This is an exploration well that was previously subject to temporary P&A works that do not meet current Eni and OEUK permanent P&A standards. The well is in the Lennox field in Liverpool Bay, approximately 900 metres east of the Lennox platform and 6 km west of Southport.

The P&A work is being carried out to safely cap 110/15-6z and prevent further gas release. The required intervention programme for the P&A of this well has been subject to substantial planning. This is because the P&A works will secure the Lennox reservoir in preparation for the permanent geological storage of CO_2. Additionally, the works have commenced because the suspension consent granted by the NSTA requires the P&A works to have commenced by 31 March 2024.

The 2024 plan is to now re-enter -/6z and drill and mill out the existing cement plugs. P&A of Well -/6z can then be carried out to AB2 status to current OEUK P&A guidelines, with two rock-to-rock cement barriers, tagged and pressure tested as a permanent decommissioning of the well 110-15/6z, and for which the following consents have been granted:

- Due to the operational risks of re-entering the original 110/15-6 well, Eni has opted to design and plan a standalone intersection drilling well that is covered under the DRA/1042 MAT on the NSTA portal. To ensure that there is even footing of the spudcans when engaging with the seabed, Eni has the contingent placement of rock stabilisation material permitted under the Consent to Locate (CL/1413).
- The Environmental Assessment Justification (EAJ) that refers to and covers the Consent to Locate (CTL-OPRED reference CL/1413 under WIA/1587 MAT).
- The use of the Bismuth as an environmental plugging material for cement plugging under Chemical Permit (CP-OPRED reference CP/3224 under WIA/1587 MAT); and
- The Marine Licence Application (ML-OPRED reference ML/1053 under WIA/1587 MAT).

Upon P&A to AB2, Well -/6z will be monitored by the rig based remotely operated vehicle (ROV) for gas bubbles during the 24-hour cement plug #2 Wait on Cement (WOC) period. After the successful completion of the 24-hour bubble watch while WOC with no bubbles seen, Well -/6z will be judged as satisfactorily sealed and the rig will be moved to its next location.

Meanwhile, a Vessel of Opportunity (VO) will conduct periodic video surveys of Well -/6z to observe its continued integrity. If gas bubbles are still flowing from the -/6z location during and after the 24-hour Plug #2 WOC period, the rig will be moved from its 110/15-6z location to the 110/15-8 intersection well location, 100m from Well-/6z, and operations will start to drill the -/8 well to intersect, and kill, Well 110/15-6.

If bubbles are seen to re-start after the rig has departed the-/6z location by the periodic ROV survey, the rig will suspend its P&A activities at a natural break in the programme. It will then move to the 110/15-8 location to drill the intersection well and kill Well 110/15-6 and isolate the gas source with a permanent rock-to-rock barrier. Well 110/15-6 will be confirmed to be sealed during 110/15-8 operations when gas bubbles are no longer seen at the 110/15-6 location.

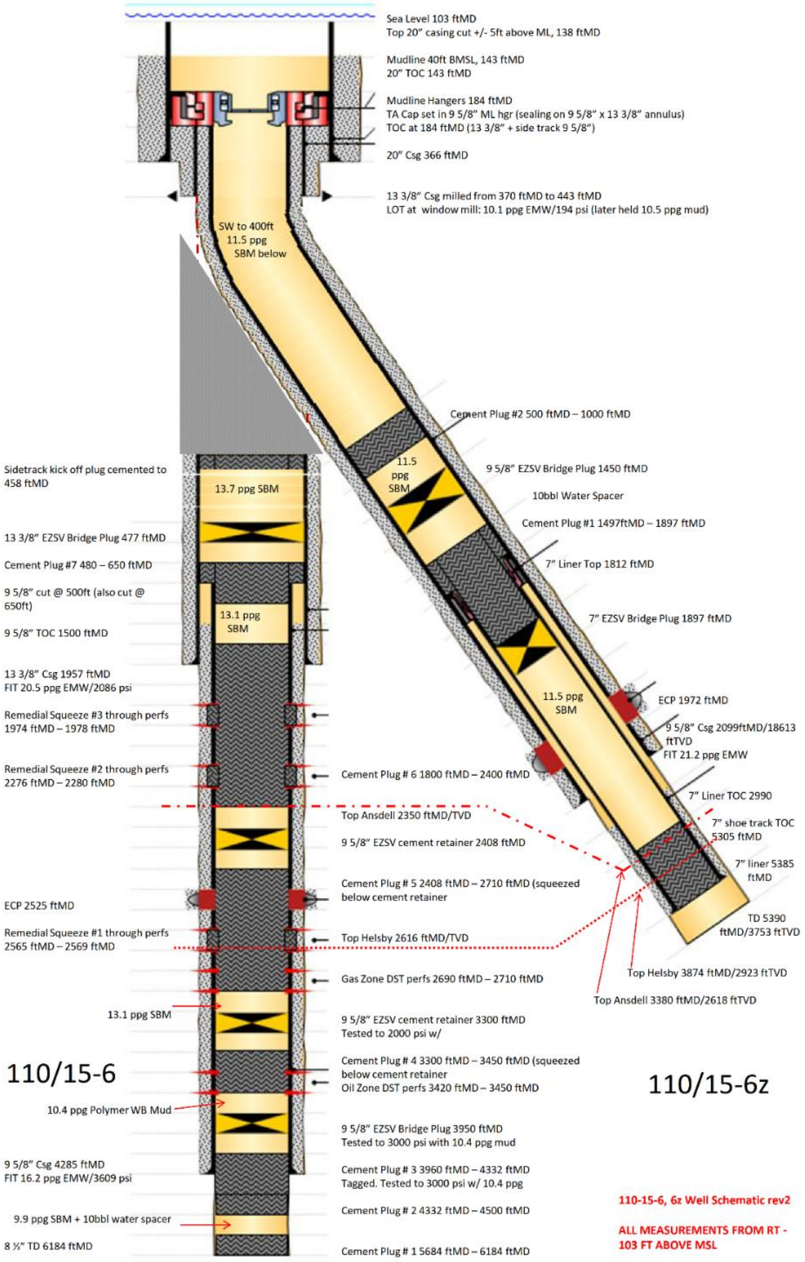


Figure 3.2: Cross section of Well 110/15-6, and 110/15-6z.

P&A activities at Well 110/15-8 will be completed to AB2 status, which will enable its location to be periodically video surveyed for gas bubbles by an ROV deployed from a VO. At 110/15-8 AB2, the rig will be moved off location to resume P&A operations across LBA.

The VO ROV will continue to run periodic video surveys of Well110/15-/8 and 110/15-6 and -/6z to observe their continued integrity.

P&A of Well 110/15-6z and 110/15-8, if drilled, will be to AB3 status (conductor and casings cut and recovered from 10 ft BML) by a VO after their successful long term monitoring is satisfactorily completed.

Eni UK-OpS - Asset Decommissioning - 110-15-6z abandonment procedure contains all the well abandonment details. In this document, Eni outlines the procedures for milling out the current barriers and installing new ones that will fully comply with OEUK Well Decommissioning Guidelines Issue 7, and OEUK Well Decommissioning CO_2 Storage Guidelines Issue 1. Eni anticipates that the present gas leak will be completely fixed by this process, and the integrity of the Lennox reservoir for long-term geological storage of CO_2 can be confirmed.

3.3.3 CO_2 storage sites

3.3.3.1 Geological characterisation

The three proposed storage sites (Hamilton Main, Hamilton North, and Lennox) are depleted oil and gas reservoirs managed by the Applicant that have been in production since 1996. Throughout this time, the assets have performed as expected without any exceptional event. The experience acquired has allowed the Applicant to develop a comprehensive understanding of the CO_2 storage sites.

The Hamilton Main and Hamilton North storage sites are shown as red areas on Figure 3.3, and the Lennox storage site in green, which are described as follows:

- **Hamilton Main** - The Hamilton Main field is a horst block structure located in the East Irish Sea Basin (EISB), Block 110/13, approximately 23 km from the Lancashire coast. The Hamilton Main field was discovered in 1990 by well 110/13-1 and has been appraised with a further two wells at the Hamilton platform. The discovery well encountered 155 m of gas-bearing from the Triassic Sherwood Sandstone Group with apparent gas water contact at about 887 m true vertical depth subsea (TVDSS). The field consists of a north-south trending horst block forming a structural trap fault-bounded on all sides with some dip closure, about 10 km long and 3 km wide. The reservoir comprises the Triassic Sherwood Sandstone Group, characterised by excellent permeability sand deposited by fluvial and aeolian processes. The Sherwood Sandstone Group extends over most of the EISB. The original (pre-natural gas extraction) pressure of the Hamilton reservoir was 97 bar and production began in 1997. As of October 2023, the reservoir recovery factor (RF) was 97% and the pressure was 4 bar.
- **Hamilton North** - The Hamilton North field is a structural trap consisting of several fault blocks that dip close to the south-east and are closed elsewhere, about 3 km long and 2 km wide. The fault blocks lie at the northern end of a horst feature running through Block 110/13. The field was discovered in 1991 (well 110/13-5), at the Hamilton North platform, which encountered about 144 m of the gas-bearing reservoir from the Triassic Sherwood Sandstone Group. The well found an apparent gas water contact of 965 m TVDSS and tested at 70 and 80 MMCFD from two intervals. The North Hamilton Field reservoir rock is represented by the Triassic Sherwood Group sandstones sealed by the overlying shales and evaporites of the Triassic Mercia Mudstone Group. The Sherwood Sandstone in the field comprises two formations, the St Bees Sandstone overlain by the Ormskirk Sandstone. The original (pre-natural gas extraction) pressure of the Hamilton North reservoir was 106 bar and production began in 1996. As of October 2023, the reservoir recovery factor (RF) was 94% and the pressure was 6 bar.
- **Lennox** - The Lennox field is in the EISB, approximately 5 km off the west coast of Lancashire and in shallow water (5-10 m depending on tidal excursions). The field is principally located within Block 110/15a, although it extends into the neighbouring Block 110/14c on its western flank. The field

was discovered in 1992 by exploration well 110/15-6, at the Lennox platform. The well targeted a four-way dip closed structure identified on 2D seismic lines shot between 1981 and 1990. Well 110/15-6 was drilled on the crest of the structure and encountered about 227 m gas column overlying a 44 m oil column. The reservoir interval is the still Triassic-aged Ormskirk Sandstone Formation, exhibiting high-quality reservoir sandstones throughout. Lennox is a mature saturated oil reservoir developed in time through two phases; oil rim development (phase I) and final gas cap blow down since 2012 (phase II, ongoing). The original (pre-natural gas extraction) pressure of the Lennox reservoir was 112 bar and production began in 1996. As of October 2023, the reservoir gas recovery factor (RF) was 91% and the pressure was 7 bar.

The Triassic-aged Ormskirk Sandstone Formation belonging to the Sherwood Sandstone Group represents the reservoir for all three fields. It consists of fluvial and aeolian sandstones of variable grain size. The quality of the Ormskirk Sandstone reservoir is extremely high with average porosities of between 14% and 19%.

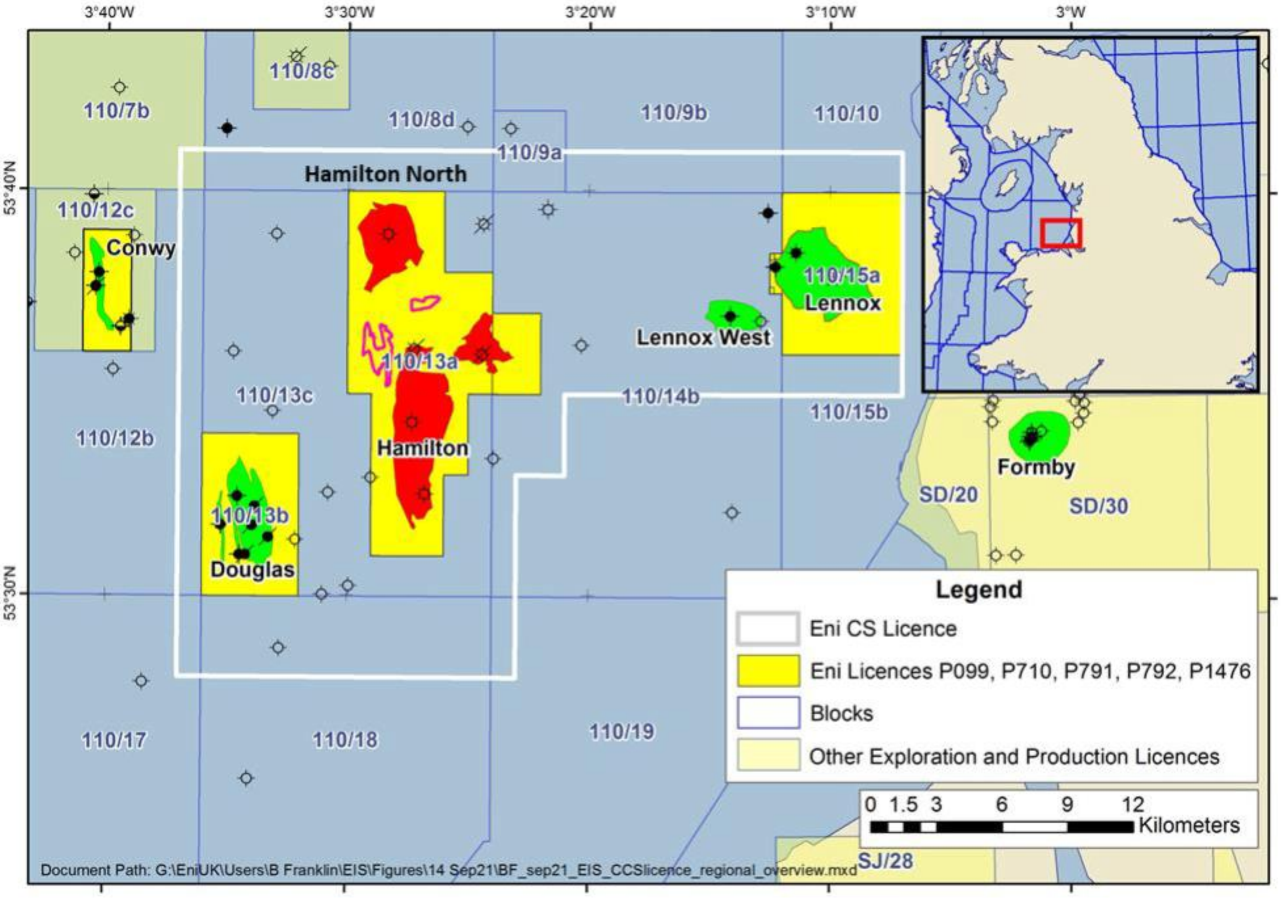


Figure 3.3: Location of the storage sites in relation to the Eni licence blocks

3.3.3.2 Seal description

The Mercia Mudstone Group (MMG) provides the top seal, which consists of a cyclic sequence of sandy mudstones and halites. The Rossall and Mythop halites are less than 15 m thick each while the Preesall Halite has a thickness between 150 m and 223 m.

The geological formations shown in Figure 3.4 identify the main barriers (primary, and secondary seals) preventing the upwards migration of CO_2, their relationship to the Storage Site, and Storage Unit, and their place within the overall Storage Complex. The Primary and Secondary Seals comprise the following geological formations:

- **Primary seal:** Blackpool Mudstone, Rossall Halite; and Ansdell Mudstone.

- **Secondary seal:** Dowbridge Mudstone, Preesall Halite, Cleveleys Mudstone; and Mythop Halite.

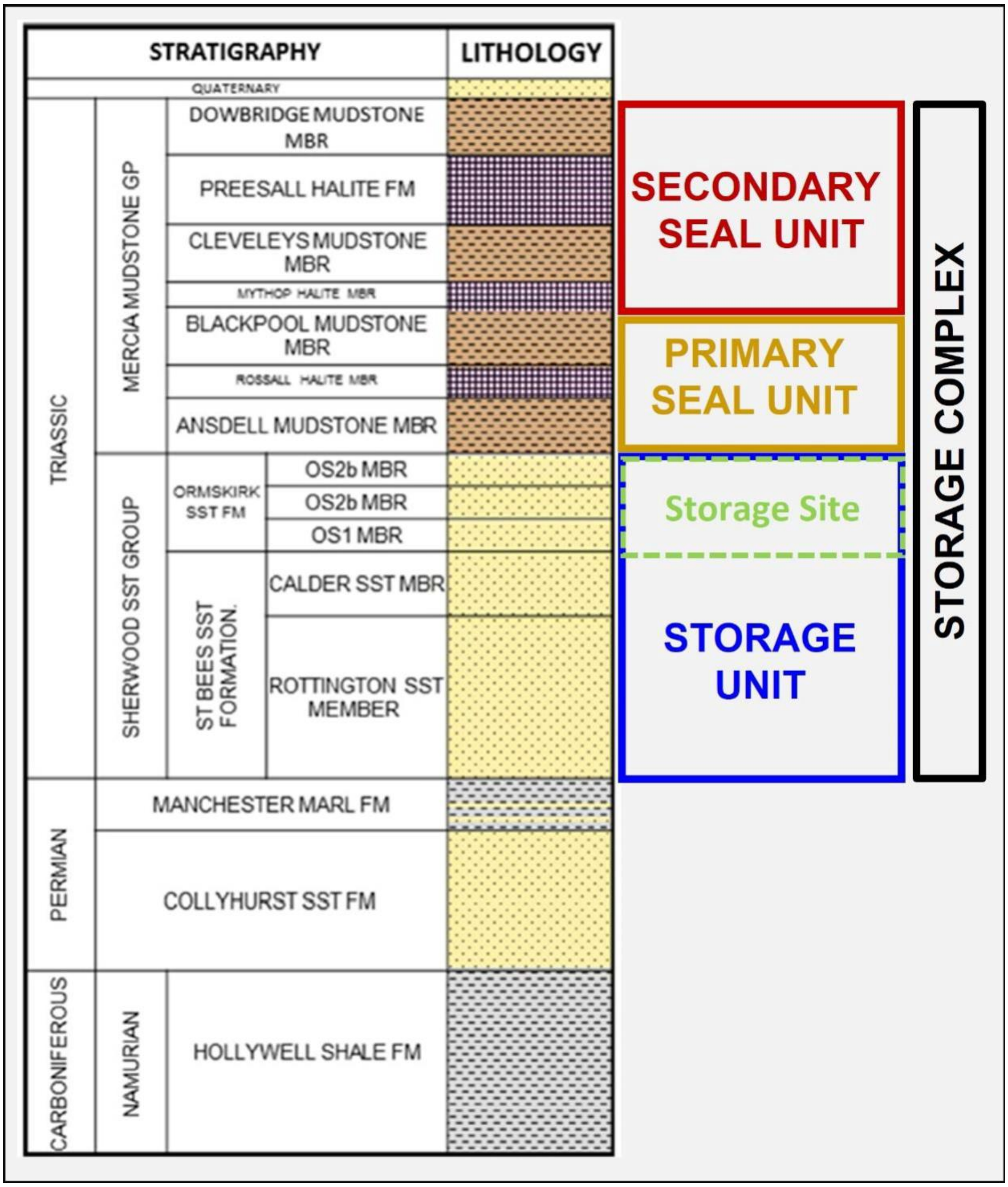


Figure 3.4: Relationship of storage unit and storage complex to the cap rocks

The project base case scenario foresees the injection of 109 Mt of CO_2 in 25 years, with a constant rate of 4.5 MTPA after an initial ramp up phase. The identified injection strategy will ensure that the three fields experience a comparable re-pressurisation trend during the whole injection period.

3.3.4 Wells

3.3.4.1 Preparation of CO_2 injection wells

The development of the Hamilton Main, Hamilton North, and Lennox hydrocarbon depleted reservoirs for CO_2 storage requires the drilling and re-completion of wells for CO_2 injection, by side-tracking existing production wells.

In addition to the CO_2 injector wells, monitoring, and sentinel wells are planned for CO_2 conformance and containment monitoring, and to inform the Monitoring Plan, during the pre-injection, operation, and post closure phases.

Their locations have been selected to accommodate the Monitoring Plan needs and target sensitive areas that require tailored monitoring.

The current base case for the Proposed Development includes a total of 13 wells, of which:

- eight will be CO_2 injector wells (four at Hamilton Main, two at Hamilton North, and two at Lennox). These will be drilled as side-tracks from existing producer wells, within the existing footprint (template) of each platform, to install CO_2 resistant tubulars and cement;
- two will be new monitoring wells (one at Hamilton Main, and one at Hamilton North). These will target areas on the flanks of the reservoirs not previously drilled hence why new wells will be needed;
- one will be an additional monitoring well, side-track from an existing producer well within the existing footprint (template) of the platform. This will be drilled at the Lennox field; and
- two will be sentinel wells (one at Hamilton North, and one at Lennox). These wells will be existing wells within the existing footprint (template) of each platform that will be recompleted for additional reservoir monitoring. They will not have CO_2 resistant cement or tubulars. As such, they will be Plugged and Abandoned (P&A) once the CO_2 front in the reservoir reaches them.

All CO_2 injection and monitoring wells will be drilled from the existing platform well slots (either as side-track or as new ones), while the sentinel wells will be only recompleted and therefore not require any drilling activity.

3.3.5 Offshore platforms

3.3.5.1 Douglas CCS platform

Overview

A new Douglass CCS platform will be installed to the northwest to the exiting Douglas complex, just beyond the blow-out/H_2S dispersion radius of the existing facilities at approximate coordinates E461607 N5932596. The new Douglas CCS platform will be a Normally Unmanned Installation (NUI), acting as a hub for the CCS operations. It will provide overnight emergency shelter in a purpose-built module for six persons. The location of the new Douglas platform in relation to the existing Douglas complex is shown in Figure 3.5.

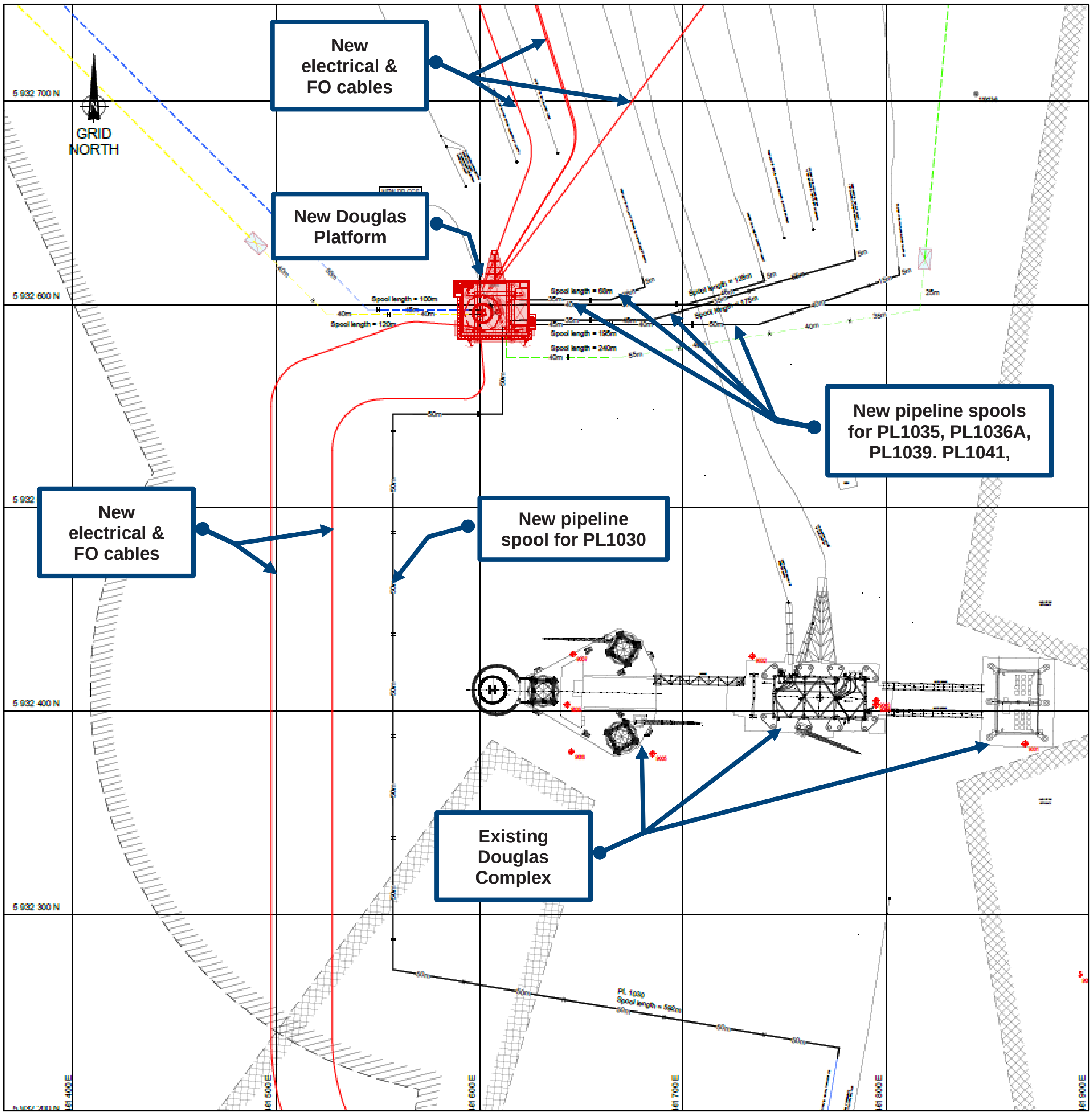


Figure 3.5: Location of New Douglas CCS platform and existing Douglas complex, and existing gas pipelines connections to New Douglas

Access to the platform will be by helicopter. A boat landing will also be provided onto the platform. The helideck is designed for helicopter approach from the West South West (WSW) including the required obstacle free zone and marking according to CAP 437 (standards for offshore helicopter landing areas) requirements.

Douglas CCS platform topsides

The topsides, shown in Figure 3.6, will comprise cellar, mezzanine, and weather decks, and have overall dimensions of approximately 33 m in length, 30 m in width, and 35.5 m in height to the weather deck/helideck.

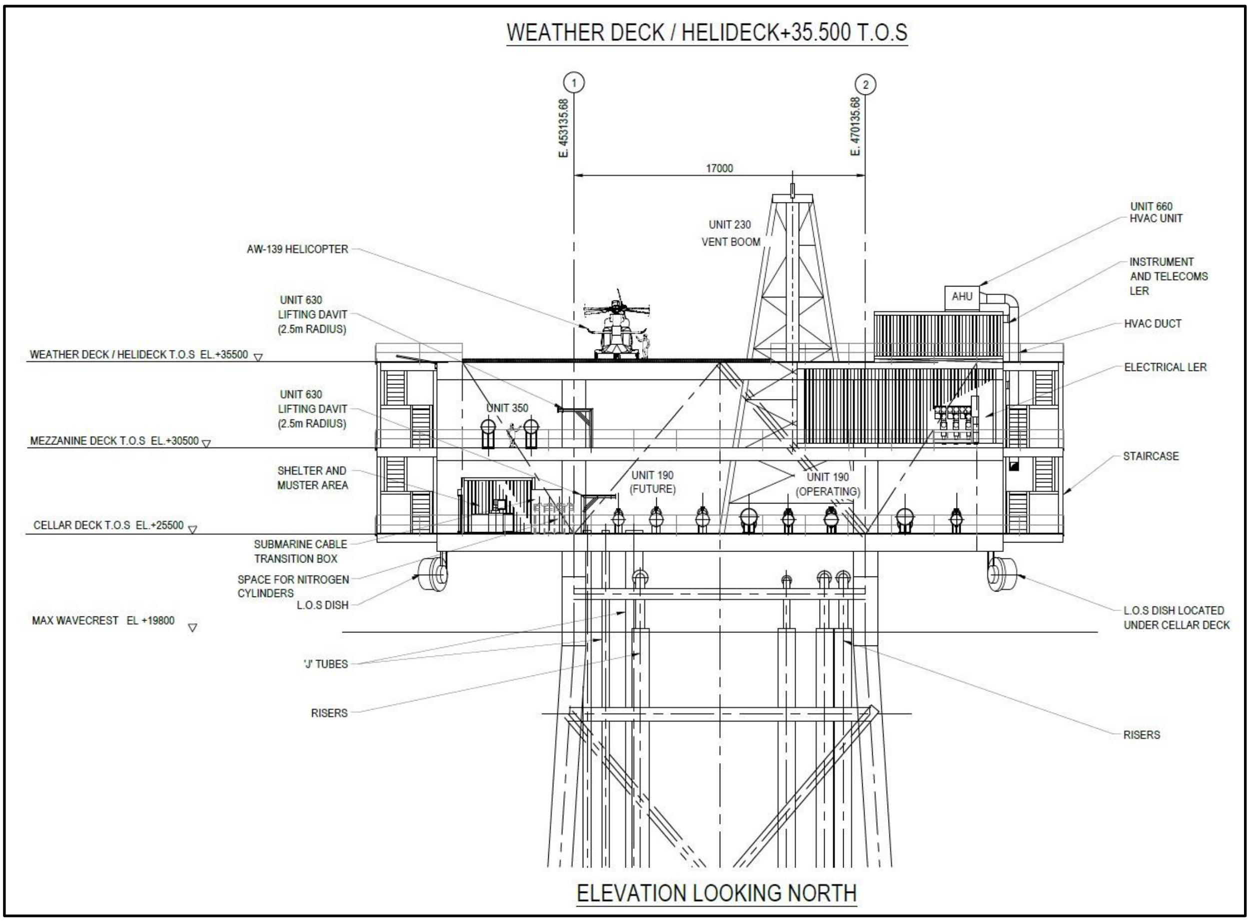


Figure 3.6: New Douglas CCS Platform Topsides

The main equipment located on the cellar deck, and mezzanine deck are set out in Table 3.1. The weather deck will comprise the helideck, four temporary lifting pad-eyes and a modularised instrument/telecoms room.

Table 3.1: Equipment located on cellar deck, and mezzanine deck

Cellar Deck	Mezzanine Deck
• pig launchers and pig receivers. • Emergency Shutdown (ESD) valving and riser pipework. • emergency overnight shelter. • survival craft. • davit crane(s). • submarine cable transition box. • J-tube head.	• electrical local equipment room. • battery room. • piping manifold area. • CO_2 gas heaters. • deck stair access to either cellar or weather decks. • helideck fire/foam fighting skid. • Heating, Ventilation, and Air Conditioning (HVAC) unit for instrumentation and electrical equipment room.

Douglas CCS jacket structure

The Douglas CCS jacket shown in Figure 3.7 will be a four-legged steel structure measuring approximately 20 m x 20 m at the lower level and 17.5 m x 17.5 m at the upper level. The jacket will support several equipment items listed below:

- 8 risers, of which 3 are provision for future dense phase gas;
- 5 J-tubes, of which one is provision for a possible future cable from PoA;
- 4 caissons for riser support;

- caisson for J-tubes support;
- cathodic protection monitoring J-tube; and
- Zodiac landing platform.

The jacket will be piled into the seabed. The piles will be vertically driven through the pile sleeves which are in turn are attached to the jacket legs via the use of shear plates, yoke plate, and stiffeners. The jacket is primarily designed to support both the lateral loads attributed to the environmental loads (wind, waves, etc.) as well as the vertical loads from the topsides. The foundation piles will transfer both the jacket weight and topsides loads directly to the soil. Each pile will be approximately 1.5 m in diameter and 40.25 m in length, with a penetration depth of around 22 m.

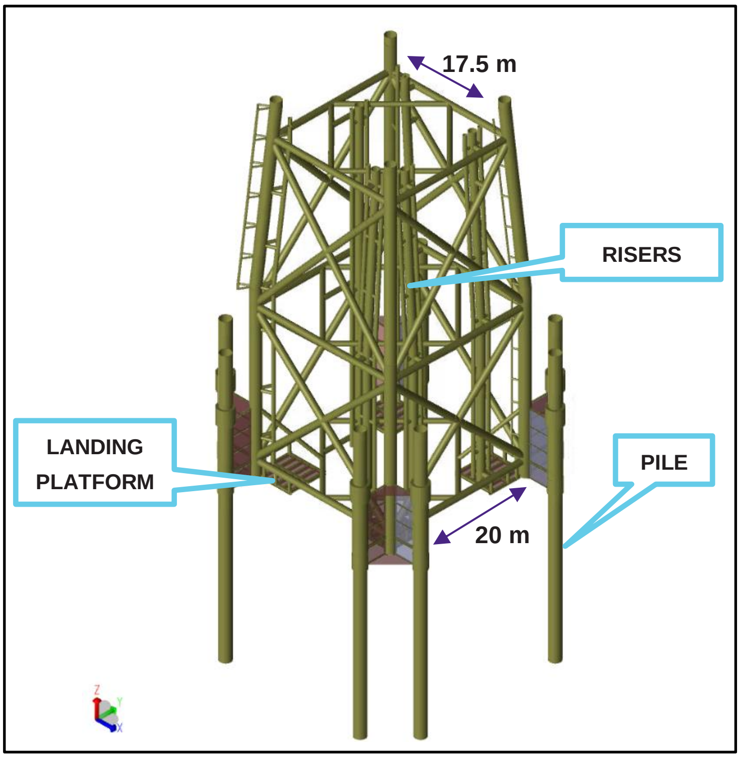


Figure 3.7: New Douglas CCS Platform Jacket Structure

3.3.5.2 Satellite platforms

The new Douglas CCS platform will receive and distribute CO_2 to the Hamilton Main, Hamilton North, and Lennox OPs. When necessary, the Douglas platform will additionally provide pressure control and heating prior to distribution of the CO_2 to the three fields. The existing Hamilton Main, Hamilton North, and Lennox OPs will be redeveloped in an incremental manner for CO_2 service, as dictated by the availability of CO_2 from the emitters.

The outcome of the Front-End Engineering Design (FEED) studies has demonstrated that a modular approach (consisting of the installation of a new module including the facilities necessary for CO_2 treatment and injection) for the modification of the satellite wellhead OPs (Hamilton Main, Hamilton North, and Lennox) is not viable. These substructures do not possess the reserve strength required to support the additional topsides weight without removal of the existing topside structures. It has, therefore, been determined that the only feasible approach is the removal of the existing topsides and the installation of new purpose-built topsides, with the installation of new risers and J-Tubes within the perimeter framework of the existing jacket to avoid additional protection frames and their additional loads on the substructures.

A new deck will be installed on each of the satellite platforms (Hamilton Main, Hamilton North, and Lennox) after removal of the existing topsides. The components will be delivered to the OPs completely fabricated and ready for integration onto their respective jackets. The main fabricated components are detailed in Table 3.2.

Table 3.2: Modules For Satellite Platforms

Platform deck	Estimated Dimensions	Estimated Dry Weight	Equipment Accommodated
Hamilton Main Integrated Deck	L: 23 m X W: 26 m X H: 12 m	~1,100 tonnes	Helideck Electrical heaters and controls Battery room UPS system Instrument room (telecoms)
Hamilton North Integrated Deck	L: 23 m X W: 26 m X H: 12 m	~950 tonnes	Helideck Electrical heaters and controls Battery room UPS system Instrument room (telecoms)
Lennox Integrated Deck	L: 24 m X W: 30.5 m X H: 12 m	~1,400 tonnes	Helideck Electrical heaters and controls Battery room UPS system Instrument room (telecoms)

3.3.5.3 Offshore accommodation flotel

It is expected that the offshore construction workforce will be accommodated in a flotel adjacent to the New Douglas CCS platform, utilising a ‘walk-to-work’ system suitable for year-round working. The flotel would come on station after the departure of the main offshore Heavy Lift Vessel (HLV) (see section 3.4.2). It is assumed that the Flotel will also be present during the Commissioning and Start-Up activities.

3.3.6 Pipelines

3.3.6.1 Repurposing of existing pipelines

Figure 3.8 shows a schematic diagram of the different pipelines currently in use transferring hydrocarbons from satellite wellhead platforms to the Douglas complex, and onward export from Douglas to Storage and the Point of Ayr Terminal. Most of this network will be repurposed for CO_2 transportation.

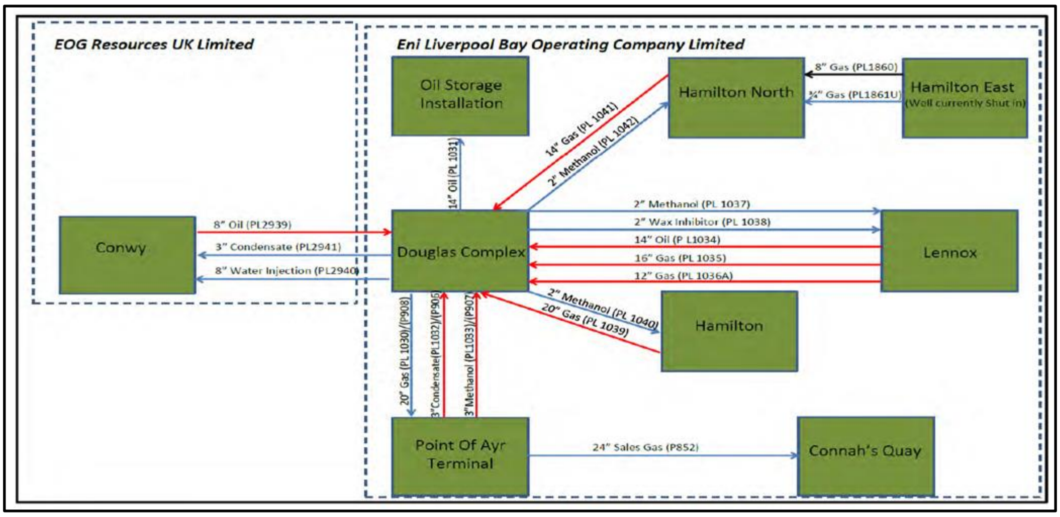


Figure 3.8: Liverpool Bay Area Existing Pipeline Schematic

New connections to existing gas pipelines

CO_2 will be transported from PoA to Douglas via the existing 20” pipeline, approximately 600 m of which will be rerouted to the new Douglas CCS platform. Four pipelines will then convey CO_2 from the new Douglas CCS Platform to the satellites. Whilst much of the existing pipeline infrastructure will be repurposed to transport CO_2, the end sections of each pipeline at Douglas would be rerouted to the new Douglas CCS platform. The following lengths of new pipeline will be required to connect to the new Douglas CCS platform, as shown in Figure 3.5:

- PL1030, existing 20" gas to Point of Ayr (approximately 592 m);
- PL1039, existing 20” gas export from Hamilton Main (approximately 175 m);
- PL 1041, existing 14” gas export from Hamilton North (approximately 68 m);
- PL1035, existing 16” gas export from Lennox (approximately 128 m); and
- PL1036A, existing 12” gas injection to Lennox (approximately 195 m).

The existing PL1034, 14” Douglas to Lennox pipeline will not be re-used for CCS and will be left in situ.

In addition to laying these pipeline lengths on the seabed, PL1030 may also require some external protection in the form of concrete mattresses over approximately 400 m of its length. The 200 m of this pipeline closest to the new Douglas CCS platform will not be provided with any external protection. No external protection will be provided for the other pipeline connections, as these lengths are all within 200 m of the new Douglas CCS platform. Material quantities for the protection of pipeline connections are given in Table 3.3.

Table 3.3: Design Envelope: material quantities for mattress protection of pipeline connections

Pipeline ID	Steel pipe (m)	No. concrete mattresses	Dimensions of each concrete mattress (m)	Weight of each mattress (kg)	Total weight of concrete mattresses (kg)
PL1030 20”	608	110	6 x 3 x 0.3	9,800	1,078,000
PL1039 20”	309	70	6 x 3 x 0.3	9,800	686,000
PL1041 14”	205	50	6 x 3 x 0.3	9,800	490,000
PL1035 16”	263	60	6 x 3 x 0.3	9,800	588,000
PL1036a 12”	329	70	6 x 3 x 0.3	9,800	686,000

In addition to the concrete mattresses used for stabilisation of the pipeline spools, concrete sleepers (rubber coated) will be required for the crossings on approach to the new Douglas platform comprising:

- 2 sleepers (6m x 2m x 1.1m) for 14” Spool PL1041 and 14” PL1031
- 2 sleepers (6m x 2m x 1.1m) for 20” Spool PL1039 and 12” PL1036A

Grout bags will be used to support spool pieces and provide protection for infield umbilicals. The footprint of the grout bags is unlikely to lie outside of that calculated for concrete mattresses. The material quantities for grout bags are given in Table 3.4.

Table 3.4: Design Envelope: material quantities for grout bags at pipeline connections

Pipeline ID	Grout bag type	No. grout bags	Dimensions of each grout bag	Weight of each grout bag (kg)	Total weight of grout bags (kg)
PL1030 20”	Pyramid	1	3 m x 3 m x 2.8 m	-	-
	Regular	100	500 mm x 300 mm x 75 mm	20	2,000
PL1039 20”	Pyramid	1	3 m x 3 m x 2.8 m	-	-
	Regular	100	500 mm x 300 mm x 75 mm	20	2,000

Pipeline ID	Grout bag type	No. grout bags	Dimensions of each grout bag	Weight of each grout bag (kg)	Total weight of grout bags (kg)
PL1041 14”	Pyramid	1	3 m x 3 m x 2.8 m	-	-
	Regular	100	500 mm x 300 mm x 75 mm	20	2,000
PL1035 16”	Pyramid	1	3 m x 3 m x 2.8 m	-	-
	Regular	100	500 mm x 300 mm x 75 mm	20	2,000
PL1036a 12”	Pyramid	1	3 m x 3 m x 2.8 m	-	-
	Regular	100	500 mm x 300 mm x 75 mm	20	2,000

The existing pipelines to be re-utilized for gas phase have been assessed to suit the CO_2 injection. There are no additional modifications needed for the purpose of transporting CO_2 other than rerouting the short pipeline sections to tie-in to the new Douglas CCS platform.

From assessments conducted to date, it has been concluded that no existing process or utility systems are suitable for reuse due to their age and condition.

3.3.6.2 Pipeline contents temperature increase

Natural gas currently flows into the PoA terminal from offshore production. As the natural gas reaches the foreshore pipeline, having travelled from the Douglas Process OP through the marine environment, it is at or near equilibrium with the sea temperature. With the Proposed Development, CO_2 will flow from the PoA terminal out through the foreshore pipeline to the Douglas Process OP. Compression at the PoA terminal will increase the temperature of the gas. There is the potential for this to increase the temperature of the surrounding environment of the foreshore and offshore pipeline. Studies (Wood, 2023) have been undertaken to understand the effect of heat from the Proposed Development. The findings of these studies are presented in the relevant topic chapters of this ES.

3.3.7 Offshore electrical and fibre optic cables

Douglas Process OP currently supplies 13.8 kV, 60 Hz power through the existing gas-fuelled turbine installed on the platform to Hamilton Main and Hamilton North OPs via a subsea cable. The Lennox OP is provided with power, in series, from Hamilton Main OP.

None of the existing inter-platforms subsea power cables have been deemed suitable for re-use for CO_2 service, consequently new inter-platform power cables would be installed as part of the Proposed Development. The Proposed Development will therefore require the electrification of Douglas OP from the Onshore PoA Terminal, as the existing gas-fuelled turbine on Douglas OP will no long have a fuel supply at the end of gas production from the Liverpool Bay assets.

It is expected that the main power to Douglas OP would be extended from PoA Terminal with two new 33 kV, 50 Hz subsea cables integrated with fibre optic (FO) connection. Power will then be distributed from Douglas OP to Hamilton Main, Hamilton North and Lennox Ops through a new single 33 kV, 50 Hz subsea cable integrated with FO, connecting Douglas OP to each of the three wellhead platforms Figure 3.1. The Offshore power and FO cables will, as a general principle, follow the alignment of the existing pipelines at an offset of around 100 m, and there may be a need to micro-route the cables around identified obstructions such as heritage assets, and unexploded ordnance (UXO).

There is planned to be 35,000 m (35 km) of Offshore power and FO cables (35 km each, for the two parallel Offshore power and FO cables) which would lead from PoA Terminal to Douglas OP. There is an additional requirement of 72,000 m (72 km) of inter-platform cabling. Approximately 15,000 m (15 km) of this subsea cabling would be present from Douglas OP to Hamilton North OP, while 12,000 m (12 km) would be present from Douglas OP to Hamilton Main OP and 35,000 m (35 km) of inter-platform cabling would be present from Douglas OP to Lennox OP (Figure 3.1 and Table 3.5). Each of the cables will have to cross several existing pipelines and cables. The number of crossings by each cable, and the typical composition of the external cable protection at these locations is presented in Table 3.5 and Table 3.7.

Table 3.5: Design Envelope: Cables

Parameter	Number of crossings	Cable Length
Cables from PoA Terminal to Douglas OP	10	35,000 m
Inter-platform cable from Douglas OP to Hamilton North OP	8	15,000 m
Inter-platform cable from Douglas OP to Hamilton Main OP	8	12,000 m
Inter-platform cable from Douglas OP to Lennox OP	6	35,000 m

The crossings for the three inter-platform cables are over existing Eni owned gas and oil pipelines. The cables from PoA Terminal to Douglas OP will cross third-party electrical cables, as described in Table 3.6.

Table 3.6: Design Envelope: Third Part Cable Crossings

Crossing ID	Third-party owner	UTM Easting (m)	UTM Northing (m)	Water depth (m)	Water above berm (m)	Berm height (m)
PoAX-1	Ørsted Burbo Bank wind farm	470974.84	5916002.39	5	4.2	0.8
PoAX-2	Greencoat UK Wind North Hoyle wind farm	468795.03	5916535.10	7	6.2	0.8
PoAX-3		468776.17	5916536.68	7	6.2	0.8
PoAX-4	Gwynt y Môr OFTO, Gwynt y Môr wind farm	461904.20	5917763.30	12	11.2	0.8
PoAX-5		461875.07	5917817.57	12	11.2	0.8
PoAX-6		461713.35	5924702.50	20	19.2	0.8
PoAX-7	National Grid/Scottish Power, Western Link HVDC cable	461713.35	5930787.10	30	29.2	0.8
PoAX-8		461713.35	5930818.38	30	29.2	0.8

Where the new Offshore power and FO cables cross existing pipelines and cable, they will require external cable protection consisting of freshly quarried rock, sand-filled geotextile bags, and concrete mattresses. There are likely to be four different crossing types that will each have their own external protection arrangements. However, the arrangements for buried pipelines and cables will be similar, as will those for seabed pipelines and cables. These are described in Table 3.7, and illustrated in Figure 3.9, and Figure 3.10.

Table 3.7: Design Envelope: Cable Crossings External Protection

Crossed infrastructure	Materials	Dimensions
Buried cable	Concrete mattresses, sandbags, and freshly quarried rock	200 m length x 7 m width x 0.8 m height
Seabed cable	Concrete mattresses and sandbags	200 m length of 18 No. 6 m x 3 m concrete mattresses
Buried pipeline	Concrete mattresses, sandbags, and freshly quarried rock	200 m length x 7 m width x 0.8 m height
Seabed pipeline	Concrete mattresses and sandbags	200 m length of 22 No. 6 m x 3 m concrete mattresses

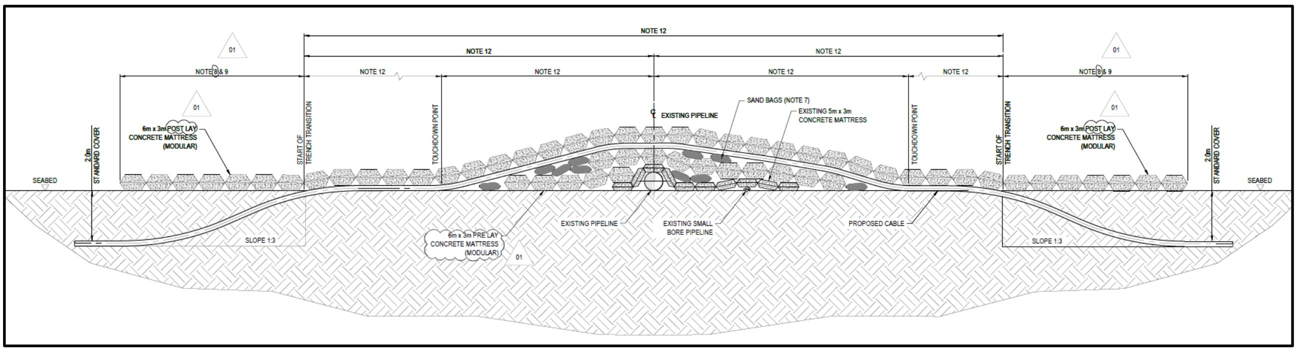


Figure 3.9: Cross Section Of Typical Arrangement For Crossing Of Existing Seabed Pipeline (arrangement for crossing existing seabed cable will be similar)

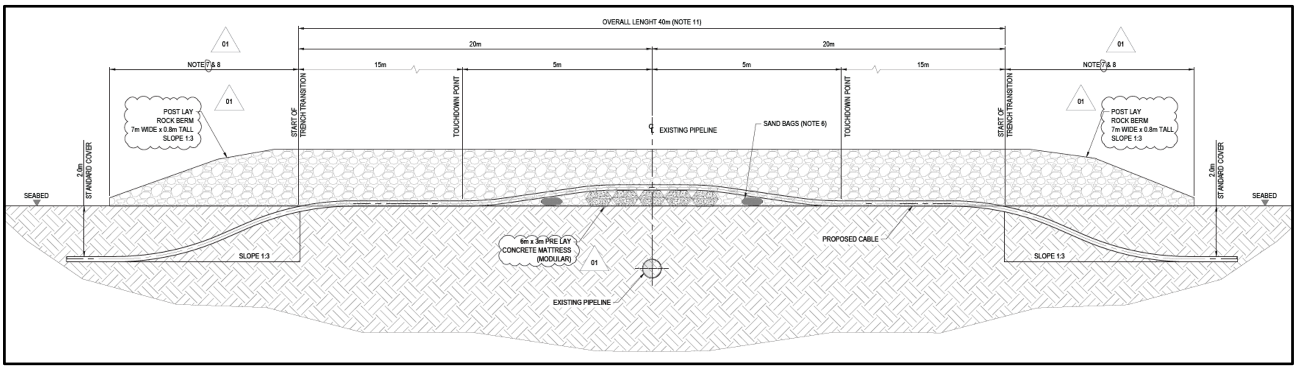


Figure 3.10: Cross Section Of Typical Arrangement For Crossing Of Existing Buried Pipeline (arrangement for crossing existing seabed cable will be similar)

Each of the offshore cables will comprise a 3-core 33 kV armoured electrical cable with bundled fibre-optic cable and an external diameter of 153 mm. The single armoured submarine cables comprise a copper conductor, XLPE (Cross Linked Polyethylene), copper wires, and copper foil bonded to the polyethylene sheath. External protection will be required on each of the electrical cables on their final approaches to the new Douglas platform and at the crossings of existing pipelines and cables. The material quantities for the cable protection are given in Table 3.8.

Table 3.8: Design Envelope: material quantities for protection of electrical cables

Cable/crossing ID	Protection type	Number	Dimensions (m)	Weight (kg)	Total weight (kg)
PoA to new Douglas Cable 1	Concrete mattress	35	6 x 3 x 0.3	9,800	343,000
PoA to new Douglas Cable 1	Concrete mattress	35	6 x 3 x 0.3	9,800	343,000
New Douglas to Hamilton North	Concrete mattress	50	6 x 3 x 0.3	9,800	490,000
	Rock	-	1,000	12,000 – 16,000 per linear metre	12,000,000 – 16,000,000
New Douglas to Hamilton Main	Concrete mattress	100	6 x 3 x 0.3	9,800	980,000
New Douglas to Lennox	Concrete mattress	60	6 x 3 x 0.3	9,800	588,000
	Rock	-	-	12,000 – 16,000 per linear metre	12,000,000 – 16,000,000
	Concrete mattress	64	6 x 3 x 0.3	9,800	686,000

Cable/crossing ID	Protection type	Number	Dimensions (m)	Weight (kg)	Total weight (kg)
PoA to new Douglas Cable 1, 10x crossings	Rock	-	1,000	12,000 – 16,000 per linear metre	12,000,000 – 16,000,000
PoA to new Douglas Cable 2, 10x crossings	Concrete mattress	64	6 x 3 x 0.3	9,800	686,000
	Rock	-	1,000	12,000 – 16,000 per linear metre	12,000,000 – 16,000,000

3.4 Offshore construction

3.4.1 Introduction

This section summarises the key Offshore construction activities of the Proposed Development. In addition, it provides details on the temporary infrastructure required for the installation of the offshore cables and associated permanent infrastructure.

Construction of the Proposed Development is anticipated to start in 2024, to enable operation to commence during 2026 and 2027.

3.4.2 Drilling

3.4.2.1 Wells overview

Table 3.9 presents an overview of the thirteen proposed CCS wells including their surface location coordinates, estimated Measured Depth (MD) and estimated True Vertical Depth (TVD).

Table 3.9: Overview Of Wells

Purpose	Well type	Field	Well name	Easting	Northing	Proposed kick-off point m MD	Measured Depth (MD) m	True Vertical Depth (TVD) m
Injector	Sidetrack	Hamilton	H1ST1	469685	5936706.2	863	1498	932
			H2ST1	470200.5	5937333.5	1686	2380	932
			H3ST1	470200.5	5935501.56	893	1366	932
			H4ST1	470200.5	5934462.3	1579	2219	933
		Hamilton North	N1ST	468323	5945412.5	783	1403	971
			N3ST	468323	5944406.4	713	1043	1010
		Lennox	L13ST2	489487.6	5942334.3	678	1668	865
			L5ST1	489487.6	5942938.2	625	1947	1124
Monitor	New well	Hamilton	HM_M2_1	470848.6	5936608.7	N/A	1894	960
		Hamilton North	HN_M2_1	468084.6	5945670.8	N/A	1781	1043
	Sidetrack	Lennox	LX_M3_2	490155.3	5941955.3	625	2466	1114
Sentinel	Recompletion	Hamilton North	HN_M3	469272	5944899	N/A	N/A	N/A
		Lennox	LX-M2_1	487637	5941932	N/A	N/A	N/A

3.4.2.2 CO_2 injection wells

Hamilton Main

At Hamilton Main, CO_2 four injection wells are required, which means that all four current production wells will be side-tracked. Each side-tracked wellbore will be carried out from a jack-up vessel and take approximately 35 days to complete. This will comprise around 15 days for drilling, and 20 days for completion. Waste streams from the vessels would be shipped onshore for onshore processing and disposal.

Hamilton North

At Hamilton North, two injection wells are required, which means that two of the current production wells will be sidetracked. The proposed drilling targets provided are very close to the existing wellbores. Where the sidetrack occurs at more than 60 degrees inclination, the target has been optimised on the right-hand side to assist building away from the wellbore.

Lennox

Two injection wells are planned for Lennox. However, three suitable target locations have been identified, two eastern and one western. Priority was placed on hitting at least one of the eastern targets. As mentioned above, the directional challenges are significantly greater at Lennox due to a change in depth of the reservoir target compared to the original production wells. As such, very few of the existing wells are deemed suitable for sidetracking. Only L05, L13 and L01z have been identified as candidates. L01 would require a difficult slot recovery to complete the sidetrack. L05 and L13 will also require casing recovery to sidetrack at the 13 3/8” shoe.

3.4.2.3 Monitoring wells

Two new dedicated monitoring wells, one each at Hamilton North, and Lennox, will be drilled. These are required to enable the calibration of 4D seismic data, to monitor the structural spill point, and to calibrate the 3D reservoir models. Overall, their objective is to monitor both CO_2 conformance and containment, which will be carried out through the acquisition of pressure and temperature data (via permanent bottom-hole gauges), as well as fluid sampling and 3D Vertical Seismic Profile (VSP).

The two monitoring wells will be drilled to a maximum depth of between 914 m to 975 m TVD. The target depth for Hamilton North, and Hamilton Main would be 782 m TVD, and 838 m TVD respectively. Drilling will be carried out from a jack-up vessel and take approximately 50 days to complete. This will comprise around 30 days for drilling, and 20 days for completion. As there is no riser back to the rig, drill cuttings would be left on the seabed, with the estimated quantity being around 140 m^3 per well. Waste streams from the vessels would be shipped onshore for onshore processing and disposal.

The Lennox monitoring well would be side-tracked from an existing production well, with a target depth of 831 m TVD, and maximum depth of 1067 m TVD. Drilling will be carried out from a jack-up vessel and take approximately 45 days to complete. This will comprise around 25 days for drilling, and 20 days for completion.

3.4.2.4 Sentinel wells

A decision is still pending on whether the two sentinel wells would require the installation of fibre optics. If fibre optics are not required, it is conceivable that these wells would not require a workover and would only require a slickline intervention. The data acquisition requirements for the sentinel wells would be via cased hole logging on an annual basis for three years, and downhole pressure measurement. If wireless gauges can be used for the downhole measurements, a workover of the wells could be avoided.

3.4.2.5 Programme for wells installation

The drilling and side-tracking of CO_2 injection wells will be carried out at each of the Hamilton Main, Hamilton North, and Lennox platforms. Figure 3.11 shows that the works at Hamilton North will take approximately five months commencing in September 2024. The drilling works are comprised of three main activities: plugging and abandonment of the existing wells (via separate Decommissioning Plan); side-tracking; and completion of wells to be used for CO_2 injection. Perforation of the wells is then scheduled later during November/December 2027. The works at Hamilton Main involve the same main activities and are scheduled to commence in February 2025 and take approximately seven months. Perforation of the wells is then scheduled later during August/September 2027. The last works in the sequence at the Lennox platform are planned to take around 12 months commencing in October 2025. Perforation of the wells is then scheduled later during April/May 2028.

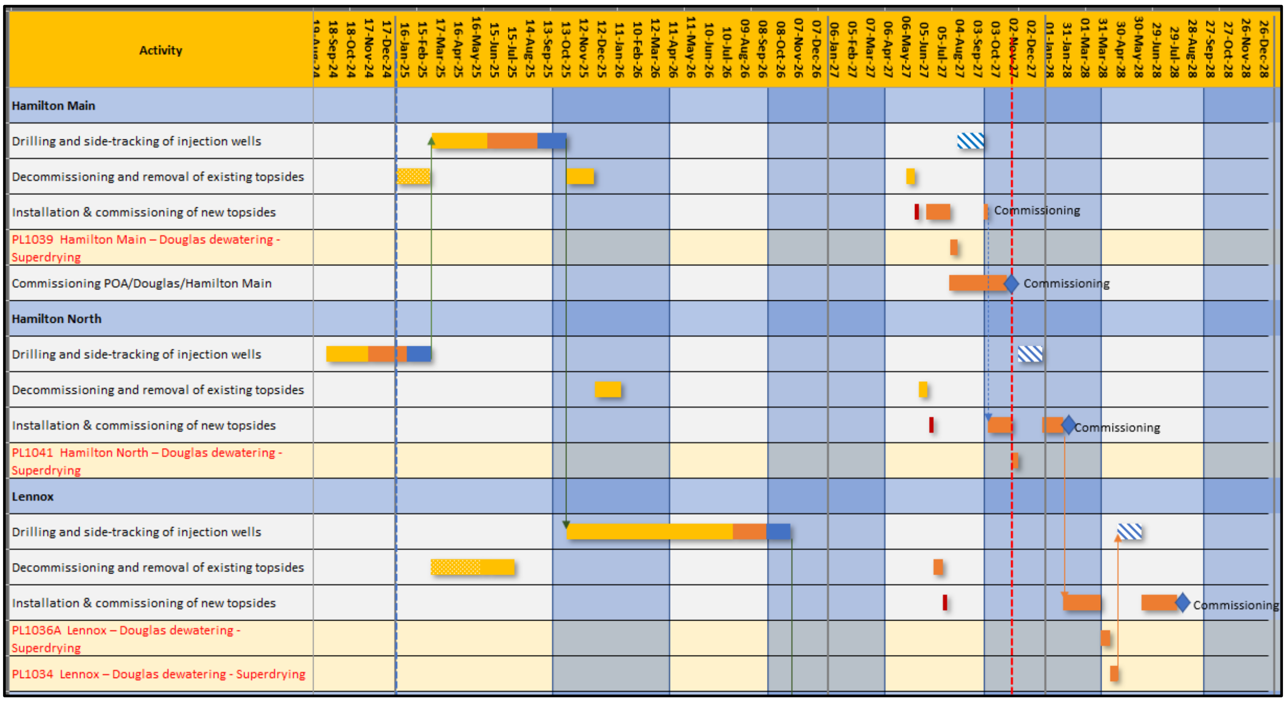


Figure 3.11: Summary Programme for Installation and Commissioning CO_2 Injection Wells and Satellite Platforms

3.4.3 Offshore platforms

The Proposed Development will re-utilise the existing jackets of Hamilton Main, Hamilton North, and Lennox Oil and Gas Platforms. Structural assessments have been performed that have identified that they are suitable to support the modifications required for CO_2 service.

The new Douglas CCS platform jacket will be designed to allow the structure to be installed offshore as a direct lift from the transportation barge to its field position. Installation of topsides would utilise a HLV or a Floating Shear Legs (FSL) crane. A standard 300' barge (91 m x 27.5 m) will be utilised for transporting the topsides.

The new topsides for the satellite platforms will be installed as single units using a HLV or Crane Barge. Figure 3.11 shows that the jackets of Hamilton Main, Hamilton North, and Lennox will be installed sequentially during May-July 2027. The potential vessels required for installation of the fabricated modules and equipment packages is shown in Table 3.10.

Table 3.10: Illustrates The Offshore Installation Methodology

Platform	Water Depth (LAT)	Module/Equipment		Installation Equipment
		Item	Est. Lift Weight (Gross, rounded)	
Douglas CCS	29.2 m	Jacket	2,940 tonnes	Transportation barge, direct lift.
		Topsides	2,290 tonnes	Transportation barge and HLV or FLS
Hamilton Main OP	25.8 m	Deck replacement	1,100 tonnes	HLV 2,500t class
Hamilton North OP	22.1 m	Deck replacement	900 tonnes	HLV 2,500t class
Lennox OP	7.2 m	Deck replacement	1,300 tonnes	HLV 2,500t class

The present structural design for the new Douglas CCS platform allows for eight jacket foundation piles: two at each leg. The foundation piles will be prefabricated at an onshore facility and delivered offshore by means of a transportation barge. The piles will be vertically driven through the pile sleeves into the seabed to reach a target penetration depth (see Figure 3.7).

3.4.4 Intra-field pipelines

The existing pipeline from the PoA Terminal to the Douglas OP, and a selection of the existing pipelines connecting Douglas OP to Hamilton North, Hamilton Main, and Lennox OPs will be repurposed to transport CO_2, and no physical changes to the current pipelines are expected.

While no new intra-field pipelines are required, a short length (595 m) of the existing Douglas to PoA (PL 1030) pipeline will need to be re-routed to the new Douglas CCS platform, along with tie-ins from Douglas CCS to the intra- platform lines. These pipeline connections will be laid on the seabed, and not buried. Section 3.3.6.1 presents the approximate pipeline connection lengths.

Sandwave ridges are present to the south of the proposed new Douglas CCS location. It will therefore be necessary to carry out some pre-lay seabed preparation through these features to create the corridor for the pipeline connection. This would be created probably using either a mass flow excavator, or a jet sled. The sand waves are approximately 2 m to 3 m in height, and a corridor approximately 10 m in width would be created through them. It would take approximately 3 to 5 days to create the corridor.

3.4.4.1 Programme for platforms and intra-field pipelines

Installation of the new Douglas CCS platform will be carried out over approximately two months commencing with the new jacket, piles, and topsides during Spring 2027. To make way for the new Douglas jacket, during late summer to autumn 2025, there will be some subsea decommissioning works to remove redundant pipework and cabling from the seabed. These removals will also include disconnecting the gas export pipework from the existing Douglas complex and making it ready for later connection to the new Douglas CCS platform. Figure 3.12 presents a summary programme for installation and commissioning of new Douglas CCS platform.

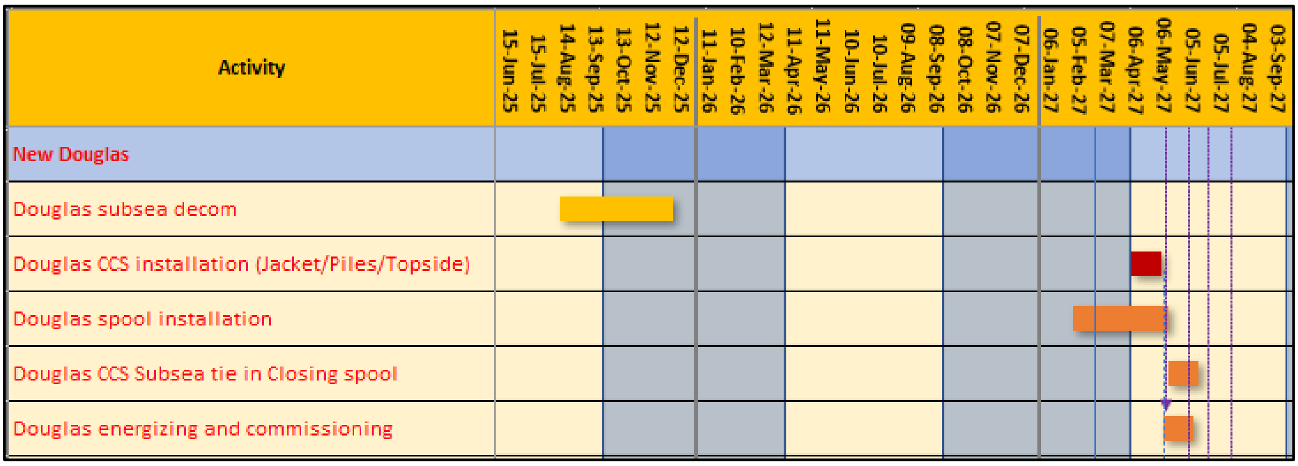


Figure 3.12: Summary Programme For Installation And Commissioning Of New Douglas Platform

A summary programme for installation and commissioning of satellite platforms is shown in Figure 3.11. This shows a sequential campaign for drilling and side-tracking injection wells that will commence at Hamilton North will commence in Q3/Q4 2024 for approximately six months. The drilling rig will then move to Hamilton Main in Q1 2025 to carry out an up to seven months campaign until Q3/Q4 2025. Lastly, injection well drilling will be carried out at Lennox for up to 12 months from Q4 2025 until Q4 2026.

The removal of the existing topsides at the satellite platforms is scheduled to start at Hamilton Main in May 2027, then move to Hamilton North, and finish at Lennox in June 2027, as shown in Figure 3.11. The removal campaign at each platform will take around four to five weeks. The sequence for the installation and commissioning of the topsides at each satellite platform will be the same as for the removal works and will commence in June or July 2027. The commissioning works at each platform will also include the flushing and drying of the existing gas export lines from each platform to make ready for CO_2 transport. Figure 3.11 shows that these works will take approximately six to nine months at each platform and pipeline, with the final works in the sequence scheduled for completion at Lennox in July 2028.

3.4.5 Offshore power and fibre optic cables

3.4.5.1 Cable installation

Cable laying

The cable route from PoA Terminal to Douglas OP, in its initial Onshore segment, heads out of PoA Terminal and will pass under the Talacre dune system to the MHWS point, via two parallel conduits that will be installed using a Horizontal Directional Drilling (HDD) trenchless method. Planning permission from Flintshire County Council (FCC) for the Onshore segment was granted on 10 January 2024 (application reference FUL/000246/23). The entry/exit pit for the Talacre dune system HDD on the intertidal side will be placed between 2-3m below ground level into the sand with pumps and storage tanks sited close to the pit to contain any fluid. As the pit will be at the same depth as the proposed cable depth, and given the Applicant's experience with similar installations, it is not expected that any external cable protection will be required. Access to the beach will be from the Talacre Beach car park. Temporary matting will be placed to facilitate vehicle access within the Foreshore Area over the soft sand as necessary (**T-PD-016** of the **REAC**). Figure 3.13 presents some illustrative cross-sections of how the electrical cable will be installed across Talacre beach and under the dunes.

At the end of the HDD works required to prepare the conduits, the first cables will be brought into the area via a cable-laying vessel and pulled ashore. The cable-laying vessel will be beached as far up the intertidal stretch of beach as possible. The cables will then be guided by excavators and brought down on to rollers, pre-installed on the beach, pegged at approximately 2m intervals. It will then be attached to the HDD pulling equipment, including a winch, pulled to the entry/exit pit, and drawn under the Talacre dunes to the Submarine Cable Junction Boxes. Once the pull is complete, the cables will be buried on the beach using an intertidal trenching machine, plough, dredgers, and supported by excavators. With the foreshore work completed, the vessel will then lay the cables from the MLWS at the Foreshore (and on to the Offshore Douglas Complex). The process will then be repeated for the second cable. An example cable lay vessel is shown in Figure 3.14.

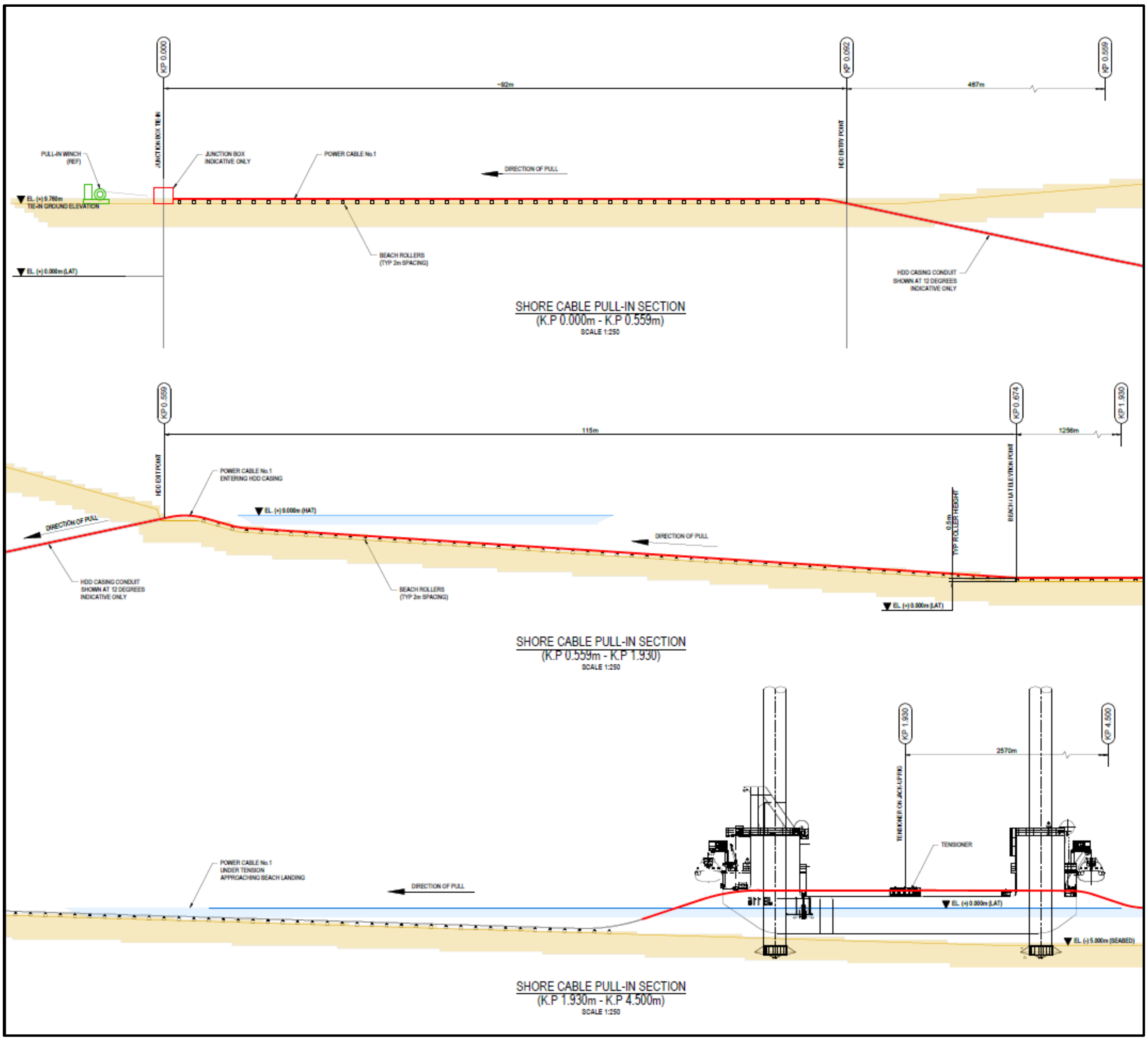


Figure 3.13: Cross Sections Of Cable Installation Through Dunes And Across Talacre Beach

Because of the presence of the Welsh Channel (shipping channel for the Port of Mostyn) and the West Hoyle Spit (a series of sand banks exposed at low tides) directly offshore, it is possible that a suitable vessel will not be able to approach near the shore. In this case, the vessel will remain on the offshore side of the spit, and smaller boats and barges will be required to control the movement of the cables on to the beach, with a jacking barge likely to be set up in the intertidal area. The cable will be floated using buoyancy units, installed from the cable-laying vessel. Once ashore, the buoyancy units will be removed, and the cables will be placed on intermediate rollers as per the previous method described.

Seawards of the shore approach, the cables routes of the Proposed Development would broadly follow the alignment of the existing pipelines connecting PoA Terminal to Douglas OP and Douglas OP to Hamilton Main, Hamilton North, and Lennox OPs (Figure 3.1 and Figure 3.16).

To take the cable directly across the West Hoyle Bank, will require dredging a channel (most likely with a barge operated backhoe dredger) approximately 1,000 m in length, 60 m in width, and 7 m in depth (approximately 3 m to take bank down to LAT, then approximately 3 m depth for cable burial). The excavated material would be side cast along the length of the trench, and then backfilled after cable installation. It would take approximately two to three weeks to excavate the trench. The route of the Proposed Development across the West Hoyle Bank is shown in Figure 3.16.

Figure 3.14: Example Of A Typical Cable Installation Vessel Showing The Cable Carousel On The Deck

Figure 3.15: HDD Exit Pit And Cable Approach (Typical For Liverpool Bay Area) Showing Jack-Up Vessel At MLWS Mark, And Cable Rollers Set Out On The Beach – The Exit Pit For The Proposed Development Would Be Further Up The Beach Just Below The MHWS Mark

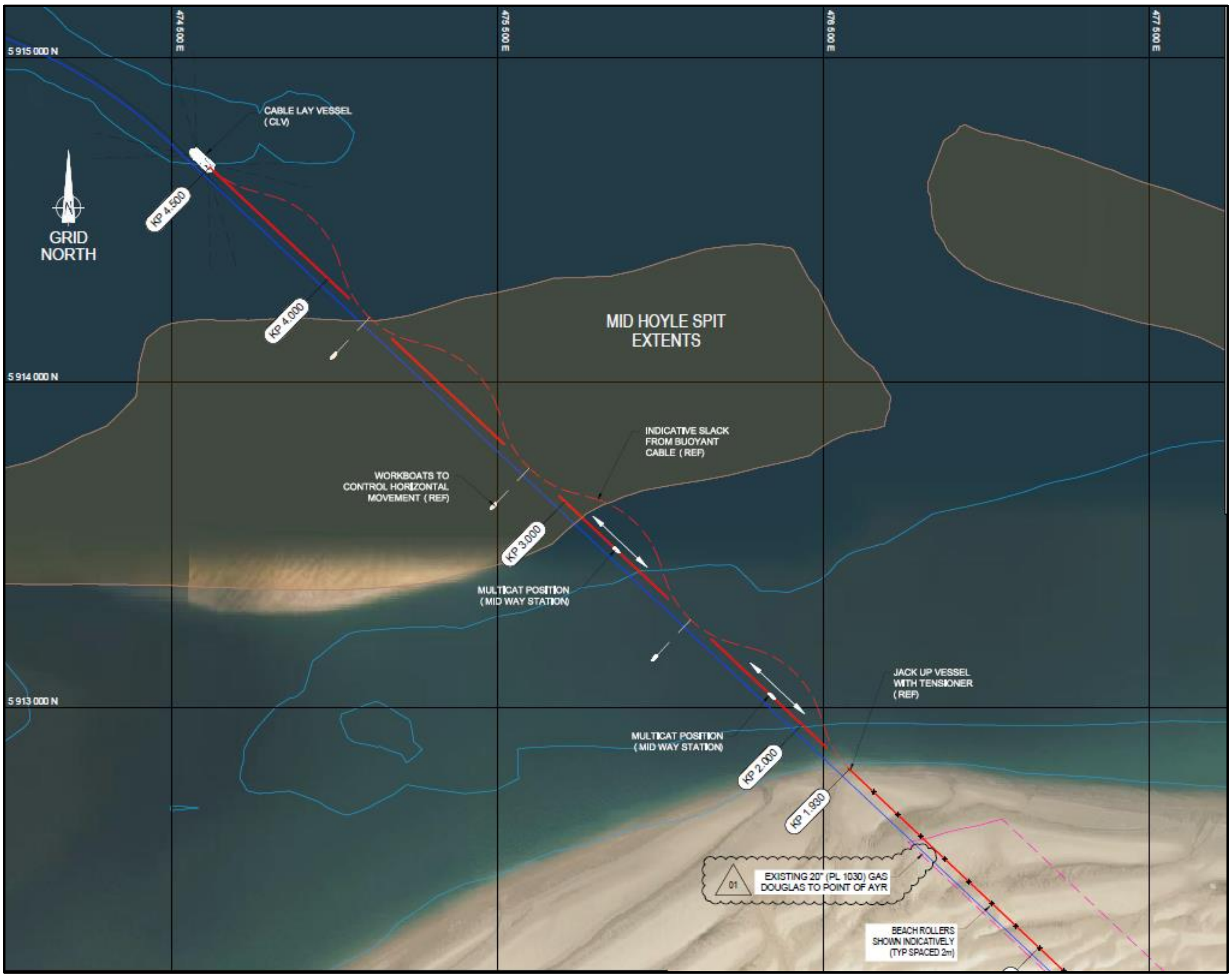


Figure 3.16: Cable Route Option (Red Line) To Cross West Hoyle Bank Following Parallel Alignment To Existing PoA To Douglas Natural Gas Pipeline (Blue Line)

The section of beach required for the intertidal works is envisaged to be closed to the public for a maximum of 8 weeks when the cable installation work will be undertaken. This is expected to be separated into two different periods: one for the Talacre dunes HDD crossing works (estimated at 6 weeks), and another for the cable pulls (estimated at 8 weeks), during which certain locations will be closed off entirely to the public. Temporary diversions will be arranged across the dunes during this period for pedestrian use.

As part of the construction works, a temporary fence will be erected to safeguard both the public and workforce and provide security of the works. This temporary fencing will be removed upon completion of the works.

Seawards of Mean Low Water Springs (MLWS), at the shore approach, the cables route corridor of the Proposed Development shown in Figure 3.1 is taking allowance for possible alternative options currently under assessment, considering the presence of the West Hoyle Spit sandbank and other constraints, such as availability of cable lay vessel.

An alternative under consideration is to route the cable further to the east, via a tidal channel through the spit, as shown in Figure 3.17. The water depth that remains in this location is less than the amplitude of a spring tide and therefore some pre-lay dredging would still be required to allow for a self-beaching Cable Lay Vessel (CLV) to ground itself at low tide on a ‘flat’ area of sandbank. The area to be dredged and flattened as required to allow beaching of vessel on seabed, in this scenario would be approximately 180 m length, 60 m wide and 1 m to 2 m below LAT. It would take approximately four to seven days to excavate the area depending on dredging technique applied.

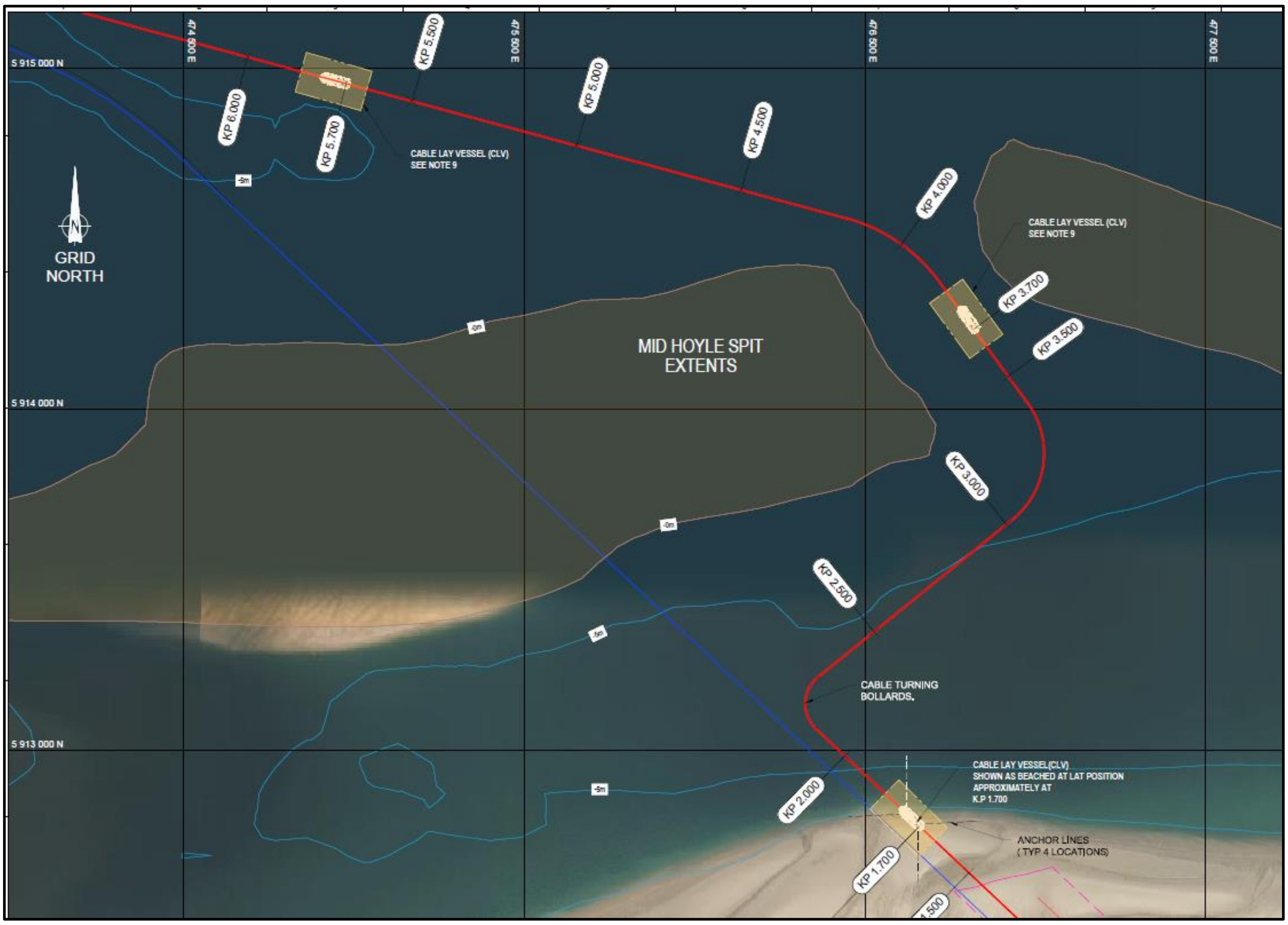


Figure 3.17: Cable Route Option To East Of West Hoyle Bank

Cable burial

It is anticipated that the offshore cables will be installed via either ploughing, or cable trenching, or a combination of both these techniques, depending on ground conditions along the specific cable route.

The zone of disturbance for the cable burial using a plough is expected to be around 15 m total width for each cable, as this accounts for the overall width of the plough as it traverses the seabed on its skis. However, the skis are designed to minimise the disturbance on the seabed. The plough 'slices' a trench approximately 1 m to 1.5 m in width, while simultaneously burying the cable to the desired burial depth of 2 m to 3 m. This area of disturbance is localised between the plough skis. On this basis, the potential Zone of Disturbance (ZoD) under the cable burial equipment through the intertidal area would be approximately 18,000 m^2, with around 1,800 m^2 (10%) of this area disturbed by either the plough or cutter blades.

A typical cable plough is illustrated in Figure 3.18 showing the plough engaged. Some spoil does arise in this instance from the shearing action caused by the plough. Most of the sediment falls back into the trench as the plough progresses forwards, and the cable is placed at the base of the trench. These ploughs can trench through a wide variety of soils and are particularly suited to projects where long continuous lengths of cables are to be buried through variable ground conditions.

Figure 3.18: Photo Of Typical Power Cable Plough (Photo Credit: Boskalis)

3.4.5.2 Programme for cable installation

An indicative summary schedule for the electrical cable laying and tie-ins to the CCS platforms is shown in Figure 3.19. This shows the cable laying activities are scheduled to commence and be completed in Q2 2026. Prior to this from July 2025 until April 2026, the onshore HDD tunnel under the Talacre sand dunes will be constructed in preparation for the offshore cable lay and pull in operations during spring 2026. During winter 2026/2027 the cable ends will be wet stored (i.e. left on the seabed) prior to the cable recovery and pull into each of the CCS platforms during Q2/Q3 2027.

Figure 3.20 presents the indicative activity durations for the electrical cable shore approach operations for the PoA to new Douglas CCS platform cable. There will be a period of approximately 3 months for the onshore preparatory works for the cable installation. The allocated activity durations for the foreshore pull in operation are presented in Figure 3.20. The electrical cable will be laid from the new Douglas platform to the nearshore area at Talacre Beach while the onshore preparation work for the cable shore pull operations is being carried out. The cable lay, including the pull in at the new Douglas, will take approximately 12 days. These activities are shown in Figure 3.22.

The indicative activity durations for electrical cable burial operations for the PoA to new Douglas CCS platform cable are shown in Figure 3.21. Cable burial will take approximately two days, assuming a burial rate of 3,000 m/day, with intervention works and the as-built survey taking the duration of the works to approximately seven days in total. The schedule shown in Figure 3.21 also indicates a 30% contingency to allow for poor weather conditions leading to vessel downtime. A similar period for cable burial can be anticipated for each of the electrical cables to the Hamilton Main, Hamilton North, and Lennox platforms. The overall duration for the laying and burial activities for all the electrical cables will take approximately two to three months, plus a 30% contingency to allow for poor weather conditions leading to vessel downtime.

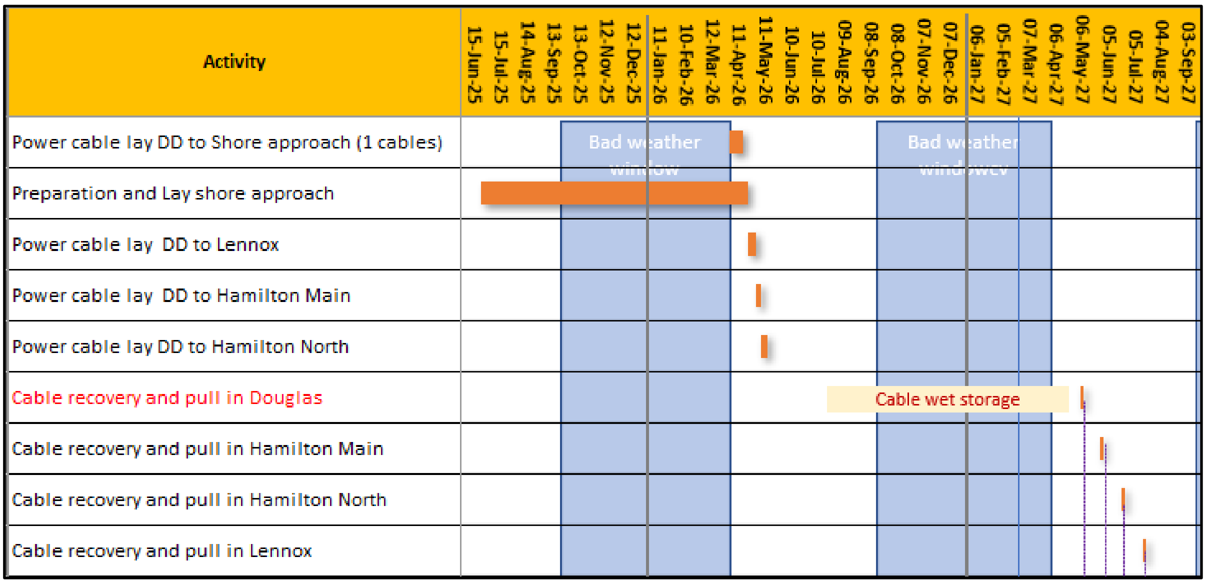


Figure 3.19: Indicative Summary Schedule For Electrical Cable Laying And Tie-Ins To CCS Platforms

Activity	Work duration Day	Time D1-D7	D8-D14	D15	D16	D17	D18	D19	D20	D21	D22	D23
Onshore prep work for cable installation	**19 days**											
Equipment mobilisation	7 days											
Levelling and roller set-up (570@2m spacing)	7 days											
Set-up cable winch	2 days											
Set-up traction winch	1 day											
Set-up onshore cable roller from landfall to winch location	1 day											
Function test	1 day											
Cable Pulling Operation	**3 days**											
Cable Lay Vessel set-up and vessel mooring	1 day											
Run pull-in rope from shore to Cable Lay Vessel	0.5 days											
Play out cable from Cable Lay Vessel to shore (70m/hr)	1 day											
Nearshore cable laydown	0.9 days											
Cable lay vessel start lay-away (milestone for shore pull operation)	0.6 days											
Waiting on Weather contingency 30% net duration for Cable Lay Vessel only	0.9 days											
Total Cable Shore Pull	**23.9 days**											

Figure 3.20: Indicative Activity Durations For Electrical Cable Shore Approach Operations For PoA To New Douglas CCS Platform Cable

Activity	Work duration Day	Time D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
Cable burial	**7 days**										
Mobilisation	2.5 days										
Cable burial @ rate 3000m/day	1.5 days										
Intervention works	2.5 days										
As-built survey	0.5 day										
Waiting on Weather contingency 30% net duration for cable burial	2.1 day										
Total Cable Shore Pull	**9.1 days**										

Figure 3.21: Indicative Activity Durations For Electrical Cable Burial Operations For PoA To New Douglas CCS Platform Cable, And New Douglas To Hamilton Main, Hamilton North, And Lennox

Activity	Work duration Day
PoA to new Douglas (from KP 4.5km) Cable No. 1	**11.7 days**
Mobilisation + dydnamic positioning (DP) trial + survey calibration	1 day
Pre-Lay survey + intervention works	4.2 days
Cable lay (laying rate 6,000m/day)	5.0 days
Pull in at J-Tube at new Douglas	1.5 days
PoA to new Douglas (from KP 4.5km) Cable No. 2	**11.7 days**
Mobilisation + dydnamic positioning (DP) trial + survey calibration	1 day
Pre-Lay survey + intervention works	4.2 days
Cable lay (laying rate 6,000m/day)	5.0 days
Pull in at J-Tube at new Douglas	1.5 days
New Douglas to Lennox	**10.4 days**
Mobilisation + dydnamic positioning (DP) trial + survey calibration	1 day
Pre-Lay survey + intervention works	1 day
Pull in at J-Tube at new Douglas	1.5 days
Cable lay (laying rate 6,000m/day)	5.4 days
Pull in at J-Tube at Lennox	1.5 days
New Douglas to Hamilton Main	**6.8 days**
Mobilisation + dydnamic positioning (DP) trial + survey calibration	1 day
Pre-Lay survey + intervention works	1 day
Pull in at J-Tube at new Douglas	1.5 days
Cable lay (laying rate 6,000m/day)	1.8 days
Pull in at J-Tube at Hamilton Main	1.5 days
New Douglas to Hamilton North	**7.4 days**
Mobilisation + dydnamic positioning (DP) trial + survey calibration	1 day
Pre-Lay survey + intervention works	1 day
Pull in at J-Tube at new Douglas	1.5 days
Cable lay (laying rate 6,000m/day)	2.4 days
Pull in at J-Tube at Hamilton North	1.5 days
Post lay survey for all cables	**4 days**
Demobilisation	**2 days**
Waiting on Weather (WoW) for all cables (30%)	**15 days**
Total	**67.2 days**

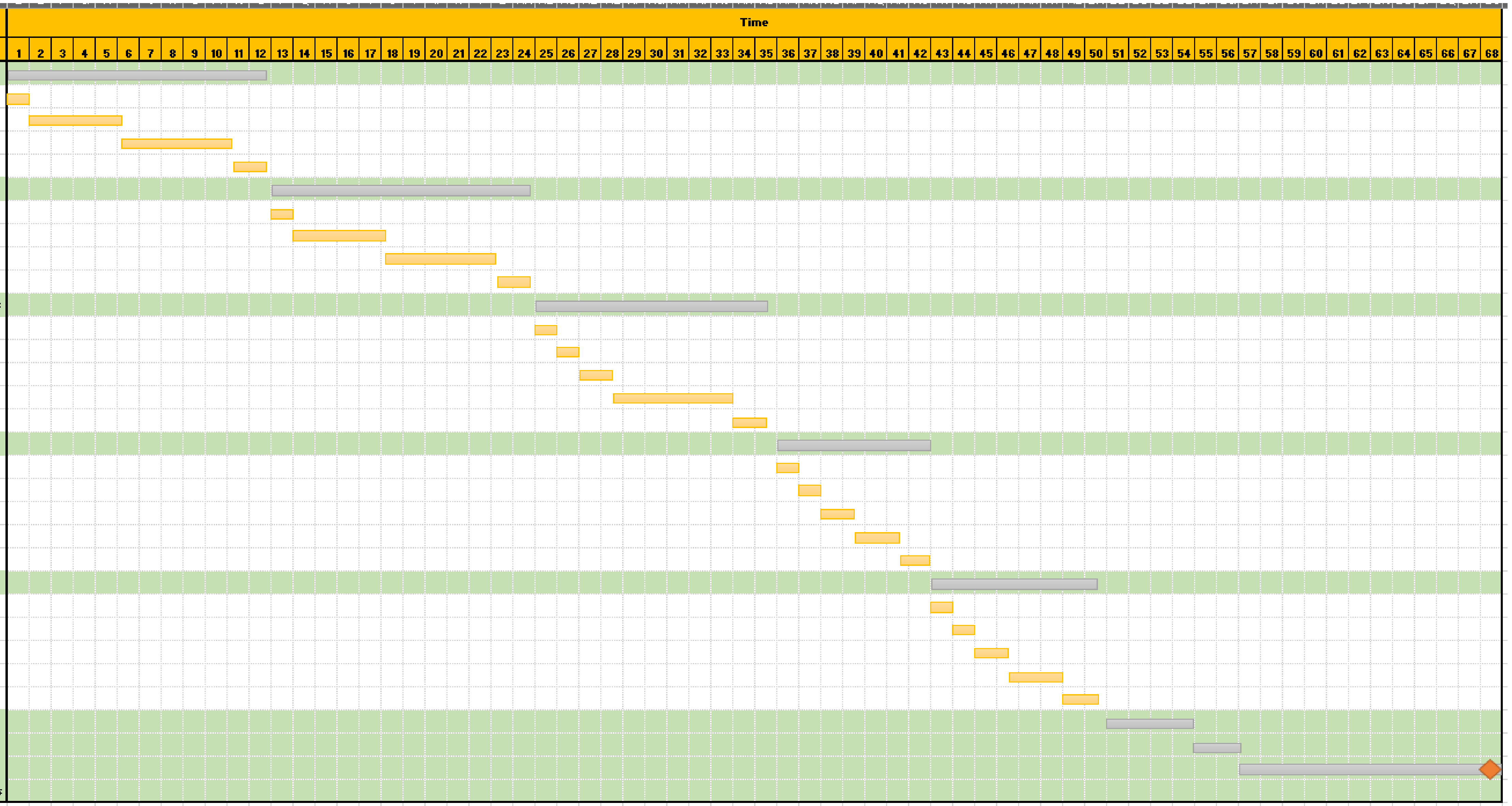


Figure 3.22: Indicative Activity Durations For Electrical Cable Lay Operations To All Platforms

3.4.6 Unexploded ordnance

There is potential for Unexploded Ordnance (UXO) to be encountered during the installation of the new infrastructure for the Proposed Development. The assumptions about the UXO that could be encountered, and the donor charges that could be used to detonate them *in situ* are set out in Table 3.11.

Table 3.11: Potential Donor Charge Configurations And UXO Sizes

Charge size (kg TNT equivalent)	Notes
Low-order and low-yield donor charge configurations	
0.08 kg	Maximum size of donor charge used for low-order technique
0.5 kg	Maximum size of clearing shot to neutralise any residual explosive material
2 x 0.75 kg	Charge configuration for low-yield technique for most UXO
4 x 0.75 kg	Maximum charge configuration for low-yield technique
High-order charge options	
1.2 kg	Most common donor charge for high-order UXO disposal
3.5 kg	Single barracuda blast-fragmentation charge for high-order disposal
Potential UXO (high order disposal)	
25 kg	Smallest potential UXO size
130 kg	Most common/likely UXO size
907 kg	Maximum UXO size

3.4.7 Vessel utilisation

A range of installation vessels would be used for the construction of the Proposed Development. This includes main installation vessels (e.g. jack-up or dynamic positioning vessels with heavy lifting equipment), support vessels, tugs and anchor handlers, cable installation vessels, guard vessels, survey vessels, crew transfer vessels and scour/cable protection installation vessels. In addition, helicopters are expected to be used for crew transfers to the OPs, when required. The potential location of these vessels during cable installation is shown in Figure 3.16 and Figure 3.17.

Alternatively, for well drill rig location and positioning, geotechnical and geophysical 'ground truthing', which includes borehole and seabed surveys with accompanying environmental analysis, may be carried out by two different types of survey vessel.

The main construction vessel for the cable laying work will be a dynamic positioning class two vessel or anchor mooring vessel with shallow draft and flatbed. Multi-Purpose Supporting Vessels (MSV) or Supply Vessel and crew boats will be utilised for Touch Down Point (TDP) monitoring, survey activities and post-trenching work. TDP monitoring provides live visualisation and monitoring of cable survey and installation activities. Additionally, anchor handling tugs will be utilised for anchor mooring vessels.

All the integrated decks for Hamilton Main, Hamilton North and Lennox OPs could be transported using a sea transportation barge. The offshore installation of these components would require Heavy Lift Vessels (HLV) or Floating Shear Legs (FSL) cranes.

Maintenance activity in Liverpool Bay is currently undertaken by the Irish Sea Pioneer (ISP) four-legged jack-up barge. It is intended to continue to use the ISP during the construction phase, to accommodate any major maintenance requirement for repurposing the Offshore OPs to CO_2 service.

3.5 Operation and maintenance phase

The following operational schedule is based upon a phased approach for Stage configurations in Gas Phase Operating Mode. These stages are as follows, with respect to the impact to the existing offshore platform infrastructure:

- **Stage 1** – Free Flow: in this early operating mode in which the initial pressures of the storage reservoirs are building up, CO_2 can flow in gas phase from the emitters directly into the storage reservoirs without the need for intermediate pressure boosting. The Offshore configuration does not require any flow control system or continuous heating requirements at this stage.
- **Stage 2** – Compression at PoA: due to the constant reservoir pressures build-up and the flowrate ramp-up, the installation of a pressure boosting unit at PoA is required. During this stage, the Offshore configuration again does not require any flow control system. Heaters are required on each satellite platform for transient/shutdown conditions.
- **Stage 3** – Pressure Control at Douglas CCS: when CO_2 volumes approach 4.5 MTPA, some hydraulic limitations could be observed in the existing 20” PoA to Douglas pipeline. The Joule-Thompson (JT) effect in the 20” pipeline can lead to a very cold arrival temperatures at Douglas CCS, especially during winter conditions. These cold temperatures may give rise to ice formation in the topside piping and liquid CO_2 drop-out in the rest of the distribution network. To avoid this issue, a pressure control system will be brought into operation at the Douglas CCS to maintain a minimum pipeline operating pressure, which will in turn, reduce the pressure to drop along the pipeline. With this pressure regulation, the minimum CO_2 receiving temperature at Douglas CCS (topside) can be maintained at acceptable levels to avoid the risk of ice formation. In conjunction with the pressure control, a heating unit is also required at Douglas and on each of the satellite platforms. The two existing pipelines (12” and 16”) between Douglas and Lennox OPs will be used to support a more homogeneous distribution of the CO_2 injection.

3.5.1 Operation and maintenance activities

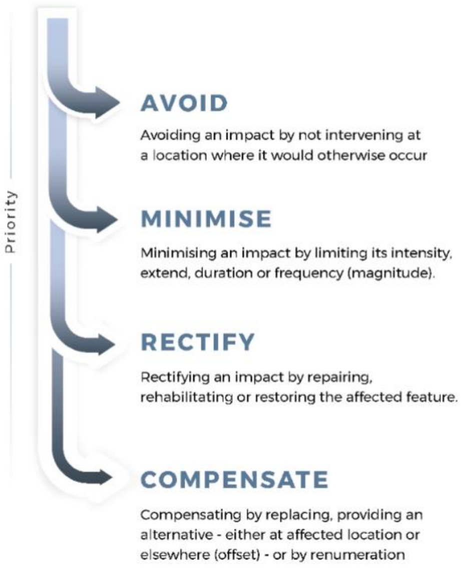
3.5.1.1 Fugitive and venting emissions

During the operation phase of the Proposed Development, fugitive and venting emissions may take place but every effort will be made to minimise. Fugitive emissions are unintentional leakages of gases or vapours from pressure-containing equipment or facilities and typically would occur at flanges, valves, and other equipment interfaces. During the operation phase, fugitive emissions will be monitored through a Leak Detection and Repair (LDAR) programme as part of the preventive maintenance activities, to avoid or minimise their presence as low as reasonably practicable.

There is no requirement currently set out for routine venting of CO_2 equipment during the operation phase. However, there would be a requirement for periodical venting of CO_2 equipment during planned maintenance activities and the potential for venting in case of pipeline depressurisation required for maintenance or decommissioning.

3.5.1.2 Measurement, Monitoring and Verification Programme

The effectiveness of the storage sites depends upon the ability to prevent potential environmental impacts connected to leakages. Preventing the migration of injected fluid from the storage formation to the atmosphere or water column requires correctly tailored monitoring, measurement, and surveillance activities. This is also a requirement for ensuring safe and reliable operations.



Given the integrity of the storage sites is dependent on the effectiveness of the whole storage system, the monitoring is based on a **monitoring plan** that is grounded in the principles of the 'mitigation hierarchy'. The 'mitigation hierarchy', shown in the adjacent diagram, demonstrates that the priority for the Proposed Development was to prevent leaks from occurring by embedding 'avoidance' and 'minimisation' measures.

The 'avoidance' measures that have been embedded into the design of Proposed Development, include the repurposing of depleted oil and gas reservoirs, of which much is known about their integrity from over 30 years of operating the assets. This knowledge, coupled with the design of the new elements of the storage system, provide evidence for confidence in the effectiveness of the **containment** systems within the LBA Storage Complex. This should allay stakeholder concerns about the potential for leakage, and has provided knowledge to trigger early intervention, should this be needed.

The physical, operational, and abatement controls built into the Proposed Development system, present 'minimisation' measures that will demonstrate that the storage sites are progressing as expected and the long-term behaviour of the CO_2 is understood. The data collected through these controls will demonstrate **conformance** with the required performance requirements and help to show that predictive models are consistent with the collected monitoring data.

The collected data will also provide **confidence** that the storage complex is performing as predicted and required, and support emission accounting and the transfer of long-term responsibilities to relevant authorities to maintain the licence to operate.

Therefore, as part of the Storage Permit application requirements, a Measurement, Monitoring, and Verification (MMV) programme has been developed, The MMV programme covers the pre-injection, operation and maintenance and post-closure phases of the Proposed Development. The objective of the MMV programme is to establish an environmental baseline and to assess whether injected CO_2 is behaving as expected, and to detect if any unexpected migration or leakage occurs.

The preparation of the MMV Programme has adopted the following stepwise approach:

1. **Assessed site-specific storage risks**: established definitions for loss of conformance and loss of containment as reported in the Containment Risk Assessment.
2. **Characterised geological safeguards**: identified and appraised the integrity of each geological seal within and above the storage complex.
3. **Defined engineered safeguards**: identified and assessed the engineering concept selections that provide safeguards against unexpected loss of well integrity.
4. **Established monitoring requirements**: defined monitoring tasks to verify the performance of the initial safeguards and, if necessary, triggers timely control measures.
5. **Selected monitoring plans**: selected monitoring technologies according to a cost-benefit ranking. This includes baseline monitoring as well as monitoring during the injection and closure phases (including seismic, micro-seismic, ground deformation, wellbore, and environmental monitoring).
6. **Identified control measures**: design interventions to reduce the likelihood or the consequence of any unexpected loss of conformance or containment. These include operational controls and updates to model-based predictions.

The MMV programme contains Regular Environmental Monitoring proposals that will identify long-term changes in environmental features. Additionally, should the data collected through the 'avoidance' and ‘minimisation’ measures identify any potential or actual loss of containment, targeted Environmental Monitoring is proposed, as an Environmental Contingency Monitoring, to identify the magnitude and extent of this loss, and the environmental consequences. This data would then be used to identify the action required to ‘rectify’ through repairing, restoring, or rehabilitating the affected feature. Where required, ‘compensating’ by replacing, or providing an alternative, either at the affected location, or elsewhere (offsetting).

Additionally, UK regulation (UK Statutory Instruments, 2010) and EU directive (EU Commission 2009/31/CE Directive, 2009) and relative guidelines (EU Commission, 2011), (NSTA, Guidance on Applications for a Carbon Storage Permit, 2022) establish that the operator monitors the storage complex to be able to:

1. Compare the actual and modelled behaviour of the CO_2 in the storage site.
2. Detect any significant irregularities anomaly.
3. Detect of any migration and/or leakage of CO_2.
4. Detect of any significant adverse effects on the surrounding environment, and on offshore and nearshore water resources, human and biological receptors.
5. Assess of the effectiveness of any corrective measures taken.

Monitoring is split into a series of phases across the Proposed Development:

- **Baseline characterisation (pre-injection):** Before injection of CO_2 into the reservoir commences, there will be comprehensive baseline data acquisition for technical assessment and for future comparison.
- **Operational phase (injection):** During the 25-year CO_2 injection period, data acquired will be monitored to assess CO2 movement within the storage sites; and
- **Closure/post-closure/pre-transfer phase (post-injection):** Site closure is anticipated to be performed from 2052 onwards. Post-closure period and obligations are to be defined during dialogue with authorities and will be documented in a post-closure plan.

The MMV programme developed covers the full extent of each storage complex, meeting the requirements of the CCS Directive and incorporating lessons learned from the Applicants best practices. At the core of the MMV plan, there are three main documents:

- **Monitoring Plan (MP)**: This document stems from CRA findings, providing additional safeguards through monitoring. The objective is to demonstrate effective conformance (i.e., the CO_2 plume behaviour is as expected) and to verify containment (i.e., CO_2 remains within the storage complex), identifying any deviations or irregularities.
- **Corrective Measure Plan (CMP)**: identification of corrective measures to be employed in the unlikely event of significant irregularities identified during the standard monitoring activities, defined in the Monitoring Plan.
- **Provisional Post Closure Plan (PPCP)**: The purpose of this document is to clarify how closure will take place and to demonstrate that CO_2 remains permanently enclosed in the reservoir, with the current state of technology and experience. Monitoring activities in the post-injection phase are aimed at demonstrating the absence of any detectable leakage and the conformance with the dynamic modelling.

The MMV programme will be applied for the 25-year life cycle of the Proposed Development, and throughout the post-closure phase, which is currently anticipated for a further 20 years. The plan will be updated according to the requirements and, in any case, every five years. The update process will include learnings from the initial phase of injection and from new information from wells, site-specific technical feasibility assessments, and monitoring performed during the injection phase. Updated MMV programmes will also consider changes to the assessed risk of leakage, changes to the assessed risks to the environment and human health, new scientific knowledge, and improvements in best available techniques. The key parameters for the assessment of the Monitoring Programme are set out as the Maximum Design Scenario (MDS) within each of the environmental assessment topic chapters.

3.5.1.3 Environmental Monitoring

3.5.1.3.1 Purpose of monitoring

The storage project will include pre-injection, injection, and post-closure environmental monitoring. To ensure CO_2 containment and compliance with permit conditions, the environmental monitoring will support the asset integrity monitoring that is covered elsewhere in the MMV.

Two types of environmental monitoring are proposed: Regular Environmental Monitoring (REM); and Environmental Contingent Monitoring (ECM). These are described in the following sections.

3.5.1.3.2 Regular environmental monitoring

REM will be carried out at locations around, and above the storage project assets i.e., at the injection and monitoring wells, P&A and legacy wells, and along CO_2 pipelines. The REM will be carried out during the pre-injection, injection, and post-closure phases of the storage project, as shown in Figure 3.23. The REM will include collecting environmental data from the seabed, the water column, and the atmosphere, using the methods and analysis set out in Table 3.12, Table 3.13, and Table 3.14 respectively.

During the pre-injection phase, the REM will be carried out simultaneously with the 3D/4D seismic acquisition, and ground deformation, and micro-seismic monitoring, as shown in Figure 3.23: Illustrates the frequency of environmental monitoring. These pre-injection surveys will provide a robust baseline characterisation against which future observable, and measurable changes to the subtidal environment can be attributed to the geological storage of carbon dioxide.

The pre-injection REM will then be repeated on a frequency to coincide with the 3D/4D seismic acquisition. The REM carried out to the same scope and specification identified in the Monitoring Plan, using the methods and analysis set out in Table 3.12, Table 3.13, and Table 3.14 respectively.

3.5.1.3.3 Environmental contingent monitoring

ECM will be carried out when the findings of other monitoring activities, such as the continuous Ground Deformation (GD), seismic (VSP or 4D) Microseismic Monitoring (MM) and well monitoring (SLM, SLI, WRM, WRI).

The ECM will be carried out during the injection, and post-closure phases of the storage project, as shown in Figure 3.23. The ECM will be carried out only when the findings of other monitoring activities, such as the continuous Ground Deformation (GD), seismic (VSP or 4D) Microseismic Monitoring (MM) and well monitoring (SLM, SLI, WRM, WRI) indicate that a potential pathway for a CO2 leak has opened.

For example, regular 2D/3D/4D seismic has detected the unexpected lateral and vertical migration of the CO2 plume towards areas where it may breakthrough to the seabed. (see Monitoring Plan item 11 in Appendix 1). Also, ground deformation monitoring, coupled with the 2D/3D/4D seismic, can show significant geomechanical changes that could identify ground surface deformations, and fracture initiation and propagation, or pre-existing fault opening and slippage, which present pathways for CO_2 leakage (see Monitoring Plan item 14, Appendix 1).

The ECM will then be mobilised to the relevant location to confirm if CO2 leaks are appearing at the surface of the seabed, and into the water column. The ECM will include collecting environmental data from the seabed, the water column, and the atmosphere, using a suite of methods and analysis from those set out in Table 3.12, Table 3.13, and Table 3.14 respectively.

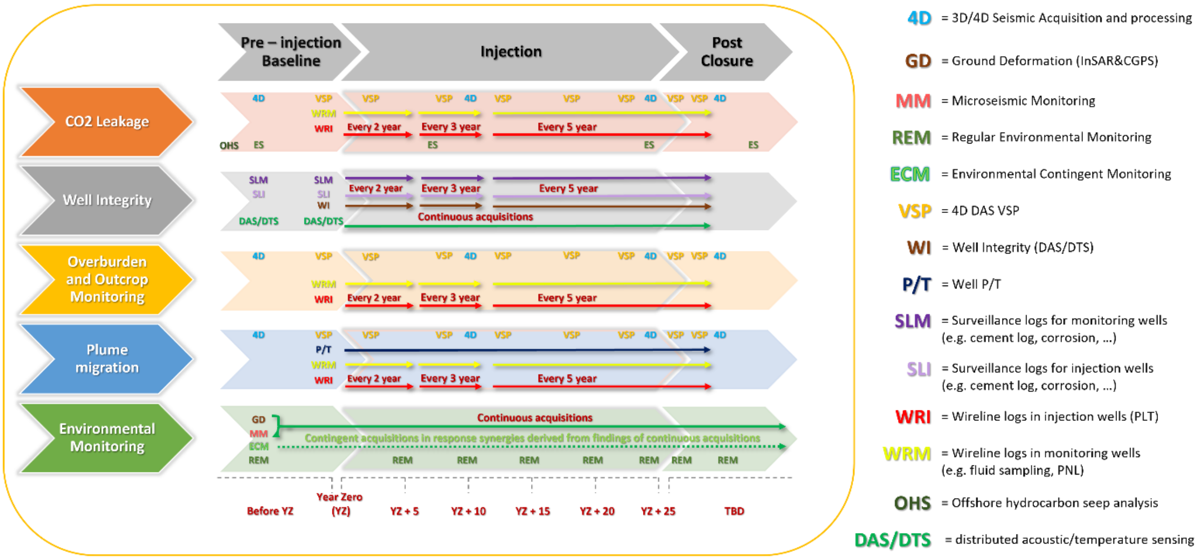


Figure 3.23: Indicative frequency of environmental monitoring

3.5.1.3.4 Survey data collection

The proposed survey methods and analysis are set out in Table 3.12, Table 3.13, and Table 3.14. These methods would be deployed in a variety of combinations for both the REM, and ECM dependent on the situation being monitored.

Table 3.12: Proposed seabed survey methods

Collection method	Sample	Analysis and interpretation
Drop down video	• Transect at each location minimum of 50 m in length; • Centred on the seabed feature of interest; • Location details; • Geographic coordinates; • Survey date and time; and Water depth.	• Identification of benthic megafauna (>1cm), faunal density, diversity, and community composition. • Macrofauna (>1mm). A log sheet of seabed features such as sediment type, bedforms, local topographic features, significant epifauna and/or macro-fauna and habitat related features (e.g. geogenic [cobble] and biogenic reefs, pockmarks, sponge aggregations, potential ocean quahog siphons.)
Photographic stills	• A minimum of either five (5) photographs at each photographic station, or a series of a single shots along the 50 m transects; • Location details; • Geographic coordinates; • Survey date and time; and • Water depth.	• Identification of benthic megafauna (>1cm), faunal density, diversity, and community composition. • Macrofauna (>1mm). A log sheet of seabed features such as sediment type, bedforms, local topographic features, significant epifauna and/or macro-fauna and habitat related features (e.g. geogenic [cobble] and biogenic reefs, pockmarks, sponge aggregations, potential ocean quahog siphons.)
Sonar bubble stream detection (see Monitoring Plan Appendix 1, Item 9)	detect bubble streams using video /photo surveys from the seabed	Identification of bubble streams from potential leak sites.

Collection method	Sample	Analysis and interpretation
Benthic grab samples	• A minimum of four (4) replicate grab samples at each sampling station, as follows: ○ Replicate 1: physicochemistry samples; Replicates 2, 3 and 4: macrofauna samples.	• Benthic infaunal analysis. Identification of benthic megafauna (>1cm), faunal density, diversity, and community composition. • Macrofauna (>1mm). • Physico-chemical analysis ○ Full particle size distribution; ○ Total organic matter; ○ Total petroleum hydrocarbons; ○ Saturate/aliphatic hydrocarbons; ○ Polycyclic aromatic hydrocarbons; and ○ Heavy and trace metals.

Table 3.13: Proposed water column survey methods

Collection method	Sample	Analysis and interpretation
Water column samples (e.g. CTD sampling frame)	Conductivity/salinity; Temperature; pH; Depth; Dissolved oxygen; phytoplankton; Chlorophyll-a	• Higher Conductivity demonstrates a PH range 6.5- 7.5 in presence of CO_2 ; • Temperature increase when CO_2 concentration increase; • Depth; if CO_2 release, currents will slowly carry it to the surface. • Dissolved oxygen: Presence of carbonic acid – effect on aquatic animals
Deployment of lander* with multiple sensors/probes	• Deployment at well injection sites, or potential leak sites, for at least 10 days to measure: • Pressure; Temperature; Conductivity/salinity; pH; Depth; Dissolved oxygen; nitrate; phosphate; water current; and acoustic data	• Higher Conductivity demonstrates a PH range 6,5- 7,5 in presence of CO_2; • Temperature increase, when CO_2 concentration increase; • Depth; if CO_2 release, currents will slowly carry it to the surface; and • Dissolved oxygen: Presence of carbonic acid – effect on aquatic animals.

* *similar to NOC lander from Goldeneye monitoring*

Table 3.14: Proposed atmospheric survey methods

Collection method	Sample	Analysis and interpretation
infra-red diode lasers or non-dispersive infra-red gas analysers	Atmospheric CO_2 measurement	○ Measure any increase in CO_2 % taking into consideration the environment of the area (vessels movement, wind, etc.)

3.5.1.4 Vessel utilisation and asset integrity

It is expected that there will be fewer supply vessel, standby vessel coverage, and helicopter traffic movements than current operations at the Liverpool Bay fields area, due to the unmanned OPs.

Cable repair, pipeline maintenance, and associated surveys are expected to utilise one supply vessel and one standby vessel. However, during the operations and maintenance phase, no cable repairs are anticipated, as the cable will be buried, and installed as a single, unjointed length offshore. Where the cable cannot be buried (e.g. at crossings), it will have external cable protection. General inspection works will be carried out, including using high resolution Multibeam Echosounder, Side Scan Sonar, and drop-down camera of the entire cable length cable in one event every two years. From experience of existing operations, reburial of up to 500 m of cable in one event every 5-10 years is anticipated. It is anticipated that the external cable protection at existing cable crossings is unlikely to require maintenance, as the rock and concrete mattresses are expected to remain in place. Maintenance or repairs are only anticipated should the cable protection be impacted by either fishing activity, or anchor snagging. Any movement of the rock and mattresses from these external interventions would be identified through the annual asset integrity surveys, and the necessary repairs carried out accordingly. These repairs would be carried out within the maximum design envelope described for the cable crossings external protection in Table 3.7.

Well interventions and service activity in Liverpool Bay is currently undertaken by the Irish ISP, a four-legged jack-up barge, as the OPs are relatively small and without cranes. It is intended to continue to use the ISP or similar for future well interventions and to support general maintenance activity. There will also be a requirement for drilling rig and support vessels from time to time. The ISP is a self-propelled jack-up vessel that has four lattice legs (73 m) and four 360-degree thrusters. Additionally, the ISP is equipped with two cranes designed for supply boat operations. It is intended to continue to use the ISP or similar for future well interventions and to support general maintenance activity.

3.6 Decommissioning phase

3.6.1 Overview

Existing UK legislation requires that when an offshore Carbon Capture, Usage, and Storage (CCUS) site is closed, the installations and injection facilities must be removed when decommissioned. In addition, all other items of equipment, infrastructure and materials that have been installed or drilled are expected to be entirely removed for disposal onshore in accordance with the government's aim to achieve a clear seabed.

When the Proposed Development reaches the end of its useful life or is no longer required, it will be decommissioned safely, with due regard to the environment. A comprehensive decommissioning and restoration plan would be developed for the Offshore Infrastructure and would be agreed with the relevant stakeholders.

The decommissioning process would be undertaken in accordance with all the environmental legislation and the technology available at the time. Any necessary licences or permits would be acquired.

3.7 References

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North Sea Transition Authority (NSTA) (2020) Carbon dioxide appraisal and storage licence – CS004 (ENI UK Limited), 8 October 2020. Available at: https://www.nstauthority.co.uk/licensing-consents/carbon-storage/ Accessed April 2023.

Offshore Petroleum Regulator for Environment and Decommissioning (OPRED) (2023). Scoping Opinion for HyNet Carbon Dioxide Transportation and Storage Project - Offshore.

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4 SITE SELECTION AND CONSIDERATION OF ALTERNATIVES

4.1 Introduction and overview

This chapter of the Offshore Environmental Statement (ES) provides a description of the site selection process and the alternatives considered, from award of the Carbon Dioxide Appraisal and Storage Licence (CS004) (awarded on the 8 October 2020) through to final design and definition of the offshore components of the HyNet Carbon Dioxide Transportation and Storage Project, hereafter referred to as the 'Project' (with the offshore components seaward of Mean High Water Springs (MHWS) hereafter referred to as the 'Proposed Development').

This chapter has been prepared in accordance with Schedule 6(2) The Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020 (The 2020 EIA Regulations), and Regulation 12(2)(b) of the Marine Works (Environmental Impact Assessment) (Amendment) Regulations 2017 (The 2017 EIA Regulations), which respectively state that an EIA should include:

'6(2) - A description of the reasonable alternatives (for example in terms of project design, technology, location, size and scale) studied by the developer and an indication of the main reasons for the option chosen, taking into account the effects of the project on the environment and including a comparison of environmental effects.'

and

'12(2)(b) - a description of the reasonable alternatives studied by the applicant which are relevant to the project and its specific characteristics, and an indication of the main reasons for the option chosen, taking into account the effects of the project on the environment.'

As outlined above there is a requirement under the 2017, and 2020 EIA Regulations for all projects, as part of the consent application process, to provide information on the options considered and process used to inform selection of the Proposed Development for which consent is sought.

4.2 Project overview

The UK Government considers Carbon Capture Utilisation and Storage (CCUS) as necessary to meet national and international climate change targets (HM Government, 2017). Failure to deploy CCUS would also mean the country could not credibly adopt a 'net zero emissions' target in line with the Paris Agreement's 1.5°C aspiration.

The UK is considered to have one of the most favourable environments globally for commercial CCUS, ranking fourth in the Global Carbon Capture Storage (CCS) Institute's CCS Readiness Index (Global CCS Institute, 2018). The Liverpool Bay Area (LBA), with its offshore fields of Hamilton Main, Hamilton North, and Lennox, was identified as one of the best sites for CO_2 storage in a 2015/16 Government sponsored study (Pale Blue Dot, 2016). These fields are approaching the end of their economic life and would be progressively decommissioned over the period 2023 to 2025 without the prospect of re-configuring as a CCS project.

The Proposed Development is being developed in parallel with, and as a key part of the HyNet North West full-chain hydrogen and CCS industrial decarbonisation project (the HyNet Project), which is designed to transform a region of the UK into the world's first low carbon industrial cluster by 2030. The HyNet Project was conceived in 2016 with the objective of decarbonising the entire industrial cluster to Net Zero. While industrial decarbonisation is the anchor, the HyNet Project builds the infrastructure backbone for a full regional hydrogen economy, and leverages the opportunity to repurpose, for future CCS service, the existing oil and gas facilities at Point of Ayr (PoA) and offshore in Liverpool Bay. CO_2 storage is provided by depleted and well-known gas fields that are owned and operated by Eni UK Limited (Eni) and are coming to the end of their economic life. The HyNet Project's CCS network will provide the infrastructure to transport and store the CO_2 produced as a by-product of the hydrogen production process, and CO_2 from a number of the UK's largest industrial emitters, including Stanlow Refinery, Ince Fertiliser plant, and Padeswood Cement plant located in this cluster.

In October 2020, the Oil and Gas Authority (OGA), known as the North Sea Transition Authority (NSTA) since March 2022, announced that it had awarded a CO_2 appraisal and storage licence (CS licence) to Eni. The CS licence covers an area located within the Liverpool Bay Area of the East Irish Sea. Under the CS licence, Eni plans to reuse and repurpose depleted hydrocarbon reservoirs (the Hamilton Main, Hamilton North, and Lennox fields) and associated infrastructure to permanently store CO_2 captured in NW England and N Wales.

CO_2 coming from industrial facilities in the Merseyside region will be sent to the coast at PoA, where a pipeline, previously used to transport natural gas inland from the fields, will be re-purposed to transport CO_2 offshore to a new Douglas platform, and from there via existing Wellhead Platforms, to the reservoirs, where it will be permanently stored.

4.3 Assessing the 'Do Nothing' scenario

A 'Do Nothing' scenario is a projection of the existing baseline to show what changes, if any, would take place if the project did not go ahead. The following section considers the 'do nothing' scenario in the context of the Project objectives set out above in particular in relation to tackling climate change.

In accordance with the EIA Regulations, an assessment of the future baseline under the 'do nothing' scenario has been completed for all technical topics (see volume 2, chapters 6 to 14).

For the Proposed Development, the 'Do Nothing' alternative would mean that following the end of life of the natural gas reserves in the Liverpool Bay Area fields, the gas pipeline and existing infrastructure would be decommissioned. Decommissioning would mean removal of all above ground structure as originally intended and would result in a significant increase in the decommissioning scope compared with the Proposed Development. Furthermore, the Proposed Development, which is also a key component of the low carbon hydrogen network in the region, would not be progressed. As an integral part of HyNet (the Project), this would mean that carbon emissions from industrial sources in North Wales and the North West of England region would remain unabated.

One of the key risks with the 'do nothing' scenario is being unable to contribute to addressing the climate change emergency and the need for rapid decarbonisation. Climate change is the defining challenge of our time. Human-induced global warming has reached approximately 1°C above pre-industrial levels and without a significant and rapid decline in carbon emissions across all sectors, global warming is not likely to be contained (IPCC, 2021).

The 6th and most recent Intergovernmental Panel on Climate Change (IPCC) Synthesis Report, published in 2022, presents a narrowing window to mitigate and reduce the probability of the most catastrophic events that could result from anthropogenic climate change, and which are forecast to have far-reaching negative effects on human populations globally. It also states that every ton of carbon dioxide (CO_2) emitted increases global warming and that the more rapidly decarbonisation is achieved noticeable reductions in the rate of climate change will likely be observed.

Any delay in reducing carbon emissions today results in greater carbon emissions to the atmosphere, higher global temperature rises and an increased level of and speed of action required to halt impacts. A rise in global temperatures above 1.5°C has potential to cause irreversible climate change, the potential for widespread loss of life and severe damage to livelihoods. Yet greenhouse gases projected at a global scale (using Nationally Determined Contributions (NDCs)) are now set to exceed 1.5°C by 2030 and look increasingly likely to exceed 2°C after 2030 (IPCC 2021). Therefore, any delays incurred now, make the challenge significantly more difficult for the years ahead.

4.4 Approach to Site Selection, Project Definition and Refinement

The alternatives assessment undertaken for the Proposed Development was a phased process, starting with undertaking considerations of the best method for the transportation of CO_2 in gas phase, followed by comprehensive assessments of the best corridor for the refurbished pipelines and associated infrastructure. The identified site is considered to be most suitable for the Proposed Development, given its reutilisation of existing infrastructure, proximity to existing infrastructure (onshore and offshore), and strong transport connections.

The Proposed Development strategy is to make use of existing assets wherever possible, including pipelines and offshore platforms (OPs). Specifically, the existing offshore natural gas export pipeline to the PoA gas terminal will be repurposed to become a CO_2 import pipeline and will transport the CO_2 to the Douglas Complex. From the Douglas Complex, CO_2 will be transported along repurposed natural gas pipelines to the Hamilton OP for injection into the Hamilton reservoir, to the Hamilton North OP for injection into the Hamilton North reservoir, and to the Lennox OP for injection into the Lennox reservoir.

Additionally, the Proposed Development is based on the utilisation of new facilities and partial re-utilisation of the existing facilities which provide flexibility in decommissioning activities. A new Douglas CCS platform will be installed to the northwest of the exiting Douglas complex (see volume 1, chapter 3 for full details).

Well sites and reservoirs at Hamilton Main, Hamilton North, and Lennox are notable for their significant pressure depletion and shallow depth. Therefore, these well sites have been denoted as being some of the most suitable CO_2 storage sites within UK Waters.

As part of the iterative design process, the detailed design of the Proposed Development will continue to evolve to take account of issues including environmental, health, and safety and engineering constraints and opportunities. The Enhancement, Mitigation and Monitoring Commitments intended to reduce the potential environmental impacts that are included within the design are summarised in volume 3, Enhancement, Mitigation and Monitoring Commitments (RPS Group 2023).

As part of the aforementioned process of assessing alternatives to the Proposed Development, the option of ‘do nothing’ or ‘no development’ was considered. However, the potential beneficial socio-economic outcomes of the Proposed Development (including alignment with Net Zero objectives and local employment opportunities) and associated environmental risks of not progressing with the Proposed Development, were considered greater than the potential adverse environmental and social impacts that will result from the construction, operation and maintenance, and decommissioning of the Proposed Development and its associated infrastructure.

4.5 Re-use of existing facilities

4.5.1 Wellhead OPs

The design concept for the Proposed Development aimed to re-utilise the existing Hamilton Main, Hamilton North and Lennox OPs and to convert them to CO_2 injection through the installation of an additional new module on each OP. To facilitate the future conversion of the Proposed Development to dense phase CO_2 injection would also require the installation of new risers and riser protection frames to connect the OPs with new offshore pipelines that would be installed in the future.

Structural analysis has been carried out to identify the effect of installing a new CCS equipment module supported on the top of the existing topsides. The CCS module would be positioned to avoid obstructing access to the existing conductors. A new helideck would be installed at the top of the new module, replacing the existing helideck. Electrical power would be supplied from a new submarine electrical cable that would be installed via some new risers and J-tubes on each platform. The new risers and J-tubes, and the riser protection structures, would create additional environmental loads (wind and wave loading), which would increase the overall weight of the new module.

The structural analysis demonstrated that each repurposed platform would be affected by additional loads due to an increase in:

- topsides' weight;
- wave loading on the newly installed risers and boat impact protection frames;
- dynamic amplification factor (increase in platform natural period i.e. the natural sway of the platform structure); and
- wind loading on the newly installed topsides modules.

The results of jacket structural analysis for the satellite OPs showed that the existing platform substructures are not capable of supporting the extra topsides' equipment weight, and the additional environmental loads arising from new risers and J-tubes.

Therefore, the existing topsides will be removed and replaced with the new topsides, reducing the overall weight, and allowing the installation of new risers inside the jackets, so avoiding the need for additional protection frames, resulting in a reduction of the environmental loads.

The new topsides components will be delivered to the OPs completely fabricated and ready for integration onto their respective jackets.

4.5.2 New Douglas CCS Platform

4.5.2.1 Concept evaluation

The initial concept for the Proposed Development, which was brought forward in the Offshore EIA Scoping Report (September 2022) (Liverpool Bay CCS Limited, 2022; see RPS Group 2022), proposed the existing Douglas Platform Complex to be repurposed for CO_2 service, by reconfiguring it to receive and distribute CO_2 to the Hamilton Main, Hamilton North, and Lennox OPs.

Specifically for the Douglas Platform Complex, the concept was to reuse the Douglas Main (DD) jacket and topsides, remove the hydrocarbon surface facilities from the topsides and replace them with CCS equipment, and convert the facility into a Normally Unmanned Installation (NUI). This would be done by adding a dedicated helideck and shelter, and then disconnecting from the other two bridge-linked Platforms in the Douglas Complex; Douglas Accommodation (DA) and Douglas Wellhead (DW). This would leave these two platforms free to be decommissioned outside of the CCS project schedule. This concept is hereafter referred to as 'Douglas Conversion'.

During the Front-End Engineering Design (FEED) stage, the Applicant has undertaken extensive work on the Douglas Conversion concept to develop it into a deliverable strategy. This work led to a more well-defined understanding of the challenges of implementing the Douglas Conversion strategy following the incorporation of resourcing and sequencing constraints. The main findings from this work were:

1. **Interdependencies with Decommissioning and Hydrocarbon Safety Systems.** The Douglas Complex is the existing hub for the whole Liverpool Bay Hydrocarbon Field, and as such is connected via pipelines and control systems to all the other Liverpool Bay Offshore Assets (including those not being re-used). Operationalising the Douglas Conversion strategy found that:
    a. All offshore hydrocarbon assets would need to be flushed and cleaned after production cessation (including non-reuse assets) before the Douglas Conversion could commence; and
    b. Real estate currently used by key field safety/control systems would be needed for CCS; therefore, multiple complex safety systems (field communications, fire and gas detection, power distribution) would need to be temporarily duplicated/replaced to allow CCS equipment installation to occur,

whilst simultaneously maintaining the essential safety functionality for compliance with Health and Safety Case legislation.

2. **Brownfield Risks.** Detailed analysis of the necessary equipment removals on Douglas Main and subsequent CCS equipment installation revealed a large, complex, and interdependent volume of brownfield works:
   a. Douglas Main has congested multi-deck ‘stick built’ topsides, which were originally assembled ‘piece-small’ in a construction facility onshore. To create space for CCS facilities, and reduce weight to create structural integrity for the extension of the platform life, more than 5,000 tonnes of equipment would need to be removed ‘piece-small’. The design does not facilitate modular or bulk equipment removal;
   b. During offshore conversion, the Douglas Main site would be subject to many constraints, including People on Board (POB) limits. Amongst other things, these POB limits ensure safe egress and evacuation, safe systems of work by limiting adjacent work-fronts, and necessary enabling work such as safety system maintenance/replication; and
   c. The cumulative cost impact of a significant volume of brownfield manhours has offset any re-use cost benefits in the base case. The volume and nature of brownfield work also has consequential significant schedule and cost growth risk.
3. **Market Response.** In parallel to the FEED process, the Applicant has been preparing contracting strategies for the Project Execution Phase, with part of this work involving market enquiries for the offshore scopes. Douglas Conversion excepted, the Applicant has received a strong market response for the other major offshore scope elements including Engineering Procurement Construction (EPC) and Transportation and Installation (T&I) for NUI topsides for Hamilton Main, Hamilton North, and Lennox. However, due to the identified brownfield risks, the Applicant has received insufficient market response to its requests for Expressions of Interest to carry out the Douglas Conversion from financially and technically capable EPC companies.

Whilst the Douglas Conversion option remains a feasible design, when considering safety, technical, and environmental factors, the New Douglas option is considered preferable.

Overall, the reduced number of manhours offshore, and the reduction in complexity of the tasks being undertaken, the introduction of the New Douglas option significantly reduces the risk to personnel. Moreover, the new concept reduces the risks to the Proposed Development associated with simultaneous decommissioning, as the Douglas Complex will be decoupled from the CCS activities. The Douglas Conversion would have significant technical complexities that include the need to provide temporary systems during transitional works and require multiple interdependent work fronts on a congested work site. The New Douglas technical work will largely be undertaken in an onshore fabrication facility, thereby avoiding these technical risks.

4.5.2.2 Comparative assessment

A comparative assessment of the original ‘Douglas Conversion’ scheme with the alternative options of either, installing a new NUI close to the existing Douglas Complex, or complete replacement of the Douglas Complex ‘Douglas Deck’ Replacement has been performed.

When conducting the comparative analysis between the Douglas Conversion and the New Douglas option, the following criteria (of equal weighting) were used:

Safety: The safety criteria consider elements that impact risk to offshore and onshore personnel, including any requirement for handling HazMat/NORM. It covers the impact associated with the risk to other users (e.g. collision impact to fishing, commercial transport, and other vessels). It considers any inherent potential for high consequence events i.e. major accident hazard and major environmental incident type events. It addresses residual safety risk to other sea users (e.g. residual snag hazard risk, collision risk, etc.).

Environmental: The environmental criteria consider marine impact from noise and vessel discharges, fuel use and atmospheric emissions, other consumptions (e.g. environmental burden from processing returned materials, use of quarried rock or other new material), direct or indirect seabed disturbance, and loss of habitat.

The assessment of greenhouse gas (GHG) emissions found that the emissions created by the Douglas conversion were more than double that of the New Douglas (130,000 vs 61,000 tonnes).

Technical: The technical criteria consider the various technical risks that could result in a major project failure. Concepts such as Technical Novelty and Potential for Showstoppers can be captured along with impact on the schedule due to overruns from technical issues such as operations being interrupted by weather conditions. Technical Feasibility and Technical Maturity is also considered. The technical criteria also consider the location for the execution of the works, whether onshore (fabrication facility) or offshore (marine installation or brownfield construction).

Societal: These criteria address the economic impact of the option on commercial fishing operations from both the decommissioning activities and any residual impacts such as reinstatement of access to the area. It also addresses any socio-economic impacts on other users both onshore and offshore. Impact on the health, well-being, standard of living, structure or coherence of communities or amenities are considered.

Cost: Addresses the short-term cost of delivering the option as described and long-term cost of any liabilities (e.g. monitoring, potential future remediation cost, risk of cost escalation).

In addition to the economic criteria, a comparison of cost and schedule risk analysis has been performed, demonstrating the higher impact of risks associated with the brownfield conversion.

The result of the comparative assessment shows that, whilst the Douglas Conversion option remains a feasible design, when considering safety, technical, and environmental factors, the New Douglas option is considered preferable.

4.6 PoA to Douglas cable routes

4.6.1 Overall concept

New power supply and fibre optic (FO) cables are required to provide electrical power and data communication to the New Douglas platform once the Proposed Development is operational. The Offshore power and FO cables will, as a general principle, follow the alignment of the existing gas export pipelines at an offset of around 100 m. There may be a need to micro-route the cables around identified obstructions such as heritage assets, and unexploded ordnance (UXO).

As such, new electrical and FO cables will be installed from the PoA Terminal to the New Douglas.

As a general design principle, the cable routes are following the existing infrastructure. The advantages of this approach are that the ground conditions are relatively well-known, the reduced footprint of seabed disturbance by co-locating in an area occupied by existing infrastructure, and subject to operational activity.

4.6.2 Design response to EIA findings

Since the Offshore EIA Scoping Report (September 2022) (Liverpool Bay CCS Limited, 2022; see RPS Group 2022), the PoA to Douglas cable routes have been revised following design updates in response to the EIA. This is because offshore survey work has enabled the accurate location of the *Resurgam* and its protection area, and the actual location of the ‘gap’ around the east side of the West Hoyle Bank from the marine surveys.

4.6.2.1 Resurgam

The wreck of the *Resurgam* (see volume 2, chapter 11) has a statutory protection area of 300m under the Protection of Wrecks Act 1973 – although the wreck lies outwith the original Eni Development Area, the protection area is not centred on the does extent to within the previously proposed Area of Project Physical Work. The revised cable route misses the *Resurgam* protected area and leaves enough spaces between the protected area and the cables to allow for maintenance activities (see Figure 4.1).

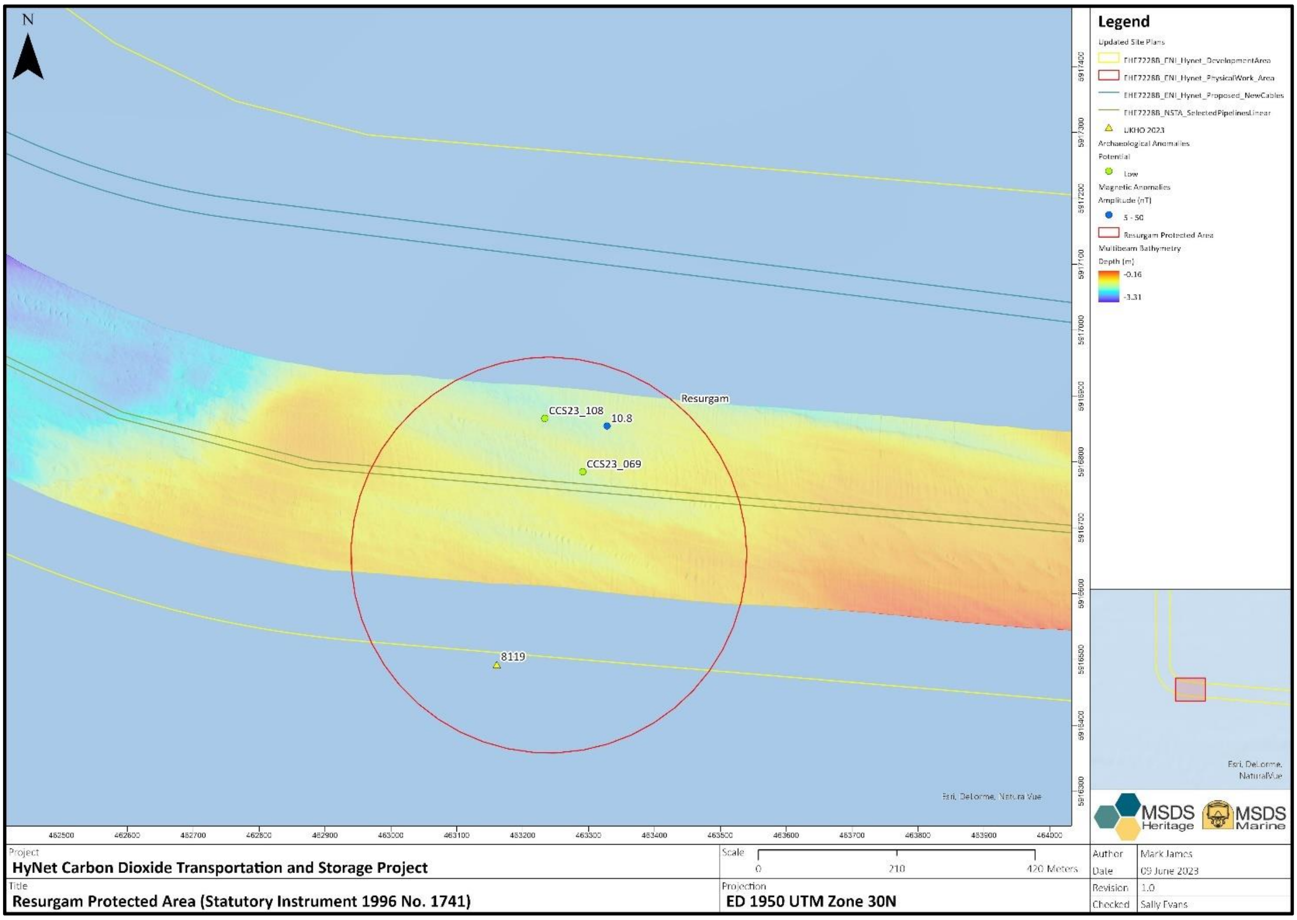

Figure 4.1: Revised Cable Routes, *Resurgam* Wreck And Protected Area

4.6.2.2 West Hoyle Bank

As discussed in the Onshore ES for the Town and Country Planning Act (TCPA) applications (Liverpool Bay CCS Limited, 2023), several route options have been developed for taking the new cables over the West Hoyle Bank. The route options are shown as high-level sketches in Figure 4.2 and described below:

- **Orange**: This route follows the existing gas export pipelines from the PoA terminal, all the way to the Offshore Douglas Complex. This is the most direct, and shortest of the three route options. Locating the foreshore cables on the east side of the gas export pipelines avoids the need for construction vehicles and equipment to cross and potentially damage the foreshore pipeline and newly laid cables. It limits construction activities to parts of the fields, dunes and intertidal area which have been previously disturbed by installation of the foreshore pipeline. To take the cable directly across the West Hoyle Bank, will require dredging a channel to provide safe navigation for the cable lay vessel. The Orange route is the preferred option for the cable.
- **Yellow**: This route aims to pass between two spits, both of which are constantly changing shape. Although beneficial for vessel draught, at low water, the tidal conditions within the channel between the spits would present a challenge for construction. The Yellow route also passes under pond habitats within the onshore

dune system. A variation to the Yellow option was developed, following the foreshore pipeline and diverting north to the Yellow route at the MLWS, as shown by a dashed yellow line on Figure 4.2. The benefit of the dashed yellow route is that it minimises construction activities in areas not previously disturbed by installation of the Foreshore Pipeline. The Yellow route was discounted, but the dashed Yellow route has been retained as a potential option to the orange route depending on the availability of specific cable lay vessels.

- **Pink**: This route deviates westwards and is the longest route offshore. Onshore cables from the offshore wind farms (including Gwynt-y-Môr) are located to the west of West Hoyle Spit, there is the potential to encounter shipwrecks in this location, and it is expected that this route would impact on the Port of Mostyn's shipping channel. In addition, this route would require the foreshore cables to cross the exisitng gas export pipeline twice to approach the Offshore Douglas Complex from the correct angle, which would create an avoidable construction risk. Additionally, this option would have the greatest impact on the the foraging areas for the Little Tern colony located on the North Wales coastline (see volume 2, chapter 8). The Pink route was therefore rejected.

The Orange route is considered the reasonable worst-case scenario, assessed in this Offshore ES, as even though it is the most direct of the options, it will require dredging a channel (most likely with a backhoe dredger) approximately 1,000 m in length, 60 m in width, and 7 m in depth (approximately 3 m to take the sandbank down to LAT, then approximately 3 m depth for cable burial). The excavated material would be side-cast along the length of the trench, and then backfilled after cable installation. It would take approximately two to three weeks to excavate the trench (see volume 1, chapter 3, section 3.4.4.1).

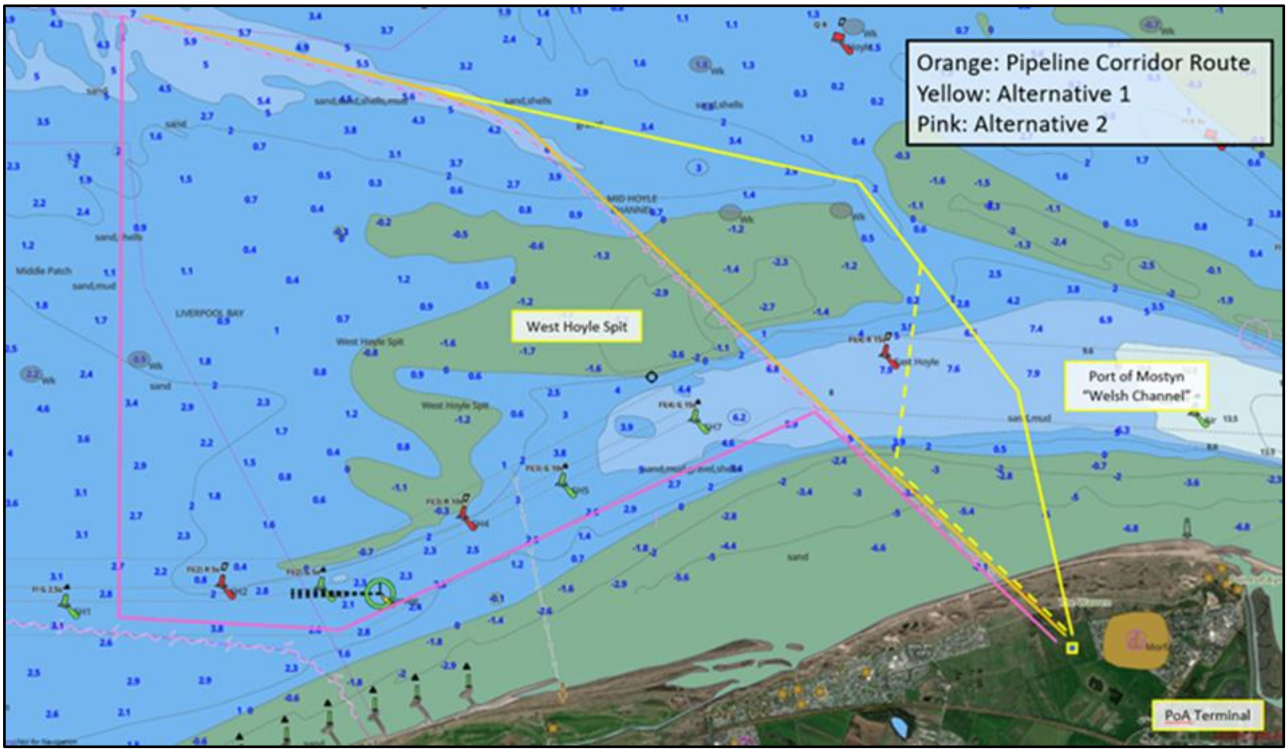

Figure 4.2: High Level Sketch Of Route Options Across West Hoyle Bank. Source: Admiralty Chart 2021 Modified By Liverpool Bay CCS Limited, 2023

4.7 Eni Development Area

Following the amendments to the PoA to Douglas cable routes, the Eni Development Area was revised accordingly, to avoid the *Resurgam* protection area, and to accommodate the options to navigate the West Hoyle Bank.

Figure 4.3 and Figure 4.4 provide an overview and a zoomed-in comparison of the original versus the revised Eni Development Area. It is noted that these are relatively minor amendments to reflect more detailed information being available during design development, and EIA. These amendments have not affected the definition of the reasonable worst-case and the likely significant effects of the project, as no new effects or receptors have been introduced.

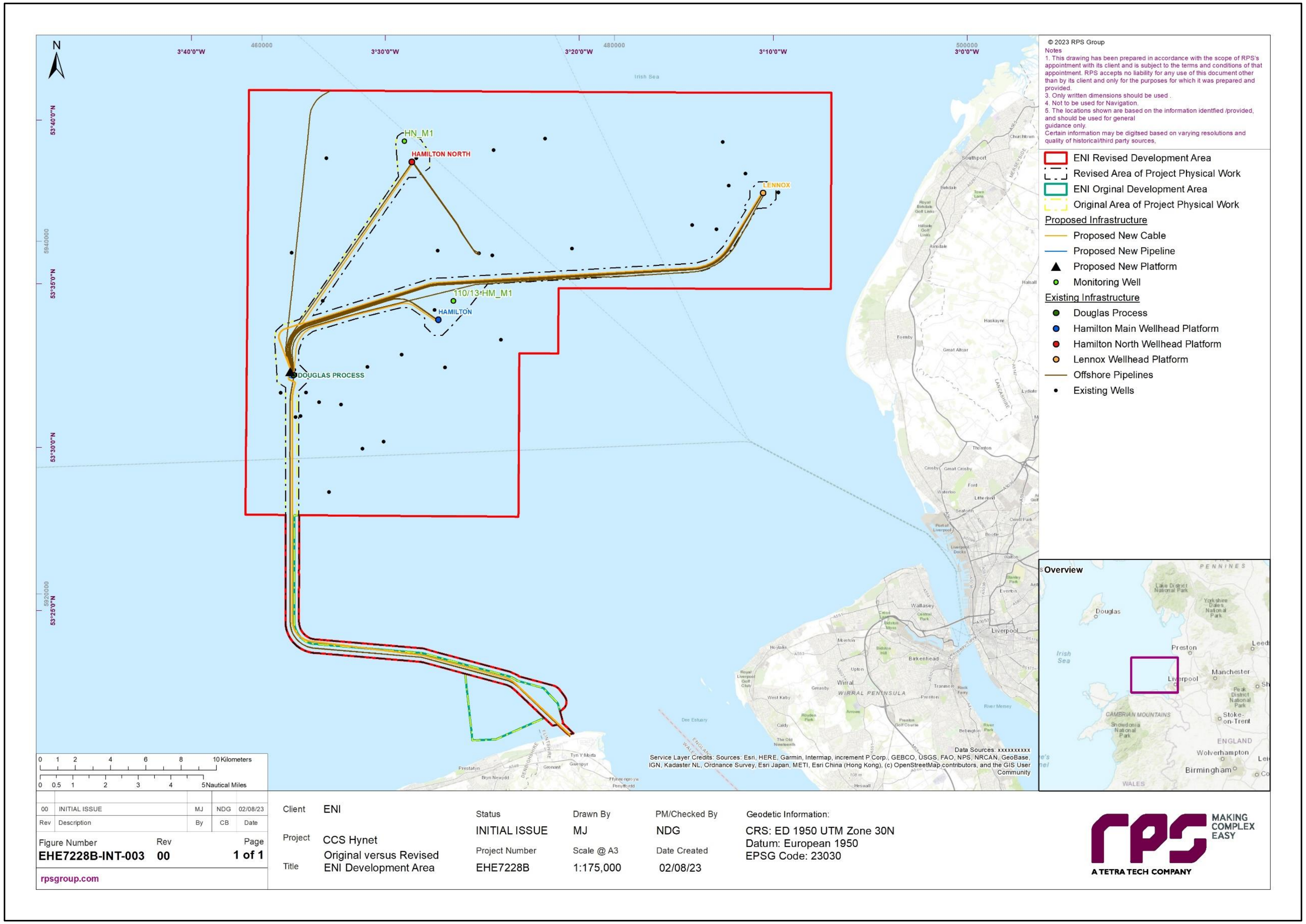

Figure 4.3: Original Versus Revised Eni Development Area

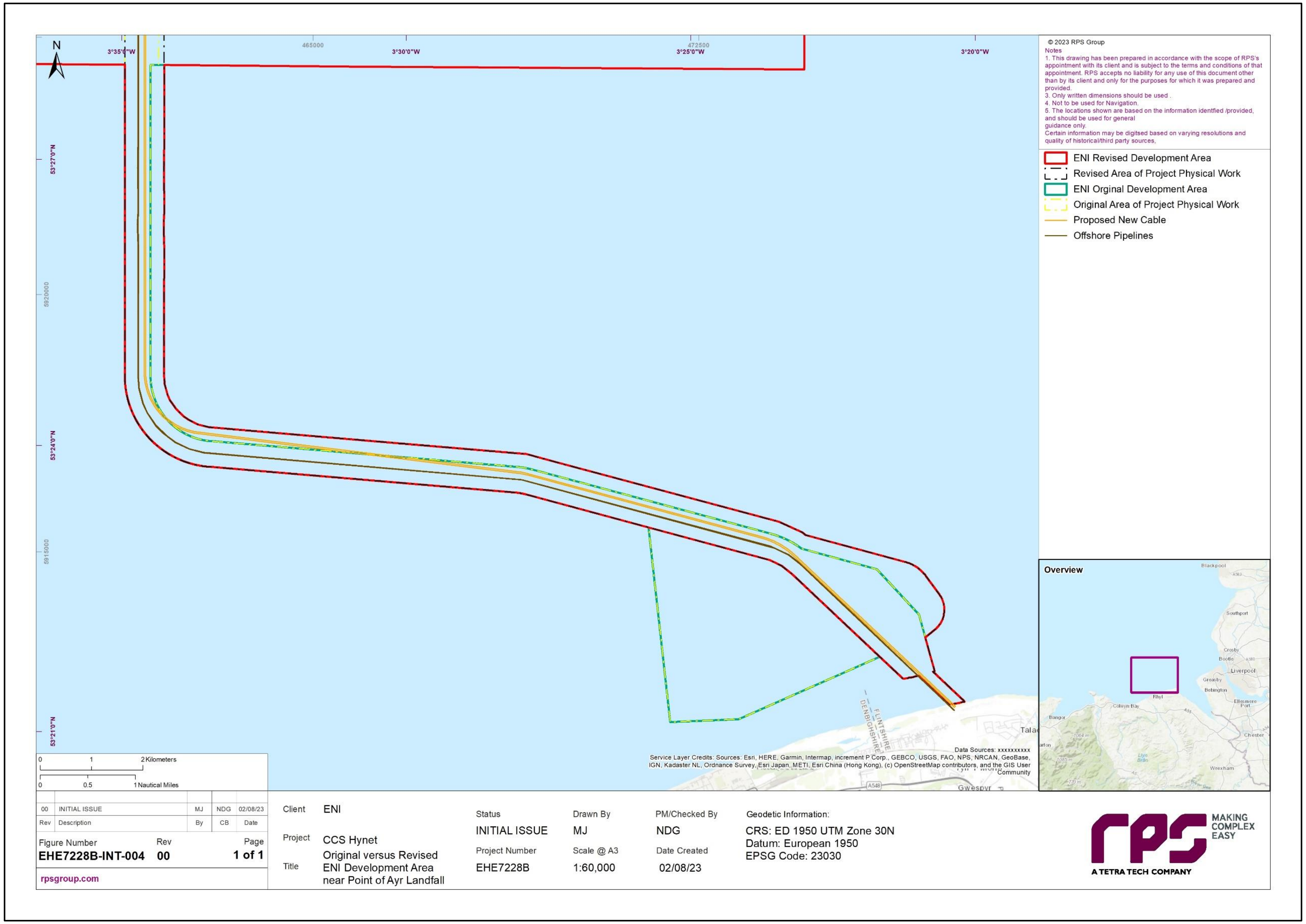

Figure 4.4: Zoomed In View Of Eni Development Area Revision Near Point Of Ayr Landfall

4.8 Overview of Project Design Envelope (PDE) Refinements

In addition to the new Douglas CCS platform, the Eni Development Area boundary change and the updated PoA to Douglas cable route, there have been a number of refinements made to the PDE since September 2022 (upon completion of the Offshore EIA Scoping Report (Liverpool Bay CCS Limited, 2022; see RPS Group 2022)). These refinements are summarised below:

- number and design of foundation piles for new Douglas platform;
- number and design of the external electrical cable protection required at crossings of existing pipelines and cables;
- modifications to routing of existing pipeline and electrical cable connections to new Douglas platform;
- worst-case assumptions developed about the UXO that could be encountered, and the donor charges that could be used to detonate them *in situ*;
- development of electrical load profiles for air coolers, compressors, and heating duty;
- provision of baseline environmental emissions monitoring system (including CO_2 emissions) data;
- updates to location, length, and depth of wells; and
- updates to vessel and helicopter movements during installation, operation and maintenance, and decommissioning.

4.9 Consultation and Stakeholder Engagement

4.9.1 Scoping and Screening Documents Submitted

Table 4.1 below provides a summary of the key screening and scoping documents submitted to date as part of the development and refinement of the Proposed Development.

Table 4.1: Documents Submitted For The Proposed Development

Document	Submission Date
Offshore EIA Scoping Report	September 2022
Offshore EIA Scoping Opinion	January 2023
Offshore HRA Screening Report	May 2023

4.9.2 Stakeholder consultation

The change in development concept from Douglas Conversion to New Douglas CCS Platform, the cable route refinements and subsequent boundary change was notified to key consultees and stakeholders.

A summary of the key issues raised during consultation relating to Site Selection and Consideration of Alternatives are outlined below in Table 4.2.

Table 4.2: Summary Of Key Consultation Issues Raised During Consultation Activities Undertaken For The Proposed Development Relevant To Site Selection And Consideration Of Alternatives

Topic	Date	Consultee and type of response	Issues raised	Response to issue raised and/or how this has influenced Site Selection and Consideration of Alternatives
Shipping and Navigation	June 2023	Royal Yachting Association (RYA) – consultation meeting	RYA noted that a key consideration would be changes to water depth due to cable protection close to the landfall.	The proposed new cable will be drilled directly underneath the dune system and buried to a target depth of 3 m below beach and seabed level, so there would be no change in datum points at landfall. The proposed new platform will be built approximately 200 m from the existing Douglas accommodation platform, within the existing 500 m safety zone. Once operational, the three existing Douglas platforms will be removed, leaving only one, smaller platform.
Shipping and Navigation	June 2023	MCA, Trinity House and Port of Mostyn – consultation meeting	Trinity House asked if cable protection would be implemented at the crossing of the West Hoyle Spit, noting that existing pipelines had become exposed due to the movement of the Spit.	The Proposed Development relies on a target burial depth of 3 m across the Spit, and cable protection is not planned to be used other than where required at cable crossings. Crossing agreements are in progress with the wind farms, noting that the wind farm cables already cross the existing pipelines. Cable route options go around the bank or go through a gap. Both options will be standard burial using ploughs.
Marine Archaeology	June 2023	Royal Commission on the Ancient and Historic Monuments of Wales (RCAHMW) – consultation meeting	Introduction to the Proposed Development; discussion of geophysical data coverage, noting the data is not full coverage; discussion of the location of *Resurgam* (Protected Wreck) and re-routing of the cables around the protected area; discussion on Archaeological Exclusion Zones (AEZs) and current routing of some cables through AEZs. Agreed a way forward which has been reflected in the documents produced as part of this application.	Key issues to be addressed are the lack of full coverage data and the routing of some cables through AEZs. Lack of full coverage data: This issue is dealt with through a commitment to collect and assess full coverage data prior to seabed impacts. This data will be reviewed by a competent and experienced marine archaeological geophysicist. Routing of cables through AEZs: This assessment makes a commitment to either investigate the AEZs and to amend them if appropriate, or to re-route around them and assess the wider area. There will be no impacts to AEZs by construction activities. The Written Scheme of Investigation (WSI) will clearly set out how this investigation and mitigation is to be achieved. See MSDS 2023.
Route alternatives	10 May 2023	NRW – comments received in relation to planning application to FCC, application reference FUL/000246/23: DETAILED PLANNING APPLICATION FOR THE RETENTION AND REUSE OF THE POINT OF AYR GAS TERMINAL AND ASSOCIATED GAS PIPELINE TO THE MEAN LOW WATER SPRING MARK FOR THE MANAGEMENT AND PROCESSING OF CO2; THE CONSTRUCTION OF 33KV ELECTRICITY AND FIBRE OPTIC CONNECTIONS FROM POINT OF AYR GAS TERMINAL TO THE MEAN LOW WATER SPRING MARK; AND OTHER ASSOCIATED DEVELOPMENT AT LAND WEST OF STATION ROAD, TALACRE.	Environmental Statement (ES) Chapter 4: Consideration of Alternatives, paragraph 4.5.10 Foreshore Cables, explains that "*The yellow route was discounted, but the dashed yellow option may eventually be selected over the orange option depending on the shifting nature of the sand banks*". We advise that you seek clarification on whether the dashed yellow route is still in scope for this application and whether it has been assessed.	The dashed yellow and orange routes both remain under consideration and were both assessed within this Offshore ES, and the HRA. See Figure 4.2. The dashed yellow and orange routes are in the same location (east side of the existing PoA to Douglas Pipeline between MHWS and MLWS), following the same alignment up to the MLWS covered by the Onshore ES and HRA supporting the Planning Application FUL/000246/23. The benefit of the dashed yellow route is that it follows the orange route onshore, so it does not protrude east and provides a more accessible route for construction vessels. However, the issue associated with constructability between the two spits offshore remains (water rushes between the two spits at speed). Therefore, the dashed yellow route and the orange route are both still under consideration. The final choice will be made during detailed design. This is because each route requires bespoke cable installation vessels to implement, and the availability of the vessels cannot be confirmed at this time. Sediment dispersion modelling has been carried out for the reasonable worst-case installation scenario, and both options are being assessed in this Offshore EIA that will support the Marine Licence application to NRW-MLT. **This has been taken into consideration within this Offshore ES.**

4.10 Conclusion

The site selection process explained within this chapter of the ES has culminated in the Application for the Proposed Development. The Applicant has endeavoured to take on board points raised by stakeholders during the scoping phase for the Proposed Development in relation to site selection and/or design.

As discussed in volume 1, chapter 5, a maximum design scenario approach has been implemented when assessing any impacts arising from the Proposed Development in relation to the site selection and/or design.

4.11 References

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5 ENVIRONMENTAL IMPACT ASSESSMENT METHODOLOGY

5.1 Introduction

This Offshore Environmental Statement (ES) has been developed to support an application for consent for the Proposed Development, in accordance with the requirements of the following regulations (collectively referred to hereafter as the EIA Regulations):

- in respect of a carbon storage permit: The Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020; and
- in respect of a marine licence application: The Marine Works (Environmental Impact Assessment) Regulations 2007 (as amended) ;

Volume 1, chapter 2 provides further details on the EIA Regulations and a detailed description of the Proposed Development can be found in volume 1, chapter 3.

This chapter of the Offshore ES presents the EIA methodology used for the assessment of likely significant environmental effects of the Proposed Development on physical, biological, and human receptors.

The HyNet Carbon Dioxide Transportation and Storage Project has both Onshore and Offshore elements.

The Onshore elements are being supported by two separate ESs:

- An ES to support the Development Consent Order (DCO) application for the HyNet Carbon Dioxide Pipeline DCO. The ES for the HyNet Carbon Dioxide Pipeline DCO application has been submitted in October 2022. National Infrastructure Planning Examination of the application started on the 20 March 2023 and is scheduled to close on the 20 September 2023.
- An ES to support the Town and Country Planning Act (TCPA) applications for the HyNet Carbon Dioxide Pipeline TCPA, these covering the elements located in Wales only. An EIA Scoping Report for the HyNet Carbon Dioxide Pipeline TCPA applications has been submitted in July 2021 and the EIA Scoping Opinion received in August 2021. Consultation on the ES closed in December 2022 and the planning applications were submitted on the 10 March 2023.

There is an overlap in jurisdiction in the intertidal area between Mean High Water Springs (MHWS) and Mean Low Water Springs (MLWS) of the Offshore and Onshore consenting and regulatory regimes. Both this Offshore ES, and ES to support the Onshore TCPA therefore present the relevant technical assessments for the landfall works in this area of overlap. Within this Offshore ES, 'Offshore' generally refers to the receptors on the seaward of MHWS, and 'Onshore' refers to the receptors on the landward of MHWS.

This chapter presents:

- the assessment methodology used to determine potential impacts including the approach that has been used to assess impact magnitude, sensitivity of receptors, and conclusion on the likely significance of effects;
- the methodology used for assessing cumulative effects assessment (CEA);
- the methodology for assessing inter-related effects; and
- the methodology for assessing transboundary effects.

Further details on topic-specific methodologies (e.g. methodologies for site-specific surveys) are provided in the relevant Offshore ES topic chapters (volume 2, chapters 6 to 14).

5.2 Environmental Impact Assessment legislation and guidance

The assessment of effects methodology employed in this Offshore ES draws upon relevant legislation, policy, and guidance, including those listed below:

5.2.1.1 Legislation

- The Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020 ('the 2020 EIA Regulations') (relevant to the Carbon Storage Permit application to the NSTA);
- The Marine and Coastal Access Act 2009 (as amended) (relevant to the Marine Licence application);
- The Marine Works (Environmental Impact Assessment Regulations) 2007 (as amended) (the 2007 EIA Regulations) (relevant to the Marine Licence application to Natural Resources Wales);
- The Conservation (Natural Habitats &c.) Regulations 1994;
- The Conservation of Habitats and Species Regulations 2017;
- The Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019;
- The Marine Environment (EU Exit) (Amendment) Regulations 2019; and
- The Environmental Permitting (England and Wales) Regulations 2016.

5.2.1.2 Policy

- Overarching National Policy Statement (NPS) for Energy (NPS EN-1) (including updated consultation draft) (DECC, 2011a; BEIS, 2021a);
- NPS for Renewable Energy Infrastructure (NPS EN-3) (including updated consultation draft) (DECC, 2011b; BEIS, 2021b); and
- NPS for Electricity Networks Infrastructure (NPS EN-5) (including updated consultation draft) (DECC, 2011c; BEIS, 2021c).

5.2.1.3 Guidance

- The Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020 – A Guide (BEIS, OPRED, 2021d);
- Environmental Impact Assessment for marine activities (NRW, 2023);
- The Planning Inspectorate Advice Note Seven: Environmental Impact Assessment: Preliminary Environmental Information, Screening and Scoping (PINS, 2020a);
- The Planning Inspectorate Advice Note Twelve: Transboundary Impacts and Process (PINS, 2020b);
- The Planning Inspectorate Advice Note Seventeen: Cumulative effects assessment (PINS, 2019);
- Guidelines for Ecological Impact Assessment (EcIA) in the United Kingdom (UK) and Ireland (CIEEM, 2018);
- Environmental Impact Assessment Guide to: Delivering Quality Development (IEMA, 2016);
- Environmental Impact Assessment for Offshore Renewable Energy Projects (British Standards Institute (BSI), 2015);
- Delivering Proportionate EIA, A Collaborative Strategy for Enhancing UK Environmental Impact Assessment Practice (IEMA, 2017);

- Guidelines for data acquisition to support marine environmental assessments of offshore renewable energy projects (CEFAS, 2012); and
- Nature conservation considerations and environmental best practice for subsea cables for English Inshore and UK offshore waters (Natural England and JNCC, 2022).

Where relevant topic specific guidance and legislation exists, this is discussed within the relevant Offshore ES chapters (volume 2, chapters 6 to 14). References to legislation in this Offshore ES are to the relevant legislation as amended.

5.3 Consultation and scoping

Consultation on the proposed offshore EIA methodology (including the CEA methodology and approach to assessing transboundary and inter-related effects) was undertaken at the offshore EIA scoping stage. The HyNet Carbon Dioxide Transportation and Storage Project – Offshore EIA Scoping Report (Liverpool Bay CCS Limited, 2022, (RPS Group 2022)) presented these methodologies and requested feedback on the proposed approaches. A summary of the key issues raised during consultation relating to this chapter are outlined below in Table 5.1, together with how these issues have been considered in the production of this chapter.

Table 5.1: Summary Of Key Consultation Issues Raised Relevant To The EIA Methodology

Consultee	Issue Raised	Response to Issue Raised/Where this has Been Considered in Chapter
OPRED (Scoping Opinion)	<u>Application Process and Cumulative Assessment:</u> Associated elements of the wider HyNet Carbon Dioxide Transportation and Storage Project are likely to be considered as part of the cumulative and in-combination effects of the Proposed Development. The ES should therefore demonstrate consideration of the wider HyNet Carbon Dioxide Transportation and Storage Project when assessing the environmental effects of the Proposed Development.	The wider HyNet Carbon Dioxide Transportation and Storage Project, including the DCO and TCPA applications being progressed by the Applicant for the Onshore elements of the HyNet Carbon Dioxide Transportation and Storage Project, are included in the CEA (see section 5.5.1).
	<u>Best Practice Advice for Evidence and Data Standards:</u> When completing the ES, the Developer should make use of the guidance document called 'Nature conservation considerations and environmental best practice for subsea cables for English Inshore and UK offshore waters.' This has been jointly developed by Natural England and the Joint Nature Conservation Committee (JNCC) in collaboration with the European Subsea Cable Association and provides high level advice on the main pressures, sensitive habitats and best practice for subsea cables.	This guidance has been accessed and used to inform the assessment of effects methodology (see section 5.2).
	<u>Cumulative and In-combination Effects:</u> The ES should identify, describe and evaluate the environmental effects that are likely to result from the Project in combination with other major developments and activities that are being, have been or will be carried out in the vicinity of the Project, for example other oil and gas developments, offshore wind and dredging activities. In particular (subject to the available information) the following types of projects should be factored in: 1. existing completed projects; 2. approved but incomplete projects; 3. ongoing activities;	The types of projects listed in the scoping opinion are included in the CEA (see section 5.5.1).

Consultee	Issue Raised	Response to Issue Raised/Where this has Been Considered in Chapter
	4. plans or projects for which an application has been made and which are under consideration by the consenting authorities (i.e. scoping projects); and 5. plans and activities which are reasonable foreseeable (i.e. projects for which an application has not yet been submitted but are likely to progress before completion of the Project and for which sufficient information is available to assess the likelihood of cumulative and in combination effects).	
	Environmental Data: All relevant environmental data is expected to be sourced, analysed and presented in relation to the project. A non-exhaustive list of potential sources of environmental information is provided, but the developer is expected to consult such other sources as it considers necessary. Relevant local environmental data should also be sourced from the appropriate local bodies which may include local environmental records centre, the local wildlife trust, local geo-conservation groups or other recording societies.	Where required, additional environmental data has been sourced and analysed to inform the EIA. See section 5.4.2.1.
	Landscape and visual impacts: It is advised that details of local landscape and seascape character areas (mapped at a scale appropriate to the Project's site) and any relevant management plans or strategies pertaining to the area are included. The ES should include assessments of visual effects of the Project (such as landscape and seascape) together with any physical effects (such as changes in topography). It is advised that the ES includes an assessment of the potential impacts of the Project on local landscape character using the methodology outlined within the landscape and seascape character assessment (LCA/SCA) which is almost universally used for landscape and visual impact assessment. It is also advised that this assessment includes effects of the special qualities of the designated landscape as set out in the statutory management plan for the area.	Following the scoping opinion, a Seascape, Landscape and Visual Impact Assessment (SLVIA) has been completed for the Proposed Development (volume 3, appendix C3). The SLVIA concluded the Proposed Development can be accommodated without significant effects on seascape, landscape character, and visual amenity and therefore this topic has been scoped out from further assessment.

5.3.1 Scope of impact assessment

Considering the nature, size and location, information provided in the scoping opinion and other consultation responses provided throughout the EIA process, the following topics have been identified as requiring consideration within this ES:

- Physical Processes (volume 2, chapter 6)
- Marine Biodiversity (volume 2, chapter 7)
  - Benthic Subtidal and Intertidal Ecology
  - Fish and Shellfish Ecology
  - Marine Mammals
- Ornithology (volume 2, chapter 8)
- Shipping and Navigation (volume 2, chapter 9)
- Commercial Fisheries (volume 2, chapter 10)

- Marine Archaeology (volume 2, chapter 11)
- Infrastructure and Other Sea Users (volume 2, chapter 12)
- Climate Change (volume 2, chapter 13)
- Inter-Related Effects (volume 2, chapter 14)

5.4 Key principles of the EIA

5.4.1 Overview

Within this Offshore ES, the assessment of each topic (e.g. physical processes, ornithology, shipping and navigation, etc.) is included in a separate chapter. Within each of the topic chapters, the following matters will be considered:

- identification of the study area for the topic-specific assessments;
- description of the planning policy and guidance context;
- summary of consultation activity, including comments received in the Scoping Opinion;
- description of the environmental baseline conditions; and
- presentation of impact assessment, which includes:
  - identification of the maximum design scenario for each impact assessment;
  - a description of the measures adopted as part of the Proposed Development, including mitigation and design measures which seek to prevent, reduce or offset environmental effects;
  - identification of likely impacts and assessment of the significance of identified effects, taking into account any mitigation measures adopted as part of the Proposed Development;
  - identification of any further mitigation measures required in respect of Likely Significant Effects (LSE) (in addition to those measures adopted as part of the Proposed Development), together with consideration of any residual effects.
  - identification of any future monitoring required;
  - assessment of any cumulative effects with other major developments, including those that are proposed, consented and under construction (including, where applicable, those projects, plans or activities that are currently operational that were not operational when baseline data was collected); and
  - assessment of any transboundary effects (i.e. effects on other states).

Inter-related effects (i.e. inter-relationships between environmental topic areas) have been assessed in a separate standalone ES chapter (volume 2, chapter 14) which considers the impacts of the Proposed Development on each of the identified receptor groups.

Within each topic chapter a number of key principles have been applied, and these are detailed in sections 5.4.2 to 5.7.

5.4.2 Proportionate EIA

The importance of delivering EIAs that are proportionate and accessible to a wide range of stakeholders has been acknowledged by EIA practitioners, with a recent drive for improved quality of Environmental Statements and EIA reports from a number of organisations (e.g. IEMA, 2017).

The aim of producing a proportionate EIA has been a key consideration in the development of this Offshore ES. A number of tools and processes have been used to aid the proportionality of the Proposed Development EIA. This included:

- application of the existing evidence basis; and
- commitment to embedded mitigation measures.

5.4.2.1 Existing Evidence Basis

The development area is located in Liverpool Bay, for which there exists significant data and knowledge regarding the baseline environment. This data/knowledge has been acquired through the former Liverpool Bay zonal studies, from the surveys and assessments undertaken for Burbo Bank, Morgan and Mona, Rhys Flat, and Gwynt y Mór offshore wind farms, and the multiple oil and gas platforms and developments in the area. Where possible in this Offshore ES, the Applicant has made use of these data to provide an overview of the baseline environment and the availability of existing data to support the Offshore ES; to draw upon the pre-existing evidence base where appropriate.

To inform the EIA, additional relevant environmental data in relation to the Proposed Development has been sourced and analysed. This included relevant local environmental data which has been sourced from the appropriate local bodies. All data used to inform the assessment is described and discussed in the relevant Offshore ES topic chapters (volume 2, chapters 6 to 14).

5.4.2.2 Mitigation Measures

The EIA can influence the design of a project in many ways, including:

- amending the layout and extent of a development site to avoid key sensitive receptors;
- amending the design of a specific aspect of the development to manage impacts;
- specifying construction techniques to avoid effects on receptors; and
- changing materials to reduce volume and/or transport impacts (IEMA, 2016).

There are three distinct forms of mitigation which include:

- **primary inherent mitigation**: These include modifications to the location or design of the development made during the pre-application phase that are an inherent part of the Proposed Development and do not require additional action to be taken. This includes measures such as identifying an archaeological feature which should remain unaffected by the Proposed Development;
- **secondary foreseeable mitigation**: These include actions that will require further activity in order to achieve the anticipated outcome. These may be imposed as part of the consents and licences, or through inclusion in the Offshore ES. This includes measures such as those required to restore a sensitive habitat; and
- **tertiary inexorable mitigation**: Actions that would occur with or without input from the EIA feeding into the design process. These include actions that will be undertaken to meet other existing legislative requirements, or actions that are considered to be standard practices used to manage commonly occurring environmental effects. This includes measures such as the Code of Construction Practice (CoCP), and Environmental Management Plans (EMPs).

Both primary and tertiary measures can be embedded into the project design. The basis of the Offshore ES can therefore be undertaken on the basis that these measures will definitely be delivered and therefore any effects which might arise without these mitigation measures do not need to be identified as potential effects as there is no potential for them to arise (IEMA, 2016).

Primary mitigation is inherent with the Project Description and tertiary mitigation is inexorable as described above, both types of mitigation are considered as designed in measures. Secondary mitigation proposed to reduce significance of impact are detailed within the topic chapters of this Offshore ES and summarised in volume 3, appendix E.

5.4.3 Design envelope approach and Maximum Design Scenario

The Project Design Envelope (PDE) approach (also known as the Rochdale Envelope approach) has been adopted for the assessment of the Proposed Development, in accordance with current best practice and the 'Rochdale Envelope Principle'. This approach allows for the Proposed Development to be assessed on the basis of project design parameters that are not specific at the time of writing but are indicated with a range of potential values. It is not possible to provide precise final details of the Proposed Development, or the way it will be built, a number of years ahead of the time it will be constructed. As a relatively novel industry, improvements in technology and construction methodologies occur frequently and information provided as part of the consent application could become rapidly outdated, resulting in an uneconomical and potentially unbuildable project.

For each impact assessment, the Maximum Design Scenario (MDS) from within the range of potential options for each development parameter has been identified, and the assessment has been undertaken on this basis. The Design Envelope Approach employed for the Proposed Development is consistent with the Planning Inspectorate's (PINS) Advice Note Nine: Rochdale Envelope (PINS, 2018).

An example of the PDE approach would be where several types of subsea cable installation methods are considered. The assessment in this case would be based on the installation method known to have the greatest potential impact on a given receptor. In this instance, the PDE for the installation method with the greatest seabed disturbance potential would be that which leaves the largest footprint. It can be assumed that any project parameters equal to or less than those assessed will have environmental effects of the same level or less upon the receptors for the topic under consideration.

Volume 1, chapter 3 sets out the Proposed Development parameters and identifies the range of potential project design values for all relevant components of the development. For each of the topic chapters (volume 2, chapters 6 to 14) within this Offshore ES and for each of the impacts assessed, the Design Envelope considered will be the scenario which would give rise to the greatest potential impact. If, after undertaking the impact assessment it is shown that no significant effect is anticipated, it can be assumed that any project parameters equal to or less than those assessed in this 'Design Envelope' will have environmental effects of the same level or less and will therefore also have no significant effect upon the receptors for the topic under consideration.

By employing the Design Envelope approach, the developer retains flexibility in design of the Proposed Development and associated offshore infrastructure within certain maximum extents and ranges, all of which are fully assessed in this Offshore ES.

5.4.4 Impacts and effects

The Proposed Development has the potential to create a range of impacts and effects with regard to the physical, biological, and human environment related to marine receptors. For the purposes of the Offshore ES, the term 'impact' is defined as a change that is caused by an action. For example, the laying of an inter-platform cable (action) is likely to result in seabed disturbance (impact). Impacts can be defined as direct, indirect, temporary, irreversible, secondary, cumulative and inter-related. They can also be either beneficial or adverse, although the relationship between them is not always straightforward.

The term 'effect' is defined as the consequence of an impact. Using the increased sedimentation example again, the laying of an inter-platform cable (action) results in seabed disturbance (impact), with the potential to disturb benthic habitats and species (effect). The significance of effects is determined by consideration of the magnitude of impact alongside the sensitivity of each receptor/receptor group.

The magnitude of an impact is the consideration of the extent, duration, frequency, and reversibility of an impact. Receptors can be defined as the physical or biological resource or user group that could be affected by the potential impacts. In defining the sensitivity for each receptor/receptor group, the vulnerability, recoverability, and value/importance of that receptor will be taken into consideration.

In order to ensure consistency in defining the significance of an effect, a matrix approach will be adopted in the Offshore ES as presented in Table 5.2. In cases where a range is suggested for the significance of effect, there remains the possibility that this may span the significance threshold (i.e. the range is given as minor or moderate). In such cases the final significance is based upon the expert's professional judgement as to which outcome delineates the most likely effect, with an explanation as to why this is the case.

Table 5.2: Matrix Used For The Assessment Of The Significance Of Effect

Sensitivity of Receptor	Magnitude of Impact				
		Negligible	**Low**	**Medium**	**High**
	Negligible	Negligible	Negligible or Minor	Negligible or Minor	Minor
	Low	Negligible or Minor	Negligible or Minor	Minor	Minor or Moderate
	Medium	Negligible or Minor	Minor	Moderate	Moderate or Major
	High	Minor	Minor or Moderate	Moderate or Major	Major or Substantial
	Very High	Minor	Moderate or Major	Major or Substantial	Substantial

A level of effect of moderate or more will be considered a ‘significant’ effect for the purposes of the EIA. A level of effect of minor or less will be considered ‘not significant’. Effects of moderate significance or above are therefore considered important in the decision-making process, whilst effects of minor significance or less warrant little, if any, weight in the decision-making process.

The matrix approach is consistent with the general approach described in the Design Manual for Roads and Bridges (DMRB) (Highways England *et al.,* 2020) and Environmental Impact Assessment for Offshore Renewable Energy Projects – Guide (BSI, 2015). A number of modifications have however been made in the interest of proportionality, including:

- a magnitude of impact of ‘no change’ will not be assessed since it will always lead to a non-significant effect;
- a negligible magnitude impact will not be considered further because it will always lead to a non-significant effect; and
- receptors of negligible importance, value, or sensitivity will not be considered further because it will always lead to a non-significant effect.

Where significant effects are initially identified, the EIA will follow a ’feedback loop’ methodology, as illustrated within Figure 5.1. Through this process, an impact is initially assessed to determine the significance of the potential environmental effect. If the effect of an impact presents a major or substantial significant adverse outcome, changes are typically made to the Proposed Development design (primary mitigation) in order to reduce or offset the magnitude of impact. If the effect of an impact presents a moderately significant adverse outcome, mitigation such as engineering controls or construction methods (secondary and tertiary mitigation) are employed in order to reduce or offset the magnitude of the impact.

This process is repeated, as illustrated within Figure 5.1 until the EIA practitioner is satisfied that:

- the effect is reduced to a level that is not significant in EIA terms; or
- no further changes can be made to the Proposed Development design to reduce the magnitude of impact and therefore the significance of the effect. In these cases, an overall effect that is still significant in EIA terms may be presented.

Following this iterative approach ensures that the significance of effect presented for each identified impact may be presumed to be representative of the maximum residual adverse effect the development area may have on the receiving environment.

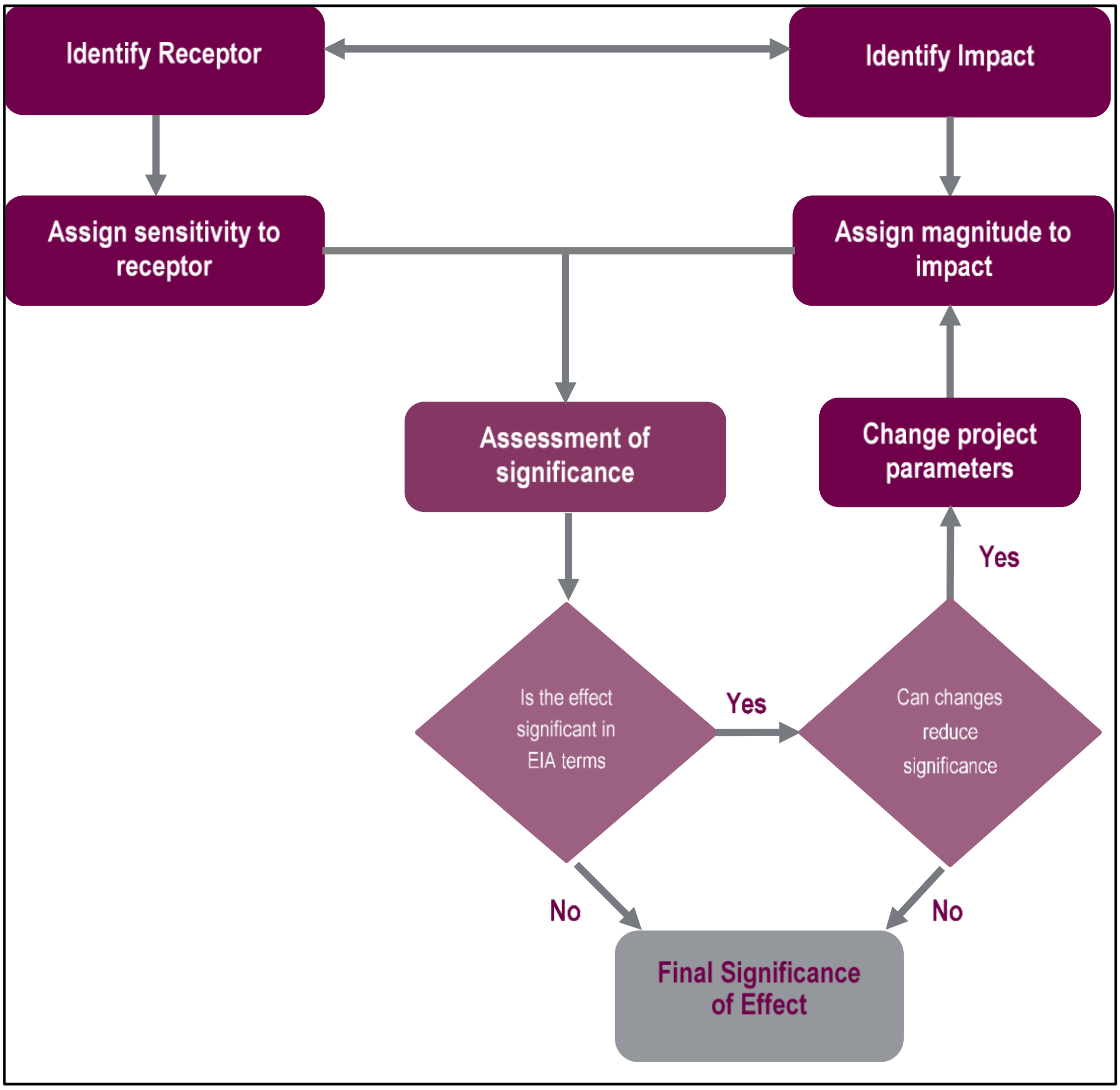

Figure 5.1: Iterative Approach To Mitigation Within The Proposed Development EIA

5.5 Cumulative Effect Assessment

5.5.1 Overview

A CEA is a legal requirement under the EIA Regulations. A CEA provides consideration of the impacts arising from the Proposed Development alone and cumulatively with other relevant plans, projects and activities. Cumulative effects are therefore the combined effect of the Proposed Development in combination with the effects from a number of different projects, on the same receptor or resource.

A fundamental requirement of undertaking the CEA is to identify those foreseeable developments or activities with which the Proposed Development may interact to have the potential to result in a cumulative impact. All phases (construction, operation and maintenance, and decommissioning) of the Proposed Development may have the potential to lead to cumulative impact.

For the Proposed Development CEA (volume 3, appendix F), other proposed major developments in the area have been taken into account within the CEA. PINS Advice Note Seventeen: Cumulative Effects Assessment Relevant to Nationally Significant Infrastructure Projects (PINS, 2019) recommend that, through consultation with Local Authorities and other relevant consenting bodies, other major developments (both onshore and offshore) in the area should be taken into account when conducting a CEA, including those which are:

- already constructed;
- under construction;
- permitted application(s), but not yet implemented;
- submitted application(s) not yet determined; and
- plans and projects which are 'reasonably foreseeable' (i.e. developments that are being planned, including, for example, offshore renewable energy projects that have a Crown Estate Agreement for Lease (AfL), offshore renewable energy projects that have been scoped).

Similarly, the scoping opinion (OPRED, 2023) stated that '*The ES should identify, describe and evaluate the environmental effects that are likely to result from the Project in combination with other major developments and activities that are being, have been or will be carried out in the vicinity of the Project, for example other oil and gas developments, offshore wind and dredging activities. In particular (subject to the available information) the following types of project should be factored in:*

i. Existing completed projects;

ii. Approved but incomplete projects;

iii. Ongoing activities;

iv. Plans or projects for which an application has been made and which are under consideration by the consenting authorities (i.e. scoping projects);

v. *Plans and activities which are reasonable foreseeable (i.e. projects for which an application has not yet been submitted but are likely to progress before completion of the Project and for which sufficient information is available to as sess the likelihood of cumulative and I in combination effects).'*

The CEA considers all other relevant plans, projects and activities that are publicly available three months prior to the Proposed Development application, these including the DCO and TCPA applications being progressed by the Applicant for the Onshore elements of the HyNet Carbon Dioxide Transportation and Storage Project.

5.5.2 Screening stage

To ensure a thorough and comprehensive approach to identification of potential projects to be considered in the CEA, an initial 'long list' of projects within a defined Zone of Influence (ZOI) was developed based on the above listed criteria. The ZOI for the Proposed Development has been based on the Ornithology ZOI, which represents the maximum screening area.

The initial CEA long list was reduced following consideration of potential for cumulative effects for each potential impact-receptor pathway staged process as set out below:

- physical overlap – Ability for impacts arising from the Proposed Development to overlap with those from other projects/plans on a receptor basis. This means that an overlap of the physical extents of the impacts arising from the two (or more) projects/plans must be established for a cumulative effect to arise. Exceptions to this exist for certain mobile receptors that may move between, and subject to, two or more separate physical extents of impact from two or more projects; and
- temporal overlap – In order for a cumulative effect to arise from two or more projects, a temporal overlap of impacts arising from each must be established. It should be noted that some impacts are active only

during certain phases of development, such as piling noise during construction. The absence of a strict overlap however may not necessarily preclude a cumulative effect, as receptors may become further affected by additional, non-temporally overlapping projects.

This screening stage was based on the experience and knowledge of technical specialists, and the current guidance and regulations. The projects or plans that remain after review of the long list are taken forwards to the assessment stage.

5.5.3 Assessment stage

Following the screening stage outlined in section 5.5.2, information is gathered on the projects, plans or activities to be taken forwards into the CEA. Where the potential significant effect for the Proposed Development alone is assessed as negligible, or where an impact is predicted to be highly localised, these will not be considered within the Proposed Development CEA, as there is not considered to be a potential for cumulative effects with other plans, projects or activities.

The level of publicly available data for each project, plan and/or activity included in the CEA will be different and dependent on the development stage of the Proposed Development. Planning Inspectorate Advice Note Seventeen recommends that *'a level of certainty, reflecting the availability of detail and information necessary for the assessment, is assigned to each development and recorded'* (Planning Inspectorate, 2019). At this point of the assessment, topic authors assigned a data confidence value to each screening in project, plan and/or activity.

In the undertaking of the CEA for the Proposed Development, a tiered approach was adopted. This provides a framework for placing relative weight upon the potential for each project/plan to be included in the CEA to ultimately be realised, based upon the project/plan's current stage of maturity and certainty in the projects' parameters. The tiered approach to the CEA is as follows:

- Tier 1:
  - under construction;
  - permitted application;
  - submitted application; and
  - those currently operational that were not operational when baseline data were collected, and/or those that are operational but have an ongoing impact.
- Tier 2:
  - the scoping report has been submitted and is in the public domain.
- Tier 3:
  - the scoping report has not been submitted and is not in the public domain;
  - identified in the relevant development plan for the Proposed Development; and
  - identified in other plans or programmes.
- Tier 4:
  - no publicly available information.

All projects/plans that have been screened into the CEA via the screening process have been allocated into one of the above Tiers and assessed in the CEA.

The CEA considers all other relevant plans, projects and/or activities that are publicly available three months prior to the Proposed Development application.

Where practicable, the CEA methodology then follows the outline of the stand-alone assessment methodology as described in section 5.4. This approach allows consistency throughout the EIA.

5.6 Transboundary effect

Transboundary effects arise when impacts from the Proposed Development within one state affect the environment of another state(s). The need to consider such transboundary effects has been embodied by the United Nations Economic Commission for Europe (UNECE) Convention on EIA in a Transboundary Context (commonly referred to as the 'Espoo Convention'). The Convention requires that assessments are extended across borders between Parties of the Convention when a planned activity may cause significant adverse transboundary impacts.

In European Union (EU) member states, Directive 85/337/EEC (as amended) (the EIA Directive) implements both the Espoo and Aarhus Conventions. EIA Regulations were adopted to implement this Directive in UK law. Following the UK's departure from the EU, EU-derived legislation continues to have effect in domestic law under the European Union (Withdrawal) Act 2018. The EU Exit Regulations establish that the regimes that inform planning decisions will remain as set out in the founding legislation. Therefore transboundary impacts are still to be considered as part of the EIA.

Transboundary Impacts Screening (RPS Group 2023) presents the update to the transboundary screening work undertaken at the scoping stage, considering the more recent project information.

This exercise identified that the following receptors may experience transboundary impacts from the Proposed Development:

- Fish and Shellfish ecology (volume 2, chapter 7: Marine Biodiversity);
- Marine mammals (volume 2, chapter 7: Marine Biodiversity);
- Ornithology (volume 2, chapter 8);
- Shipping and Navigation (volume 2, chapter 9);
- Commercial Fisheries (volume 2, chapter 10); and
- Climate Change (volume 2, chapter 13).

Each of the above topic chapters provides an assessment of transboundary effects for each receptor group.

5.7 Inter-related effects

The EIA Regulations require consideration of inter-related effects. Inter-related effects refer to the inter-relationships between EIA topics that may lead to environmental effects. There are two categories of inter-related effects:

- project lifetime effects: effects that occur throughout more than one phase of the project (construction, operation and maintenance, and decommissioning) interacting to potentially create a more significant effect upon a receptor than if just assessed in isolation in a single phase; and
- receptor-led effects: effects that interact spatially and/or temporally resulting in inter-related effects upon a single receptor. For example, the impacts of increased sedimentation the surrounding benthic ecology may be greater when multiple sources of impact interact or combine to produce a different or greater effect upon this receptor than when single sources of impact are considered in isolation. Receptor-led effects might be short term, temporary or transient effects, or incorporate longer term effects.

Within the Offshore ES, assessment of inter-related effects has been undertaken with specific reference to the potential for such effects to arise in relation to receptor groups. The term 'receptor group' is used to highlight the fact that the proposed approach to inter-relationships assessment will, in the main, not assess every individual receptor assessed at the EIA stage, but rather, potentially sensitive groups of receptors.

Where the significance of an effect within the topic-specific assessment has been identified as 'no effect across all stages of the project', the assumption has been made that these effects can not contribute to any inter-related effects. These effects have therefore not been included in the inter-related effects assessment as there will be no effect from the Proposed Development over the lifetime of the project.

The inter-related assessment considers only effects from the Proposed Development and not those from other projects, which have been considered in the CEA, see volume 2, chapter 14.

5.8 Topics scoped out of EIA

Table 5.3 identifies the effects that have been scoped out of the EIA and the reason for the exclusion. These effects will not be discussed or assessed further in this Offshore ES. The topics Seascape, Landscape and Visual Resources, Aviation and Radar, and Air Quality have been scoped out of the EIA due to no likely significant effect in EIA terms or no effect-receptor pathways identified. Justification for scoping out these topics is provided in RPS Group 2023a, 2023b, 2023c, and 2023d. Major accidents and disasters have also been scoped out of the assessment because the Proposed Development is not seen as vulnerable to, or introducing, risks of major accidents and/or disasters. Furthermore, all possible major accidents and/or disasters are covered by design measures and compliance with legislation and best practice.

Table 5.3: Potential Impacts Scoped Out From The EIA

Potential Impact Scoped Out of EIA	Receptor	Reason for Scoping Effect out of the Assessment
Presence of infrastructure may lead to changes in the local tidal regime, wave climate, and sediment transport	Physical processes	**All phases** • The proposed platform at Douglas consists of four legs c.2 m in diameter at a spacing of 17 m. Given the diminutive nature of this structure compared to neighbouring wind turbine structures for which published information is available, the impacts on physical processes would be negligible. • At the early project stages, it is anticipated that the offshore cables and inter-platform cabling will be trenched and then backfilled. Cable protection, in the form of third-party cable crossings, will be utilised but will be profiled and <1 m in height minimising impacts on physical processes and sediment transport pathways. • The presence of infrastructure potentially leading to changes in the local tidal regime, wave climate, and sediment transport can therefore be scoped out of the assessment based on these preliminary design parameters and scale of infrastructure proposed. No permanent infrastructure is placed on the seafloor within the intertidal zone. The new electrical cables will be buried to a target depth of 2-3m.
Changes to seabed morphology and water quality due to the utilisation of jack-up vessels	Physical processes	**All phases** • The utilisation of jack-up vessels during the construction and decommissioning phases of the project within the Eni development area will only be temporary and any potential disturbances on the subsea surface, potentially increasing SSCs and/or causing toxicity effects through the mobilisation of contaminated sediments would likely infill over time and be brief. Therefore, it is not expected that jack-up vessels would have any implications on the surrounding seabed morphology or water quality and this impact is to be scoped out of the physical processes assessment.
Changes to seabed morphology and water quality due to sand wave clearance	Physical processes	**All phases** • The nature of sand waves and sandbanks within Liverpool Bay is a highly mobile and dynamic one, therefore sand waves which have been altered during the construction phase would be anticipated to readily reform and is not expected to alter seabed morphology in the longer term.

Potential Impact Scoped Out of EIA	Receptor	Reason for Scoping Effect out of the Assessment
Impacts to benthic ecology due to Electromagnetic Fields (EMFs)	Benthic Subtidal and Intertidal Ecology	**Operation and maintenance phase** • Low-frequency EMFs are present along subsea cables used to transmit electricity from the Eni Development Area to the appropriate substation and terminal locations. There are limited findings on the electro sensitivity of benthic organisms and on the associated impact of EMFs on the surrounding benthic invertebrates. Bochert and Zettler (2006) studied the effects of EMF on the survival and physiology of various crustaceans, marine worms, and echinoderms in the context of cables associated with OWFs in the Baltic Sea. The authors demonstrated no significant effects for any species after three months of exposure. Furthermore, Wilhelmsson *et al.* (2010) demonstrated that there were no differences between benthic community assemblages observed in visual surveys of OWF subsea cables and their peripheral areas. Finally, the presence of diverse and seemingly healthy benthic communities on existing offshore infrastructure indicates that EMF is unlikely to cause a long-term significant effect upon benthic receptors (Linley *et al.,* 2007; Walker *et al.,* 2009). • Embedded mitigation for this impact includes cable burial and/or protection when not available (such as at cable crossings). The target cable burial depth of 2 to 3 m is sufficient to reduce the potential for impacts from EMF on benthic invertebrates. Based on this, and the literature provided above, it is proposed to scope this impact out of the assessment on benthic subtidal and intertidal ecology.
Underwater noise from marine vessels during construction, operation and maintenance and decommissioning phases	Fish and Shellfish	**All phases** • The potential for underwater noise generated from marine vessels will only occur within the Eni Development Area and the immediate vicinity. Fish and shellfish receptors are unlikely to remain in the area for long periods of time during offshore construction, maintenance, and decommissioning activities.
Impacts to fish and shellfish ecology due to EMF	Fish and Shellfish	**Operation and maintenance phase** • Low-frequency EMFs are present along subsea cables used to transmit electricity from the Eni Development Area to the appropriate substation and terminal locations. Fish and shellfish receptors may be receptive to EMF; however a recent study has demonstrated that increased cable burial depth reduces the intensity of EMF for receptive species (Hutchison et al., 2021). As an embedded mitigation measure, cables within the Eni Development Area will be buried (target cable burial depth of 2 to 3 m) and/or protected therefore, there is limited scope for impacts from EMF on fish and shellfish ecology.
Accidental pollution during construction, operation and maintenance, and decommissioning phases	Fish and Shellfish	**All phases** • The potential for accidental pollution to be released during the construction, operation and maintenance, and decommissioning phases of the Proposed Development is present. This pollution could potentially result from sources including vessels/vehicles and equipment/machinery. However, the risk of these events is managed through embedded mitigation, such as an EMP, which includes Marine Pollution Contingency Plans (MPCPs).
Impacts to marine mammal ecology due to EMF	Marine Mammals	**Operation and maintenance phase** • Low-frequency EMFs are present along subsea cables used to transmit electricity from the Eni Development Area to appropriate substations and terminal locations. Cables within the development area will be buried (to a minimum of 2 m), and/or protected therefore, there is little expected impact on marine mammals and marine turtles. Additionally, there is limited data

Potential Impact Scoped Out of EIA	Receptor	Reason for Scoping Effect out of the Assessment
		illustrating marine mammals and turtles being affected by or responding to EMF.
Accidental pollution during construction, operation and maintenance, and decommissioning phases	Marine Mammals	**All phases** • The potential for accidental pollution to be released during the construction, operation and maintenance, and decommissioning phases of the Proposed Development is present. This pollution could potentially result from sources including vessels/vehicles and equipment/machinery. However, the risk of these events is managed through EMP, including MPCPs.
Injury, disturbance, and displacement to marine mammals from operational noise	Marine Mammals	**Operation and maintenance phase** • The operational noise expected to occur from the Proposed Development will be minimal due to the nature of the infrastructure; there will only be heaters on the platforms. Additionally, the Eni Development Area exhibits varying levels of subsea ambient noise sources, the most dominant being offshore shipping. Operational noise is unlikely to add to the existing underwater noise baseline in any significant manner given the context of industrial shipping in the vicinity.
Increased Suspended Sediment Concentrations (SSCs) and associated deposition	Marine Mammals	**Construction and decommissioning phase** • Increased suspended sediment concentrations and sediment deposition from construction and decommissioning activities related to subsea pipeline refurbishment and cable installation may potentially result in indirect impacts on marine mammal ecology related to effects on prey species; however, marine mammals are well known to forage in tidal areas where water conditions are turbid and visibility conditions are subsequently poor. • Whilst elevated levels of SSCs arising during construction of the Proposed Development may decrease light availability in the water column and produce turbid conditions, the maximum impact range is expected to be localised with sediments rapidly dissipating over one tidal excursion. Therefore, it is proposed to scope this impact out for marine mammals and marine turtles.
Operational underwater noise	Ornithology	**Operation and maintenance phase** • Underwater noise during the project's ongoing operation is unlikely to result in noise levels that would impact surrounding bird species.
Injury to biodiversity from potential collision with marine vessels	Ornithology	**All phases** • The presence of construction, maintenance and decommissioning marine vessels, in addition to increased vessel traffic in the area is unlikely to cause injury to seabirds through vessel strikes and collision risks given the industrialised nature of Liverpool Bay. • Shipping and marine traffic is heavily prevalent within Liverpool Bay and seabirds and vessel strikes have not been documented within the area. The majority of seabird strikes is a direct result of attraction and sometimes associated collision with lights (Ronconi *et al*., 2015). Although unpredictable, poor weather, precipitation and cloud cover have been known to exacerbate the effects of nocturnal attraction to lights (Ronconi *et al*., 2015).
Displacement of fishing activity into other areas	Commercial Fisheries and Aquaculture	**All phases** • Given that Liverpool Bay has historically been a site for offshore oil and gas, the displacement of fishing activities into other surrounding areas is unlikely. The Proposed Development will utilise pre-existing infrastructure and essentially turn the oil and gas OPs into a novel Carbon Capture and Storage (CCS) site, with little change to the surrounding marine environment. Where new infrastructure is being installed, it is being done so either

Potential Impact Scoped Out of EIA	Receptor	Reason for Scoping Effect out of the Assessment
		within the existing operational footprint, or in proximity to the alignment of existing linear infrastructure.
Long-term increased steaming distances to fishing grounds during operation and maintenance	Commercial Fisheries and Aquaculture	**Operation and maintenance phase** • Following construction of the Proposed Development, fishing vessels will be able to transit through and around the site as they have done so in the past. The presence of the CCS infrastructure and the associated development area should not have a direct effect on steaming distances to and from adjacent fishing grounds in the area.
Alterations to sediment transport pathways affecting aggregate extraction areas impacts	Infrastructure and Other Sea Users	**All phases** • Platform structures (within the water column) consist of four legs circa 2 m in diameter at a spacing of 17 m. It assumed that, given the sandy nature of the seabed, suitable scour protection will be provided to avoid scour holes developing. Given the diminutive nature of the structure, in comparison to, say a neighbouring wind turbine structure for which suitable published information is available, the impacts on sediment transport pathways would be diminutive and as such are scoped out of the assessment.
Greenhouse gas (GHG) emissions from leaks and/or damage to the Proposed Development components within the development area into the environment during operation or during long-term sequestration use following decommissioning of the infrastructure	Climate	**Operation and maintenance-, and Decommissioning phase** • Emissions from potential leaks and damage to the structural integrity of the development area offshore components could lead to increases in surrounding CO_2 pollution and concentration, causing impacts to environmental and human health in the immediate vicinity and/or partial or full reversal of the sequestration benefits of the development. • However, these are not considered to be likely or expected effects of the Proposed Development. Engineering and geological studies undertaken in the planning of the sequestration facility to date have shown its suitability for stable, long-term storage and the purpose of the engineering design of the facility will be to ensure this is achieved. • Further, during the operation of the facility, fugitive emissions will be monitored through a Leak Detection and Repair (LDAR) programme as part of preventative maintenance activities, to ensure any unplanned CO_2 release is avoided or minimised as much as is reasonably practicable. • Any material amount of CO_2 leakage is therefore considered to be possible in an accident or disaster scenario. However, such an event is considered highly unlikely (given the above designed-in protection). The risk assessment carried out by the Applicant for the project identified that there is no significant risk of CO_2 leakage from the storage complexes, or of harm to the environment or human health. The risk assessment identified and evaluated the leak paths via which CO_2 can leave the subsurface storage complexes, and included a register itemising each foreseeable leak scenario, its associated risk levels and prevention and mitigation control measures. Of all the scenarios considered, loss of containment due to an in-field legacy well providing a leak path was judged the highest risk, but even so was judged “unlikely” once the project-specific prevention and mitigation measures are taken into account. All other scenarios were considered less likely, being ranked either “rare” or “practically non-credible”. The risk assessment took account of the Measurement, Monitoring and Verification plan (MMV) that will be implemented during operation.
In-combination effects of climate change with	Climate	**All phases** • In-combination effects will be assessed in the applicable topic chapters within the ES, through consideration of how climate

Potential Impact Scoped Out of EIA	Receptor	Reason for Scoping Effect out of the Assessment
other environmental impact pathways		change is likely to affect the future baseline environment and sensitivity of receptors, and it will not be duplicated within the scope of the climate change ES chapter.
Climate change risk to the Proposed Development and resilience/adaptation measures	The Proposed Development	**All phases** • Studies conducted from Liverpool Bay have shown that extreme wind and wave climates are not expected to change significantly from those that are currently exhibited in present day. Additionally, long-term analyses have illustrated that although there was a slight increase in the severity of most extreme events, there was little change in the extreme wave climate predicted for Liverpool Bay. • The Proposed Development will be re-using and refurbishing existing offshore infrastructure, and introducing a new offshore platform that have been designed for resilience to storms in Liverpool Bay and have been proven operationally. The design of refurbishment works to the sea-surface infrastructure will be to appropriate engineering and safety standards taking into account metocean data for this location. The pipeline and gas injection well are all undersea (and indeed under the seabed in the case of the sequestration volume) with minimal vulnerability to storm events.
All	Socio-economics	• Given the pre-existing nature of the development area, it is unlikely that there will be any potential effects and/or impacts resulting from the construction, operation and maintenance, and decommissioning of the development area as compared to those previously exhibited on offshore socio-economics in the area. • Specifically, the Proposed Development will not alter any current socio-economic opportunities within the vicinity of the development area, as the Proposed Development will utilise the existing Point of Ayr (PoA) terminal and plans on having unmanned OPs within the development area. Additionally, there will only be routine maintenance events and the majority of operations can be run through the onshore control room and terminal located at Point of Ayr.

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HYNET CARBON DIOXIDE TRANSPORTATION AND STORAGE PROJECT - OFFSHORE

Liverpool Bay CCS Ltd

Environmental Statement
Volume 2, chapter 6: Physical Processes

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Liverpool Bay CCS Limited
Final
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Offshore ES
Physical Processes

rpsgroup.com

Glossary

Term	Meaning
Bathymetry	The measurement of water depth in oceans, seas and lakes.
Cumulative effect assessment	Assessment of the likely effects arising from the offshore components of the HyNet CO_2 Transportation and Storage Project -Offshore ('Proposed Development') alongside the likely effects of other development activities in the vicinity of the Proposed Development.
'Do Nothing' Scenario	The environment as it would be in the future should the proposed project not be developed.
Ebb Tide	The tidal phase during which the water level is falling.
Effect	The consequence of an impact
Environmental Impact Assessment	A statutory process by which certain planned projects must be assessed before a formal decision to proceed can be made. It involves the collection and consideration of environmental information, which fulfils the assessment requirements of the EIA Directive and EIA Regulations, including the publication of an Environmental Impact Assessment (EIA) Report.
Environmental Statement	The document presenting the results of the Environmental Impact Assessment (EIA) process.
Impact	A change that is caused by an action
Inter-OP Cables	Cables to connect the Offshore Platforms (Ops) to each other
Intertidal Area	The area between Mean High-Water Springs (MHWS) and Mean Low Water Springs (MLWS).
Littoral Currents	Flow derived from tide and wave climate.
Magnitude	Size, extent, and duration of an impact.
Maximum Design Scenario	The maximum design parameters of each Proposed Development asset (both on and offshore) are considered to be a worst case for any given assessment but within the range of the Project Design Envelope.
Mean High Water	The highest water level reached during and average tide.
Mean High Water Spring	The most inshore level location reached by the sea at high tide during mean high water spring tide. This is defined as the average throughout the year, of two successive high waters, during a 24-hour period in each month when the range of the tide is at its greatest.
Mean Low Water Spring	The most offshore location reached by the sea at low tide during low water spring tide. This is defined as the average throughout the year, of two successive low waters, during a 24-hour period in each month when the range of the tide is at its greatest.
Mean Sea Level	The average tidal height over a long period of time.
Mitigation Measure	Measure which would avoid, reduce, or remediate an impact
Neap Tide	Tide that occurs when the sun and moon are at right angles to each other, and the gravitational pull of the sun partially cancels out the pull of the moon on the ocean.
Non-statutory stakeholder	Organisations with whom the regulatory authorities may choose to engage who are not designated in law but are likely to have an interest in a proposed development.
Project	The HyNet Carbon Dioxide Transportation and Storage Project.
Project Design Envelope (PDE)	Also known as the Rochdale Envelope, the PDE concept is routinely utilised in both onshore and offshore planning applications to allow for some flexibility in design options, particularly offshore, and more particularly for foundations and turbine type, where the full details of the project are not known at application submission but where sufficient detail is available to enable all environmental impacts to be appropriately considered during the EIA.
Project lifetime effects	Effects that occur throughout more than one phase of the project (construction, operations and maintenance, and decommissioning) interacting to potentially

Term	Meaning
	create a more significant effect upon a receptor than if just assessed in isolation in a single phase.
Proposed Development	The offshore components of the Project which are subject of this Environmental Statement, as described in Chapter 3.
Receptor-led effects	Effects that interact spatially and/or temporally resulting in inter-related effects upon a single receptor.
Residual Current	The net flow over the course of the tidal cycle. This is effectively the driving force of the sediment transport.
Residual Impact	Residual impacts are the final impacts that occur after the proposed mitigation measures have been put into place, as planned.
Scoping Opinion	Sets out the Secretary of State's response to the Applicants Scoping Report and contains the range of issues that the Secretary of State, in consultation with statutory stakeholders, has identified should be considered within the EIA.
Sedimentation	The process of settling or being deposited as a sediment.
Spring Tide	Tide that occurs when the sun and moon are directly in line with the Earth and their gravitational pulls on the ocean reinforce each other.
The Applicant	This is Liverpool Bay CCS Ltd.
Transboundary effects	Impacts from a project within one state affect the environment of another state(s).
Turbidity	The quality of being cloudy, opaque, or thick with suspended matter.

Acronyms and Initialisations

Acronym / Initialisation	Description
ADD	Acoustic Deterrent Device
AIS	Automatic Identification System
AL1	Action Level 1
As	Arsenic
BEIS	The Department for Business, Energy and Industrial Strategy, now replaced by the Department for Energy Security and Net Zero.
BSI	British Standards Institute
BODC	British Oceanographic Data Centre
CA	Competent Authority
CCC	Committee on Climate Change
CCS	Carbon Capture and Storage
Cd	Cadmium
CEA	Cumulative Effects Assessment
CERMS	Cell Eleven Regional Monitoring Strategy
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CIEEM	Chartered Institute of Ecology and Environmental Management
CoCP	Code of Construction Practice
CO_2	Carbon Dioxide
COWRIE	Collaborative Offshore Wind Energy Research into the Environment
Cr	Chromium
CtL	Consent to Locate
CTV	Crew Transfer Vessel
Cu	Copper
DCO	Development Consent Order

Acronym / Initialisation	Description
DDV	Drop Down Video
DECC	The Department of Energy and Climate Change, merged with the Department for Business, Innovation and Skills, to form the Department for Business, Energy and Industrial Strategy.
DEFRA	The Department for Environment, Food and Rural Affairs
DESNZ	The Department for Energy Security and Net Zero, preceded by the Department for Business, Energy, and Industrial Strategy (2016 to 2023) and the Department of Energy and Climate Change (2008 to 2016)
DMRB	Design Manual for Roads and Bridges
DO	Dissolved Oxygen
DR	Drilling
EAJ	Environmental Assessment Justification
EC	European Commission
EcIA	Ecological Impact Assessment
ECMWF	European Centre for Medium-range Weather Forecast
EEA	European Economic Area
EIA	Environmental Impact Assessment
EMF	Electromagnetic Field
EMODnet	European Marine Observation and Data Network
EMP	Environmental Management Plan
Eni	Eni UK Limited
EPA	Environmental Protection Agency
EPS	European Protected Species
ES	Environmental Statement
ESCA	European Subsea Cables UK Association
EMODnet	European Marine Observation and Data Network
FO	Fibre Optic
GHG	Greenhouse gas
GSI	Geological Survey Ireland
HDD	Horizontal Directional Drilling
Hg	Mercury
HRA	Habitats Regulations Appraisal
ICPC	International Cable Protection Committee
IDC	Industrial Decarbonisation Challenge
IEMA	Institute of Environmental Management and Assessment
INFOMAR	Integrated Mapping for the Sustainable Developments of Ireland's Marine Resource
JNCC	the Joint Nature Conservation Committee
KIS-ORCA	Kingfisher Information Service – Offshore Renewables and Cable Awareness
LSE	Likely Significant Effects
MAFF	Ministry of Agriculture, Fisheries and Food
MARPOL	International Convention for the Prevention of Pollution from Ships
MCA	Maritime and Coastguard Agency
MAT	Master Application Template
MBES	Multibeam Echo Sounder

Acronym / Initialisation	Description
MEDIN	Marine Environmental Data Information Network
MCAA	Marine and Coastal Access Act
MCZ	Marine Conservation Zone
MDS	Maximum Design Scenario
MFE	Mass Flow Excavator
MHWS	Mean High Water Springs
MLWS	Mean Low Water Springs
MMO	Marine Management Organisation
MMV	Monitoring, Measuring and Verification
MPCP	Marine Pollution Contingency Plan
MPMMG	Marine Pollution Monitoring Management Group
Ni	Nickel
NOAA	National Oceanic and Atmospheric Administration
NPS	National Policy Statement
NRA	Navigational Risk Assessment
NRW	Natural Resources Wales
NRW-MLT	Natural Resources Wales – Marine Licencing Team
NSTA	North Sea Transition Authority, preceded by the Oil and Gas Authority
OGA	Oil and Gas Authority, replaced by the North Sea Transition Authority in March 2022
OP	Offshore Platform
OPRED	Offshore Petroleum Regulator for Environment and Decommissioning
OSPAR	Oslo Paris Convention
P&A	Plugging and Abandonment
PAH	Polycyclic Aromatic Hydrocarbon
Pb	Lead
PCB	Polychlorinated Biphenyls
PDE	Project Design Envelope
PEIR	Preliminary Environmental Information Report
PINS	the Planning Inspectorate
PoA	Point of Ayr
PPG	Pollution Prevention Guidelines
PSA	Particle Size Analysis
PWA	Pipeline Works Authorisation
REA	Regional Environmental Assessment
RIAA	Report to Inform Appropriate Assessment
ROFI	Region of Freshwater Influence
RYA	Royal Yachting Association
SAC	Special Area of Conservation
SAT	Subsidiary Application Template
SPA	Special Protection Area
SSC	Suspended Sediment Concentration
SLA	Service Level Agreement
SMP	Shoreline Management Plan
SNCB	Statutory Nature Conservation Body

Acronym / Initialisation	Description
SPM	Suspended Particulate Matter
SSS	Sidescan Sonar
SSSI	Site of Special Scientific Interest
TCE	The Crown Estate
TCPA	Town and Country Planning Act
THC	Total Hydrocarbon Content
UK	United Kingdom
UKCP	UK Climate Projections
UKCS	United Kingdom Continental Shelf
UKHO	United Kingdom Hydrographic Office
UNECE	United Nations Economic Commission for Europe
UXO	Unexploded ordnance
WFD	Water Framework Directive
Zn	Zinc
ZOI	Zone Of Influence

Units

Unit	Description
%	Percent
cm	Centimetre (distance)
g	Gram
Hz	Hertz
km	Kilometres
km^2	Kilometres squared
kV	Kilovolt (electrical potential)
kW	Kilowatt (power)
m	Metres (distance)
mm	millimetre
m^2	Metres squared (area)
m^3	Metres cubed (volume)
m^3/d/m	Metres cubed per day per metre width
m/s	Metres per second (speed)
mg/l	Milligram per litre (concentration)
MW	Megawatt
NM	Nautical Mile (distance; equal to 1.852 km)
µg/kg	Micrograms per kilogram

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6 PHYSICAL PROCESSES

6.1 Introduction

This chapter of the Offshore Environmental Statement (ES) presents the assessment of the likely significant effects (as per The Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020, '2020 EIA Regulations') on the environment of the Proposed Development on the offshore physical processes. Specifically, this chapter considers the potential impacts from the construction, operation and maintenance, and decommissioning of the offshore and intertidal components (seaward of the Mean High Water Springs (MHWS) mark) of the Eni development area, which includes the pipelines and cables leading to MHWS.

Likely significant effect is a term used in both the '2020 EIA Regulations' and the Habitat Regulations. Reference to likely significant effect in this Offshore ES refers to likely significant effect as used by the '2020 EIA Regulations'. This Offshore ES is accompanied by a Report to Inform Appropriate Assessment (RIAA) which uses the term as defined by the Habitats Regulations Appraisal (HRA) Regulations.

The assessment presented informs the following technical chapters and reports:

- volume 2, chapter 7: Marine Biodiversity; and
- volume 2, chapter 12: Infrastructure and Other Sea Users.

This chapter summarises information derived from the numerical modelling study contained within the Physical Processes Technical Report (RPS Group, 2024a).

6.2 Purpose of this chapter

The primary purpose of the Offshore ES is outlined in volume 1, chapter 1. It is intended that the Offshore ES will provide the statutory and non-statutory stakeholders, with sufficient information to determine the likely significant effects of the Proposed Development on the receiving environment.

In particular, this Physical Processes ES chapter:

- presents the existing environmental baseline established from desk studies, site-specific surveys, numerical modelling studies and consultation with stakeholders;
- identifies any assumptions and limitations encountered in compiling the environmental information;
- presents the likely significant environmental impacts on Physical Processes arising from the Proposed Development and reaches a conclusion on the likely significant effects on Physical Processes, based on the information gathered and the analysis and assessments undertaken; and
- highlights any necessary monitoring and/or mitigation measures which may be recommended to prevent, minimise, reduce or offset the likely significant adverse environmental effects of the Proposed Development on Physical Processes.

6.3 Study area

The physical processes study area for the Proposed Development, as shown Figure 6.1, is defined as the area encompassing the area of project physical work, plus a buffer of one tidal excursion. The *c.*8 km buffer around the area of project physical work previously used in the EIA Scoping Report (RPS, 2022), has been updated on the basis of tidal ellipse modelling along the proposed cable route. The updated physical processes study area accounts for this tidal excursion and was extended to incorporate the potential for residual currents along the coastline, it therefore illustrates the areas potentially affected by changes in water quality (increases in Suspended Sediment Concentration (SSC)).

The physical processes study area forms the focus for the assessment, however the extent of the numerical models employed in undertaking the study was not limited to this region and would therefore also identify any potential impacts beyond the physical processes study area both further offshore and along the shoreline.

6.3.1 Intertidal area

The offshore topic of physical processes study area includes the intertidal area. This intertidal area overlaps with the onshore topics of Land and Soils, and Water Resources and Flood Risk (landward of Mean Low Water Springs (MLWS)).

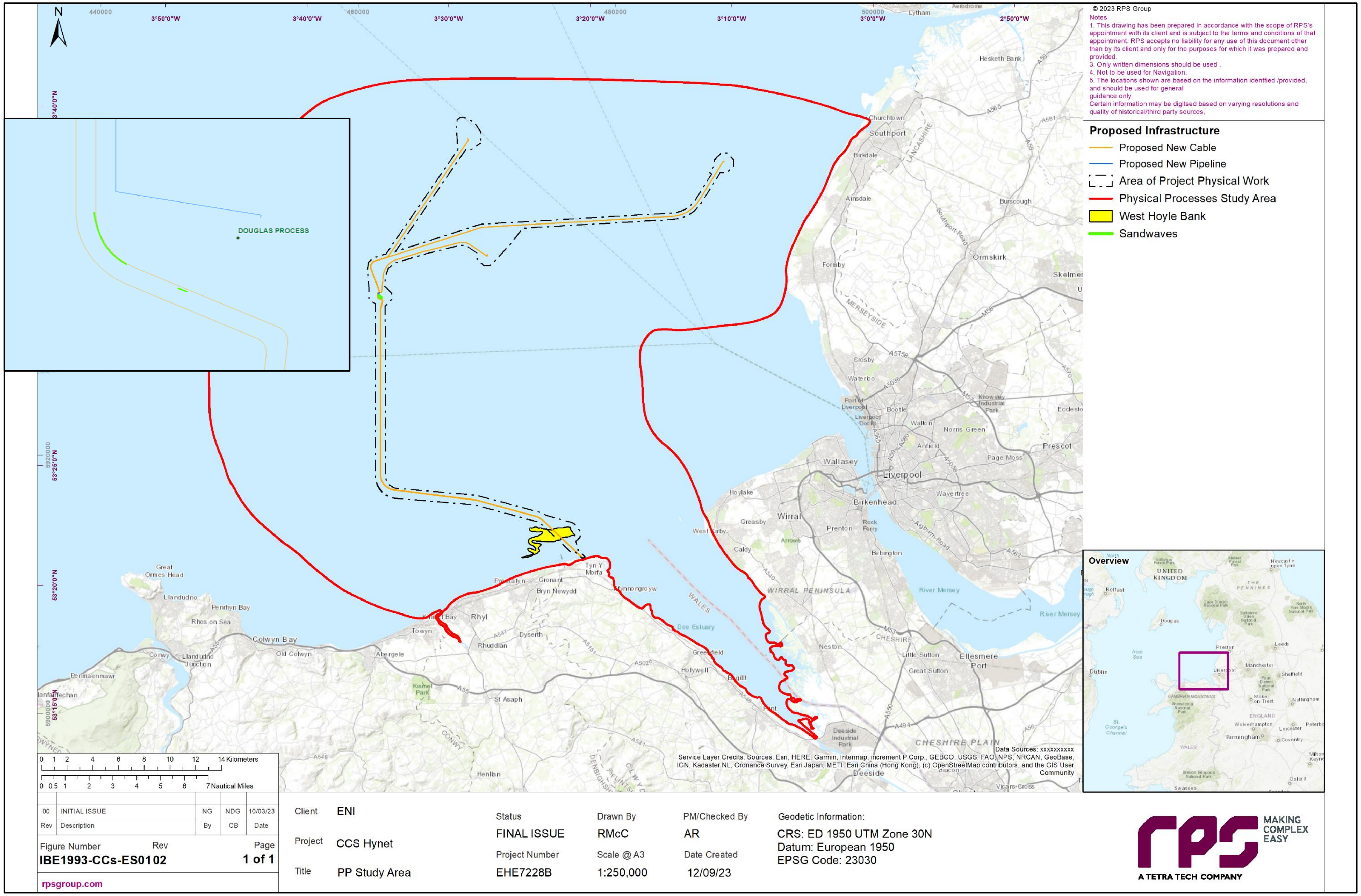

Figure 6.1: Physical Processes Study Area (inset Sand Wave Locations South of Douglas OP)

6.4 Policy and legislation

The policy context for the HyNet Carbon Dioxide Transportation and Storage Project- Offshore is set out in volume 1, chapter 2. Policy specifically in relation to physical processes, is contained in the North West Shoreline Management Plan (SMP) (Halcrow Group Limited, 2011), and the North West Inshore and North West Offshore Coast Marine Plans (DEFRA, 2021).

A summary of the SMP policy provisions relevant to Physical Processes are provided in Table 6.1, with other relevant policy provisions set out in Table 6.2.

These are summarised here with further detail presented in Compliance with Marine Plan Policies (RPS Group, 2023a).

6.4.1 North West Shoreline Management Plan

The assessment of potential changes to physical processes has been made with consideration to the specific policies set out in the North West SMP (Halcrow Group Ltd., 2010). Key provisions are set out in Table 6.1 along with details as to how these have been addressed within the assessment where appropriate.

Table 6.1: Summary of SMP Policies Relevant to Physical Processes

Location	Summary of SMP Provision	How and Where Considered in the Offshore ES
Clwyd Estuary (11a3)	The SMP recommends a policy of Hold the Line via the maintenance and improvement of defences across the subcell, up to 2030. In the longer term a policy of Managed Realignment is recommended at Forydd Railway Bridge to Rhuddlan Road Bridge Clwyd Estuary (East and West) in the interests of future habitat creation.	Impacts associated with changes in Suspended Sediment Concentrations (SSCs) and water quality have no pathway to impact on SMP policies.
Clwyd Estuary to Point of Ayr (11a4)	The SMP recommends a policy of Hold the Line via the maintenance and improvement of defences across a majority of the subcell. However, a provision of Managed Realignment is made for Barkby Beach to Point of Ayr, to allow natural processes to govern movement of the present dune system.	
Dee Estuary (11a5)	The SMP recommends a policy of Hold the Line via the maintenance and improvement of defences across the subcell, up to 2030. In the longer term a policy of Managed Realignment is recommended at Mostyn to Flint Marsh, and Sealand Rifle Range to Burton Point, with the interests of future habitat creation.	
Formby Dunes (11a9)	A policy of managed realignment is recommended in the SMP into the long term in favour of allowing natural processes to occur and encourage natural development of dune systems.	

6.4.2 North West Inshore and North West Offshore Coast Marine Plans

The assessment of potential changes to physical processes has also been made with consideration to the specific policies set out in the North West Inshore and North West Offshore Coast Marine Plans (MMO, 2021). Key provisions are set out in Table 6.2 along with details as to how these have been addressed within the assessment.

Table 6.2: Summary of the North West Inshore and North West Offshore Coast Marine Plans Relevant to Physical Processes

Summary of Relevant Legislation	How and Where Considered in the Offshore ES
NW-CAB-1 Preference should be given to proposals for cable installation where the method of protection is burial. Where burial is not achievable, decisions should take account of protection measures for the cable that may be proposed by the applicant. Where burial or protection measures are not appropriate, proposals should state the case for proceeding without those measures.	Details of the Proposed Development design criteria are detailed in volume 1, chapter 4.
NW-MPA-1 Proposals that may have adverse impacts on the objectives of marine protected areas must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate - adverse impacts, with due regard given to statutory advice on an ecologically coherent network.	Designated sites and features of importance within the physical processes study area have been identified in section 6.7.12. Potential impacts have also been identified and the significance of the effects on physical processes receptors has been assessed in section 0.
NW-MPA-4 Proposals that may have significant adverse impacts on designated geodiversity must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate - adverse impacts so they are no longer significant.	Designated sites and sites of interest due to geological importance within the physical processes study area have been identified in section 6.7.12. Potential impacts have also been identified and the significance of the effects on physical processes receptors has been assessed in section 0.
NW-BIO-1 Proposals that may have significant adverse impacts on the distribution of priority habitats and priority species must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate - adverse impacts so they are no longer significant d) compensate for significant adverse impacts that cannot be mitigated.	Sites identified as habitat directive Annex 1 habitats within the physical processes study area have been identified in section 6.7.12. Potential impacts have also been identified and the significance of the effects on physical processes receptors has been assessed in section 0. Likewise impacts on marine biodiversity have been assessed in volume 2, chapter 7.
NW-CE-1 Proposals which may have adverse cumulative effects with other existing, authorised, or reasonably foreseeable proposals must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate - adverse cumulative and/or in- combination effects so they are no longer significant.	A CEA has been undertaken and is outlined in section 6.12. Designated sites and sites of interest due to geological importance within the physical processes study area have been identified in section 6.7.12

6.5 Consultation

A summary of the key issues raised during consultation activities undertaken to date specific to Physical Processes is presented in Table 6.3 below, together with how these issues have been considered in the production of this Offshore ES chapter.

Table 6.3: Summary of Key Consultation of Relevance to Physical Processes

Date	Consultee and Type of Response	Issue Raised	Response to Issue Raised and/or Where Considered in this Chapter
January 2023	Offshore Petroleum Regulator for Environment and Decommissioning (OPRED) Scoping Opinion	Study Area - It is advised that the maximum spring tidal excursion should be used to define the zone of influence.	The 8 km buffer used for the developing the physical processes study area for scoping used a preliminary assessment of tidal currents at the offshore extent of the project to determine the tidal excursion. A more detailed assessment has been undertaken to refine the spring tidal excursion during the modelling study. See section 6.3.
January 2023	OPRED Scoping Opinion	Activities omitted from the scoping of potential impacts: • the potential for cable protection along the cable corridor; • the use of concrete mattresses across three potential cable crossings; and • the potential to protect the Horizontal Directional Drilling (HDD) exit pits located in the intertidal zone.	These activities are now included in the proposed development description outlined in volume 1, chapter 3. Cable protection is to be utilised, in the form of cable crossings, up to 10% cable routes, however, is to have a profiled cross-section and <1 m in height to minimise impacts on physical processes and sediment transport pathways. The HDD exit pit will be 3 m below beach level (just above the MHWS line), therefore there will be no requirement for external protection.
January 2023	OPRED Scoping Opinion	The presence of cable protection may alter the current and wave regime and alter the sediment transport pathways, particularly if located in shallow water. Consideration should also be given to the potential for secondary scour.	Cable protection, in the form of cable crossings, is to be utilised along up to 10% of cable routes, however, is to have a profiled cross-section <1 m in height to minimise impacts on physical processes and sediment transport pathways.,
January 2023	OPRED Scoping Opinion	Further information on the presence of any sand wave features in the area, including sand wave height, length and migratory rate should be included in order to further understand the potential impacts. Although the project does not involve dredging, clarification is required on whether any sand wave clearance will take place as part of the	Since scoping the PDE has been updated to include potential dredging along a channel through West Hoyle Bank, the details of which are presented in section 6.11.1. Likewise, the PDE has since been updated to include the clearance of 115 m of sand waves south of the Douglas OP. The details and impacts of which are presented in section 6.11.1.

Date	Consultee and Type of Response	Issue Raised	Response to Issue Raised and/or Where Considered in this Chapter
		cable laying activities. Should sand wave clearance be required then consideration should be given to the potential impacts on the seabed bed morpho-dynamics (i.e. sand banks and migrating sand wave fields).	
January 2023	OPRED Scoping Opinion	Stratification influences the hydrodynamic and sediment transport regimes within Liverpool Bay, and it is recommended that the impact assessment for the project should consider the effects of stratification on sediment transport within the Eni development area, with particular emphasis on the seasonal variability in impacts.	The nature of this proposed development, laying cables in trenches following previously installed infrastructure, would not influence the mechanisms which cause stratification. There are no elements within the water column to disrupt stratification and no changes in tidal regime.
January 2023	OPRED Scoping Opinion	It is recommended that Physical Processes are treated as a separate chapter of the ES with any cross links between chapters clearly indicated.	This is in line with the methodology adopted in this chapter. See section 6.6.
January 2023	OPRED Scoping Opinion	It is advised that a conceptual understanding of the baseline environment for physical processes is established so that the potential impacts caused by the activities resulting from the project can be properly assessed. It is recommended that Natural Resource Wales (NRW) Marine Physical Processes Guidance is used to inform the ES when conducting the proposed site surveys detailed in section 1.2.	This is in line with the methodology adopted in this chapter. See section 6.6.
January 2023	OPRED Scoping Opinion	It is recommended that the British Oceanographic Data Centre (BODC) and iMarDIS SEACAMS data portal is included in the desktop data sources to Inform the Physical Processes Scoping Assessment.	Additional data sources which informed the assessment have been detailed in Table 6.4. See section 6.6.
January 2023	OPRED Scoping Opinion	Physical processes are considered to be a pathway for other receptors, whilst also being a receptor in their own right (e.g. sand bank features, beaches and coast). The strong links between water quality and	This is in line with the proposed approach. Water Quality is presented in a separate section within the physical processes chapter drawing from the WFD Assessment (RPS Group, 2024b)and section 6.7.11) and physical processes studies.

Date	Consultee and Type of Response	Issue Raised	Response to Issue Raised and/or Where Considered in this Chapter
		suspended sediment concentration (SSC) are recognised, however, it is recommended that physical processes are treated within a separate chapter, with any cross-linkages between chapters clearly signposted.	
January 2023	OPRED Scoping Opinion	Activities relating to cable protection measures should be scoped in for the construction, operation, and maintenance phases of the project.	Cable protection is to be utilised, in the form of cable crossings, along up to 10% of cable routes, however, is to have a profiled cross-section and <1 m in height to minimise impacts on physical processes and sediment transport pathways.
January 2023	OPRED Scoping Opinion	Clarification is sought as to whether the exit pits will require rock armour protection.	The HDD exit pit will be 3 m below beach level (just above the MHWS line), therefore there will be no requirement for external protection.
January 2023	OPRED Scoping Opinion	The Developer should ensure that the ES provides clarification on how (and to what extent) suspended sediment concentrations can impact the local tidal regime and wave climate and provide details of any proposed mitigation measures.	Numerical modelling was used to quantify the dispersion and settlement of the mobilised sediment. Increased SSC will not change either the wave or tidal regimes.
January 2023	OPRED Scoping Opinion	The Dee is a Region of Freshwater Influence (ROFI) which modulates the levels of stratification in the Liverpool Bay area. Therefore, this section should consider the impacts of stratification on sediment transport within the Eni development area, with particular emphasis on the seasonal variability in impacts.	The nature of this proposed development, laying cables in trenches following previously installed infrastructure, would not influence the mechanisms which cause stratification. There are no elements proposed within the water column of sufficient scale to disrupt stratification and no changes in tidal regime.
January 2023	OPRED Scoping Opinion	Appropriate validation and calibration of any sediment dispersal/ transport model is also requested and reference to Natural Resources Wales Marine Physical Processes Guidance to inform Environmental Impact Assessment (EIA) is also recommended.	This is in line with the proposed approach. Model verification data is presented in the Physical Processes Technical Report (RPS Group, 2024a).
January 2023	OPRED Scoping Opinion	It is recommended that Marine Water and Sediment Quality are included as separate topics and are assessed as such.	This is in line with the proposed approach. Water quality is presented within the physical processes chapter drawing from the WFD assessment (RPS

Date	Consultee and Type of Response	Issue Raised	Response to Issue Raised and/or Where Considered in this Chapter
			Group, 2024b) and physical processes studies.
January 2023	OPRED Scoping Opinion	It is advised that the ES includes information on the sediment quality and the potential for any effects on water quality through suspension of contaminated sediments. The ES should also consider whether increased SSC have the potential to impact upon interest features and supporting habitats of any designated sites.	This is in line with the methodology adopted in this chapter. See section 6.6.
January 2023	OPRED Scoping Opinion	The following potential impact pathways for marine water and sediment quality which are not currently scoped-in but which will require further consideration have been identified: bacterial release from sediments due to the proximity of designated bathing and shellfish waters; pipeline contents temperature effects; and impacts to Dissolved Oxygen and Phytoplankton as a result of elevated suspended sediment concentrations.	Impacts related to water quality are discussed in section 6.11.3.
January 2023	OPRED Scoping Opinion	No background information has been provided for water quality. It is recommended that this is included.	This is presented in the WFD Assessment (section 6.7.11 and (RPS Group, 2024b))
January 2023	OPRED Scoping Opinion	It is advised that accidental releases during maintenance operations are also considered in Table 6.2.	In the modelled scenarios all potentially mobilised sediment is included and following impacts related to physical processes are discussed in section 6.11.1.
January 2023	OPRED Scoping Opinion	Potential increased temperature effects from the pipeline contents should be considered as part of the marine water and sediment quality assessment.	The proposed pipeline will be buried and therefore temperature increases will have no impact to physical processes. Impacts related to benthic ecology are discussed in volume2, chapter 7.
January 2023	OPRED Scoping Opinion	As a result of elevated suspended sediment concentration as a result of the activities it is advised that impacts to dissolved oxygen (DO) and phytoplankton are assessed.	Impacts related to water quality are discussed in section 6.11.3
December 2023	NRW Fitness Check Response	Issues raised include: 1. Assessment methodology relating to magnitude and sensitivity	Addressed in: 1. Section 6.6 and 6.9 2. Section 6.7 3. Section 6.8

Date	Consultee and Type of Response	Issue Raised	Response to Issue Raised and/or Where Considered in this Chapter
		does not follow NRW guidance; 2. Insufficient evidence to accurately describe the baseline environment; 3. Disagree with scoping pathways for seabed morphology; 4. Incomplete justification of secondary scour from cable protection measures; 5. No detail on the requirement for cable protection during operation or maintenance. 6. Incomplete detail on modelling calibration and validation. 7. Quantitative data should be used to assess cumulative effect and Mostyn Dock development should be included.	4. Section 6.11 5. See Chapter 3, Section 3.5.2, and Section 6.11 6. See Physical Processes Technical Report (RPS Group, 2024a) 7. Section 6.13

6.6 Methodology to inform the baseline

6.6.1 Data sources

A desktop study was undertaken to inform the baseline, using a range of relevant publications, modelling studies, and publicly available data sources, as it described in the section below.

6.6.2 Desktop study

Information regarding the physical processes within Liverpool Bay has been collated through a detailed and comprehensive review of currently accessible studies and datasets. To provide a wider context, the desktop review has also considered the broader area of the Irish Sea in proximity to the Eni development area. The baseline has been established through the use of data on bathymetry, geology, seabed sediments, sediment quality and contamination, suspended sediments, tidal regime, sediment transport, and waves. Key data sources, including those used within the Technical Report to inform modelling studies, are listed in Table 6.4 below.

Table 6.4: Summary of Key Desktop Reports used within the ES and Technical Report

Title	Source	Year	Author
Mona Offshore Wind Project Generation Assets Preliminary	https://www.morganandmona.com/en/consultationhub/	2023	RPS Group

Title	Source	Year	Author
Environmental Information Report (PEIR) - Technical Report			
Morgan Offshore Wind Project Generation Assets Preliminary Environmental Information Report (PEIR) - Technical Report	https://morecambeandmorgan.com/morgan/consultationhub/	2023	RPS Group
European Marine Observation and Data Network (EMODnet) – Seabed classification	https://www.emodnet-geology.eu/	2023	EMODnet
European Marine Observation and Data Network (EMODnet) – Bathymetry data	https://www.emodnet-bathymetry.eu/	2023	EMODnet
European Marine Observation and Data Network (EMODnet) – Metocean data	https://map.emodnet-physics.eu/	2023	EMODnet
Department for Environment Food and Rural Affairs (DEFRA) – Bathymetry data	https://environment.data.gov.uk/DefraDataDownload	2023	DEFRA
The Environment Agency National LiDAR Programme	National LIDAR Programme - data.gov.uk	2022	Environment Agency
National Oceanic and Atmospheric Administration (NOAA) – Atmospheric data	DHI Metocean Data Portal	2022	NOAA
National Network of Regional Coastal Monitoring Programmes	https://coastalmonitoring.org/cco/	2022	Coastal Channel Observatory
Centre for Environment, Fisheries and Aquaculture Science (Cefas) – wave data	https://wavenet.cefas.co.uk/map	2022	CEFAS
ABPmer Data explorer	https://www.seastates.net/explore-data/	2023	ABPmer
Hydrography of the Irish Sea, SEA6 Technical Report	UK Government	2005	Howarth M.J.

Title	Source	Year	Author
Atlas of UK Marine Renewable Energy Resources	https://www.renewables-atlas.info/	2022	ABPmer
Geology of the seabed and shallow subsurface: The Irish Sea.	British Geological Survey	2015	Mellett *et al*.
British Geological Survey – sediment sample data	https://mapapps2.bgs.ac.uk/geoindex_offshore	2022	BGS
Suspended Sediment Climatologies around the UK.	Department for Business, Energy & Industrial Strategy (BEIS)	2016	Cefas
Metocean Data collection for the Ormonde offshore wind project.	Marine Data Exchange	2011	Geotechnical Engineering and Marine Surveys (GEMS)
Irish Sea Zone Hydrodynamic measurement campaign	Marine Data Exchange	2010 to 2013	EMU Ltd (now Fugro Ltd)
Admiralty Tide Tables	United Kingdom Hydrographic Office (UKHO)	2023	UKHO
Marine Environmental Data Information Network (MEDIN) Seabed Mapping Programme	Admiralty Marine Data Portal	2022	MEDIN
Integrated Mapping for the Sustainable Developments of Ireland's Marine Resource (INFOMAR) Seabed Mapping Programme	Geological Survey Ireland (GSI) and Marine Institute	2022	INFOMAR
Long term wind and wave datasets	European Centre for Medium-range Weather Forecast (ECMWF)	2022	ECMWF
UK tide gauge network and database of current observation	British Oceanographic Data Centre (BODC)	2021	BODC
UK Climate Projections (UKCP)	Met Office	2018	Met Office
Review of aggregate dredging off the Welsh coast	HR Wallingford	2016	HR Wallingford
Transport and deposition of sediment-associated	Scientific Data (journal)	2005	Jamieson et al

Title	Source	Year	Author
Escherichia coli in natural streams.			
A user-friendly database of coastal flooding in the UK from 1915-2014	Scientific Data (journal)	2015	Haigh *et al.*
Awel y Môr Offshore Windfarm PEIR and ES	Awel y Môr Offshore Wind Farm Ltd.	2021 & 2022	RWE Renewables
Burbo Bank Extension Offshore Windfarm Environmental Statement	https://www.marinedataexchange.co.uk/	2013	Ørsted
Walney Extension Offshore Wind Farm Environmental Statement	https://www.marinedataexchange.co.uk/	2013	Ørsted
Marine Works (Environmental Impact Assessment) Regulations 2007 (as amended), Regulation 22 – EIA Consent Decision. Marine aggregate extraction Area 392/393, known as Hilbre Swash	https://naturalresources.wales/?lang=en	2013	NRW
Natural Variability of Turbidity in the Regional Environmental Assessment (REA) Areas.	https://www.marinedataexchange.co.uk/	2011	MALF
North West England and North Wales SMP22 - SMP2	http://www.hoylakevision.org.uk/wp-content/uploads/2012/11/SMP2Main.pdf	2011	Halcrow Group Ltd
Cell Eleven Tidal and Sediment Study Phase 2	https://coastalmonitoring.org/	2010	Halcrow Group Ltd
Cell Eleven Regional Monitoring Strategy (CERMS)	https://coastalmonitoring.org/	2010	Halcrow Group Ltd
Walney 1 & 2 Offshore Windfarm Environmental Statements	https://www.marinedataexchange.co.uk/	2006	Ørsted
West of Duddon Sands Offshore Windfarm Environmental Statement	https://www.marinedataexchange.co.uk/	2006	RSK Environment Ltd

Title	Source	Year	Author
DTI Strategic Environmental Assessment Area 6, Irish Sea, seabed and surficial geology and processes	British Geological Survey	2005	Holmes and Tappin
Ormonde Offshore Windfarm Environmental Statement	https://www.marinedataexchange.co.uk/	2005	Rudall Blanchard Associates
Barrow Offshore Windfarm Environmental Statement	https://www.marinedataexchange.co.uk/	2005	Royal Haskoning DHV
Mostyn Energy Park Extension (MEPE) Environmental Statement Chapter 6: Physical Processes.	https://publicregister.naturalresources.wales/	2022	ABPmer
iMarDIS Portal	https://portal.imardis.org/	2023	iMarDIS
Designated sites (Special Protection Areas (SPAs) and Special Areas of Conservation (SACs))	JNCC mapping data (https://jncc.gov.uk/mpa-mapper/)	2023	JNCC
Designated sites (Sites of Special Scientific Interest (SSSIs))	DEFRA Spatial Data Download	2023	DEFRA
Designated Ramsar sites	https://rsis.ramsar.org/ris/937	2023	Ramsar

6.6.3 Site-specific surveys

In order to inform the ES, site-specific surveys were undertaken, as agreed with the OPRED, NRW, MMO, JNCC, NE, NSTA, Trinity House, MoD, MCA and Cefas. A summary of the surveys undertaken to inform the physical processes impact assessment is outlined in Table 6.5, with the bathymetry survey illustrated in Figure 6.2.

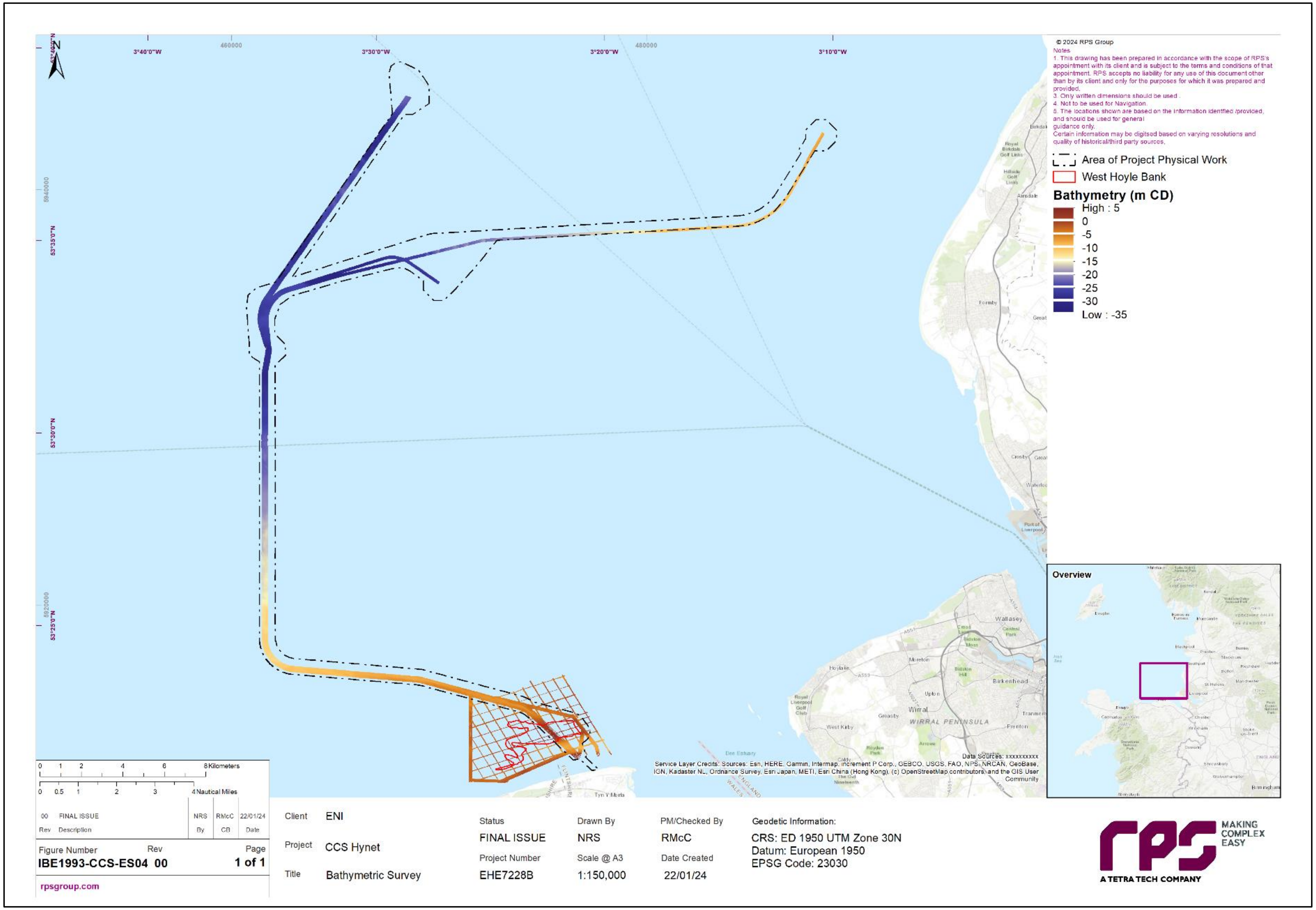

Figure 6.2: Detailed Bathymetric Survey of the Proposed Development Cable Path

Table 6.5: Summary of Site-specific Survey Data.

Title	Extent of Survey	Overview of Survey	Survey Contractor	Date
HyNet Carbon Capture Storage and Decommissioning Benthic Survey Report 2022	Project area of physical work	Benthic/ sedimentary survey carried out via seabed imagery and grab sampling utilised for Particle Size Analysis (PSA)	Ocean Ecology Ltd.	2022
Sidescan sonar	Within the Area of Project Physical Work (APPW) and Hoyle Bank	Sidescan Sonar survey to characterise seabed and existing assets	James Fisher Subtech (JFS)	2022
Multibeam	Within the APPW and Hoyle Bank	Survey to characterise seabed and existing assets	JFS	2022
Magnetometer	Within the APPW and Hoyle Bank	Survey to characterise seabed and existing assets	JFS	2022
Sub-bottom Profiler	Within the APPW and Hoyle Bank	Survey to characterise seabed and existing assets	XOcean	2022

6.6.4 Establishing Baseline Environment

The characteristics of each of the physical processes outlined in *Marine Physical Processes Guidance to inform Environmental Impact Assessment* was completed (NRW, 2020) (Table 6.6).

Table 6.6: Physical Processes as per NRW Guidance

Category	Data Requirement
Hydrodynamics	Tidal regime (water level range, current speed and direction) (See Section 6.7.5) Wind Wave and Swell (wave height, period and direction) (See Section 6.7.6) Residual water movement; (See Section 6.7.9) Surge Water Levels and Current (See Section 6.7.5)
Sediments and Geology	Characteristics of seabed sediments (See Section 6.7.7) Particle size and density (See Section 6.7.7) Lithology (origin, composition) (See Section 6.7.7) Thickness of sediment units (See Section 6.7.4 and 6.7.7) Suspended sediment concentrations (See Section 6.7.10) Seabed mobility (See Section 6.7.3 and 6.7.9) Sediment transport pathways and rates (See Section 6.7.9)
Topography / Morphology	Bathymetry (See Section 6.7.2) Bedforms and notable seabed features (See Section 6.7.2 and 6.7.3) Coastal topography, configuration and notable features (See Section 6.7.2)

By outlining further characteristics collected and identified during the completion of the accompanying Physical Processes Technical Report (RPS Group, 2024a), this allows a further refined conceptual understanding of the physical processes study area. The summary of this consultation response from NRW is outlined in Table 6.3.

6.7 Existing baseline description

6.7.1 Overview of baseline environment

A summary of the physical processes baseline environment is provided in the following sections. Full details of the analysis undertaken to develop the physical processes baseline is provided in Physical Processes Technical Report (RPS Group, 2024a), which includes information on model development, resolution, calibration, and the modelling techniques implemented to develop the baseline characteristics.

6.7.2 Bathymetry

The proposed Eni development area includes the Point of Ayr (PoA) Terminal to Douglas Offshore Platform (OP) pipeline, leading to Talacre Beach, is situated in water depths of 0.72 m (nearshore) to 35 m (offshore) referenced to Mean Sea Level, with average water depths across the Eni development area being approximately 20 m. Particularly shallow depths occur along the proposed PoA to Douglas OP cable route, specifically across West Hoyle Bank which is a drying area. The Douglas OP and Lennox OP terminals are situated in 29.20 m and 7.20 m of water respectively. Shallower water is generally present towards the southern and eastern boundaries of the area of project physical work. Figure 6.3 displays the bathymetry in the model domain. Data was collected from online sources including MEDIN (2022), Infomar (2022), (EMODnet (2023), Defra (2022). Environment Agency (2022) and site specific surveys. The geophysical survey was conducted by James Fisher Subtech (JFS) between 12 September and 30 November 2022 as part of the wider Liverpool Bay Asset and Carbon Capture Storage Acoustic Surveys 2022 Campaign. The surveys resulted in the mobilisation of a Multibeam Echo Sounder (MBES), a Sidescan Sonar (SSS), and a Magnetometer. The SSS, and Magnetometer were towed behind the vessel, the MBES was mounted to the vessels.

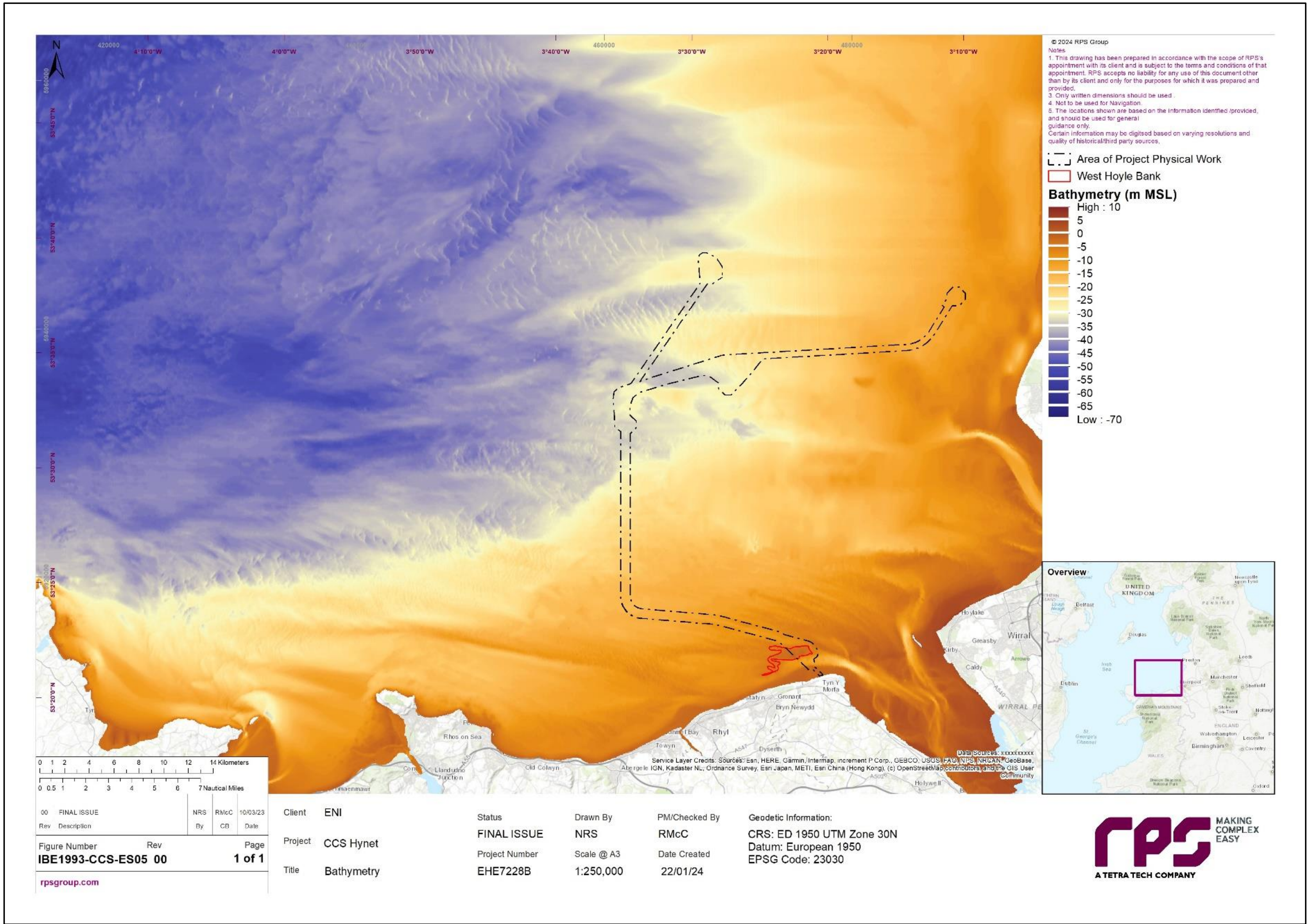

Figure 6.3: Bathymetry Data Utilised in Numerical Modelling within the East Irish Sea

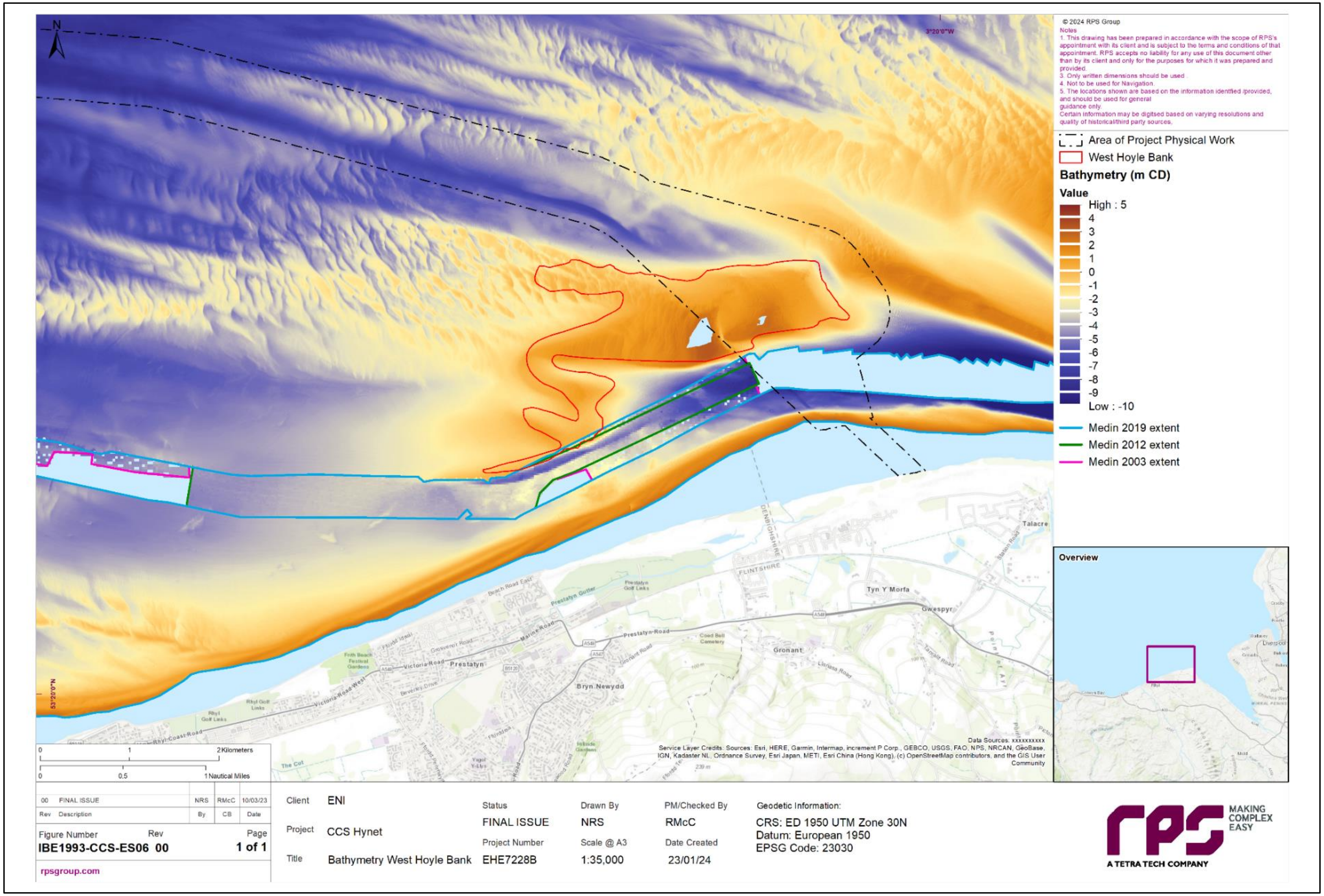

Figure 6.4: Bathymetry Data Utilised in Numerical Modelling - West Hoyle Bank

6.7.3 West Hoyle Bank

West Hoyle Bank is a sandbank of geomorphological and geological importance outside the mouth of the Dee Estuary (Figure 6.4). Although West Hoyle Bank is not a designated site, it is however a site of importance as it is a sandbank which meets the Annex 1 habitat criteria of the EC Habitats Directive (Council Directive 92/43/EEC) (EC, 1992) and acts as a natural breakwater.

Sandbanks can be highly mobile driven by tides rather than waves and the formation is reliant on the availability of sediment. The shallow shifting sandbank at West Hoyle Bank is notoriously dynamic and bathymetric change across the mouth of the Dee Estuary is commonplace. West Hoyle Bank is understood to influence the exchange of sediments with the adjacent coastline and the wave climate approaching the coastline, the removal of this feature therefore has the potential to create a coastal flood risk through increased wave energy approaching the coastline.

6.7.4 Geology

The predominant bedrock types within Liverpool Bay and more specifically the physical processes study area is comprised of Permo-Triassic and Carboniferous sandstone, mudstone and limestone. This bedrock is covered by Quaternary sediments that have a thickness exceeding 50 m in the eastern and western Irish Sea (Mellett *et al*., 2015).

Properties of the Quaternary sediments are known to be highly variable both laterally and with depth due to repeated fluctuations of ice sheets during the last glacial period (Mellett *et al*., 2015). It has also been evidenced that the uppermost surface of bedrock that is found beneath the Quaternary sediment has potentially been weathered due to the last glacial period, therefore it could be weaker than the underlying rock (Mellett *et al*., 2015).

6.7.5 Hydrography

The UK Hydrographic Office states that the mean tidal range at the Standard Port of Holyhead is approximately 3.65 m whilst at Douglas it is 4.55 m. However, it was the Standard Port of Llandudno which was utilised for calibration of the numerical models used to support this assessment given its proximity to the physical processes study area, which has an average tidal range of 5.40 m as published by Admiralty.

Semi-diurnal tides are the dominant physical process in the Irish Sea coming from the Atlantic Ocean through both the North Channel and St Georges Channel. The tidal range in the Irish Sea is highly variable with a range greater than 10 m on the largest spring tides, second largest in Britain.

At spring tides, tidal currents within the physical processes study area are relatively high, with current speeds typically between 0.80 m/s and 0.90 m/s at flood and 0.60 m/s and 0.70 m/s at ebb (Figure 6.5 and Figure 6.6 respectively). Littoral currents are driven by tides, waves, and meteorological events. The littoral currents were modelled during a 1in1 year storm event from the westerly sector, resulting in the increase of currents on the peak flood tide and decreases on the ebb. Further information including tidal flow fields for the east Irish Sea are presented in Physical Processes Technical Report (RPS Group, 2024a). Table 6.7 shows the tidal levels at standard ports in Holyhead and Douglas (UKHO, 2023). Principal hydrometric resources used for calibration include Acoustic Doppler Current Profiler (ADCP) wave buoy data, Admiralty tidal harmonics, British Oceanographic Data Centre (BODC) (BODC, 2023), and Coastal Channel Observatory (CCO).

Table 6.7: Tidal Levels at Standard Ports (UKHO, 2022)

Tidal Level	Holyhead	Douglas
Lowest Astronomical Tide (LAT)	0.0	-0.3
Mean Low Water Springs (MLWS)	0.7	0.8
Mean Low Water Neaps (MLWN)	2.0	2.4
Mean Sea Level (MSL)	3.3	3.8
Mean High Water Neaps (MHWN)	4.4	5.4
Mean High Water Springs (MHWS)	5.6	6.9
Highest Astronomical Tide (HAT):	6.3	7.9

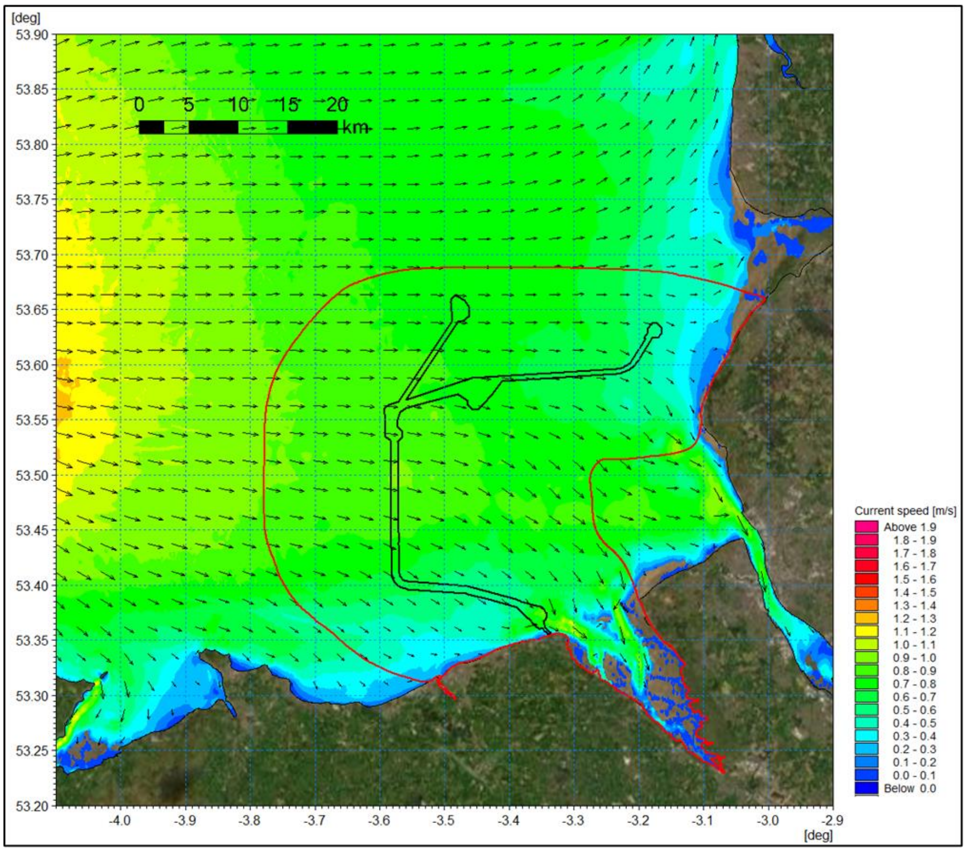

Figure 6.5: Tidal Flow Patterns – Spring Tide Flood

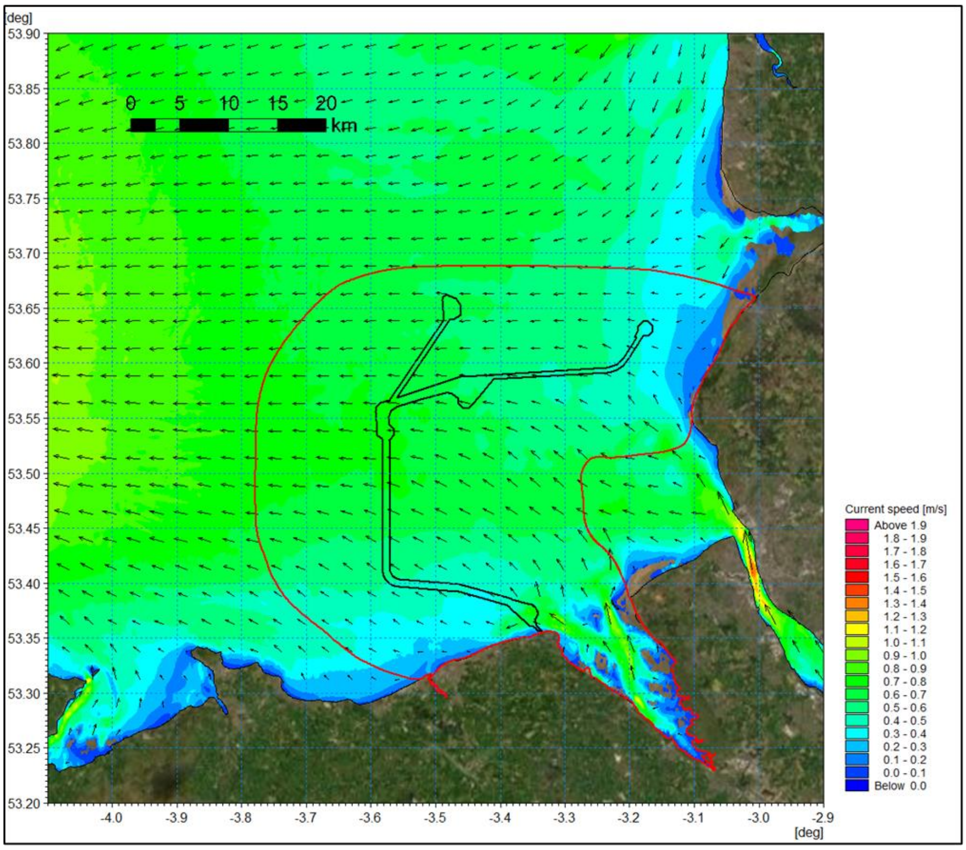

Figure 6.6: Tidal Flow Patterns – Spring Tide Ebb

6.7.6 Wave climate

Characteristic of the east Irish Sea, waves are generated by either local winds or from remote winds (swell waves). The largest portion of waves entering the physical processes study area do so from the westerly sectors, typically combined wind and swell for the Irish Sea.

The highest mean annual significant wave height of 1.39 m was recorded between the Isle of Man and Anglesey with the significant wave height reducing closer to the coast with a low of 0.73 m recorded within the physical processes study area, to the west of the Dee Estuary (ABPmer, 2023a).

Within the physical processes study area the mean annual wave height ranges from 0.80 m to 1.10 m. Over 40% of waves arise from the west with a majority of significant wave heights (>2 m) coming from this sector also (ABPmer, 2023a).

This directionality corresponds with that seen by winds, with *c*. 40% exhibiting a dominant westerly/south westerly origin. Further detail on the wave climate and meteorological conditions is provided in Physical Processes Technical Report (RPS Group, 2024a) . Figure 6.7 shows the rose plot for the significant wave height for the physical processes study area, whilst Figure 6.8 shows wind speed and direction. Figure 6.9 and Figure 6.10 show the significant wave heights for 1in1 year storms from the west and north. The model simulated water levels used boundary data extracted from the RPS storm surge model and applied meteorological conditions from the European Centre for Medium-range Weather Forecasting (ECMWF) operational dataset (ECMWF, 2022).

In addition to boundary wave data, it was necessary to analyse the wind field to include the contribution of local wind seas. For this, a representative point for each of the key directions was identified and utilised from the National Oceanic and Atmospheric Administration (2022) 40-year dataset. The model output data was then compared with measured data obtained from the National Network of Regional Coastal Monitoring Programmes held by the Coastal Channel Observatory (2022).

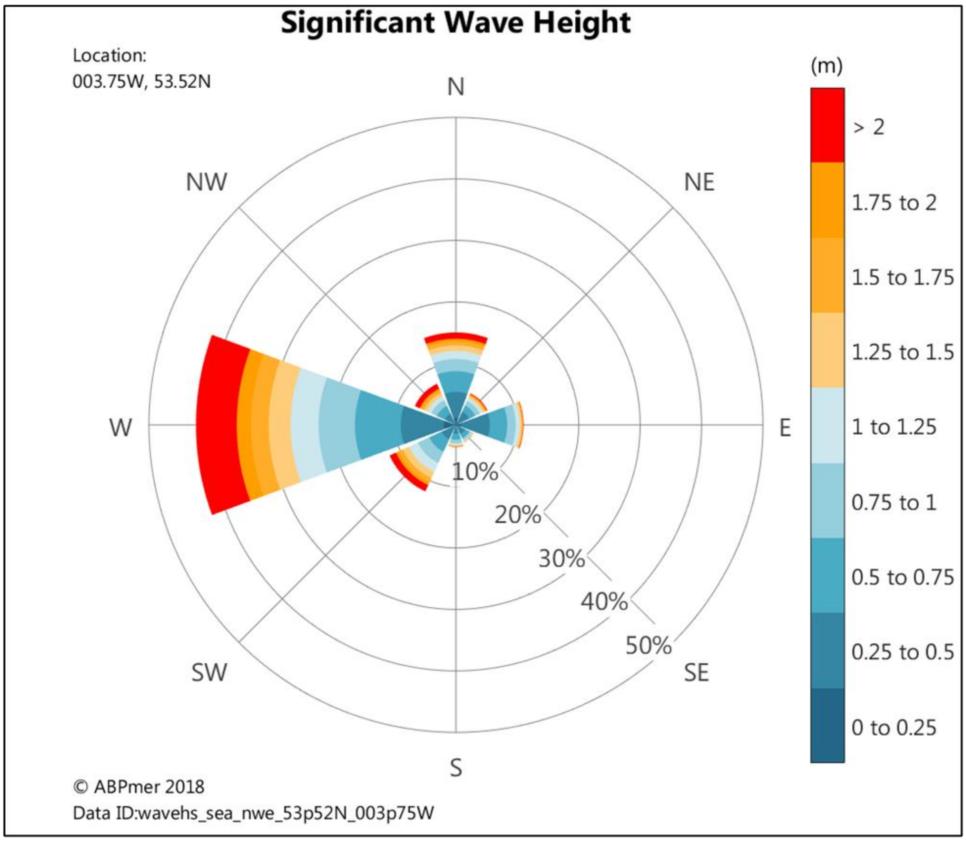

Figure 6.7: Wave Rose For The Hynet Physical Processes Study Area

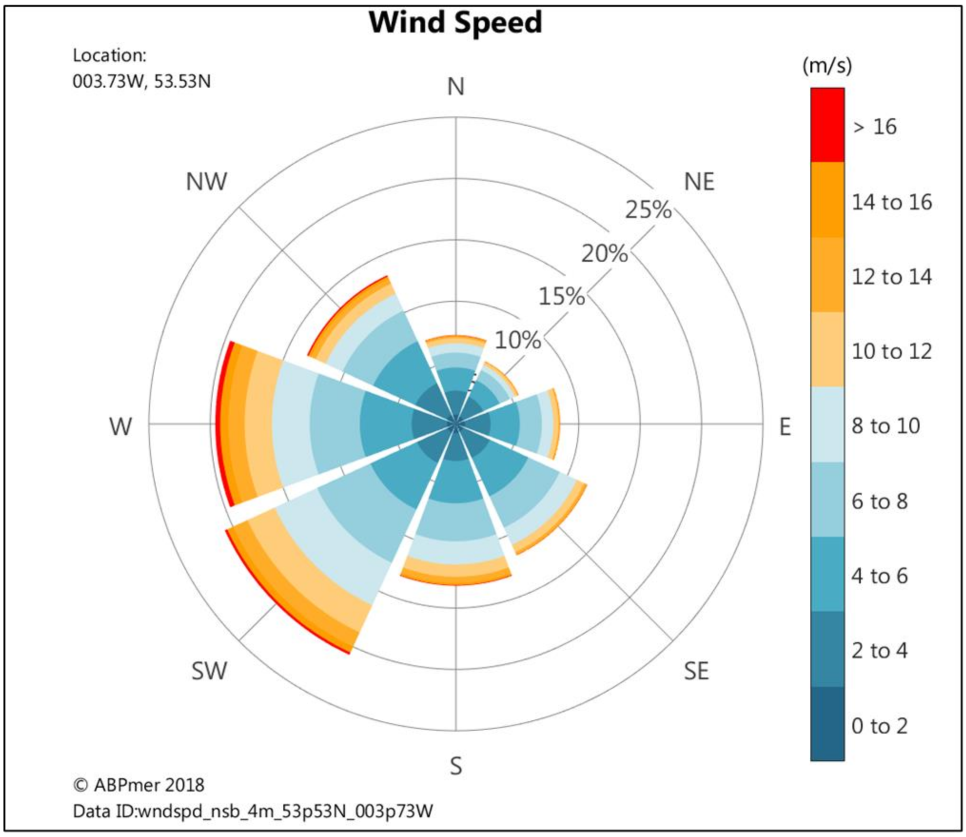

Figure 6.8: Wind Rose For Hynet Physical Processes Study Area

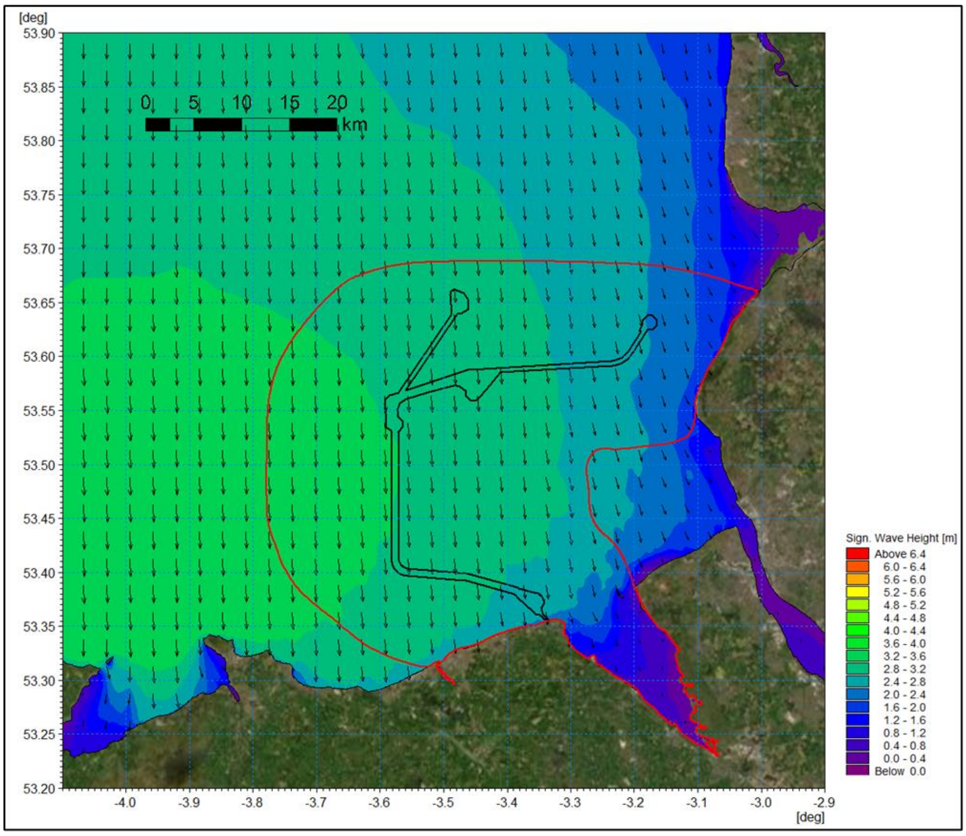

Figure 6.9: Wave Climate 1:1 Year Storm From 000° MHW

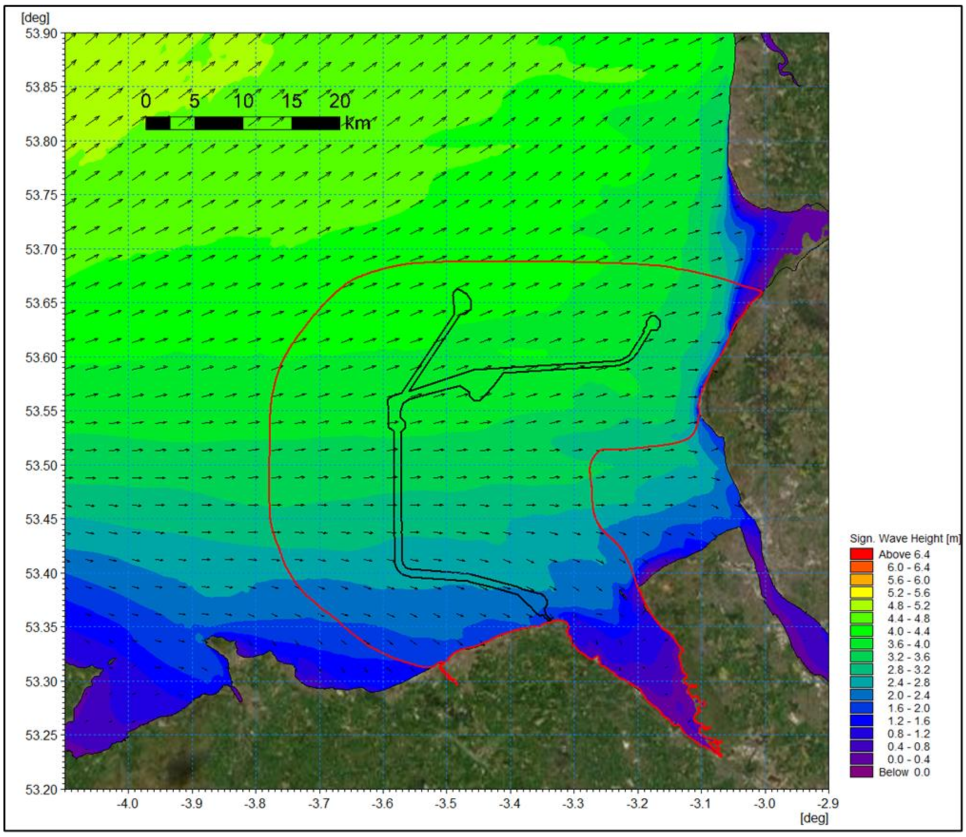

Figure 6.10: Wave Climate 1:1 Year Storm From 240° MHW

6.7.7 Seabed sediments

To inform the modelling study seabed sediment information was required beyond the extent of survey datasets, and the EMODnet Geology database (EMODnet, 2022) was utilised, as illustrated in Figure 6.11. Across the physical processes study area, the underlying geology consists of bedrock lithologies in the region are Triassic and Carboniferous sandstone and mudstone (Mellett *et al*., 2015). The bedrock of sandstone and mudstone are covered by sediments from the Quaternary age. Potential weathering during the last glacial period may have weakened the uppermost surface of underlying bedrock. Quaternary sediment thickness in the central Irish Sea is <20 m although in short distances this can increase to >100 m due to the presence of glacial valleys. However, in the east and west of the Irish Sea sediment thickness is *c*. 50 m.

In the Irish Sea, there is a high variability in the bedforms ranging from very small ripples (5 cm high) to very large sediment waves (>10 m high). Liverpool Bay itself is characterised by sand ribbons less than 30 cm in height and sand wave fields generally less than 2 m in height between and 10 and 20 m in length. A number of such sand waves can be found with the area of project physical work, with proposed cable route from PoA Terminal to Douglas OP expected to intersect with them. These bedforms can be seen in the detailed bathymetric map of Liverpool Bay presented in Figure 6.3.

In the east and west Irish Sea seabed sediments are subdivided into regions of soft mud (clay and silt) and rich sediment, separated by a central gravel belt containing coarse sand and gravel. A majority of the Liverpool Bay area is composed of circalittoral muddy/ sandy sediment (EMODnet, 2023). More specifically, the seabed sediments found within the Project area are found to be predominantly comprised of circalittoral fine sand, deep circalittoral coarse sediment, and deep circalittoral sand. As the offshore pipeline moves from the offshore development area and the Douglas OP towards the coast of northern Wales, sandy sediments grade into circalittoral muddy sand, circalittoral coarse sediment and circalittoral coarse rock.

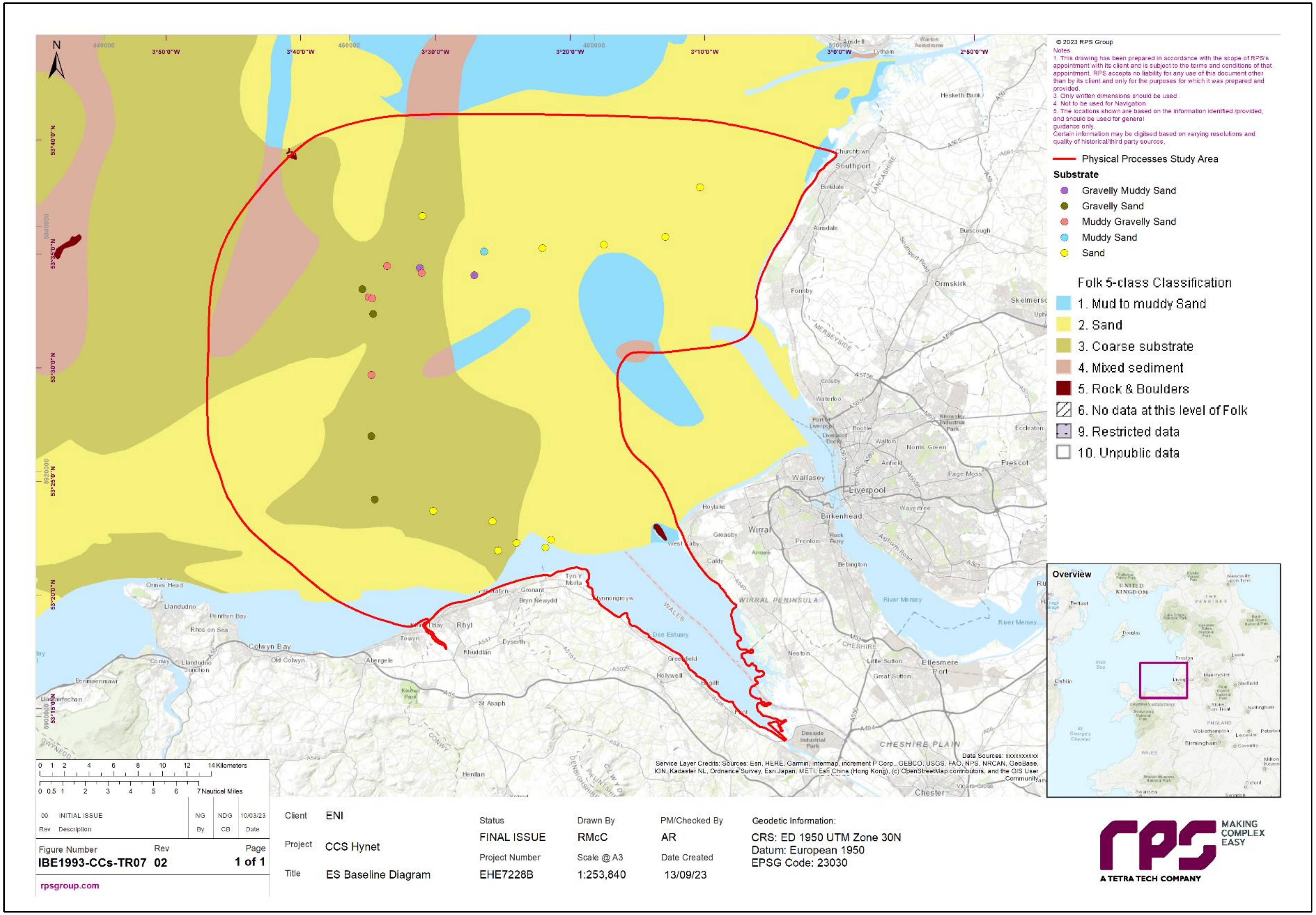

Figure 6.11: Seabed Substrate Geology Comprised Of Site Specific Grab Samples And EMODnet

6.7.8 Sediment quality and contamination

Within the Irish Sea, sediment contamination levels are typically higher than those in the seawater (Cefas, 2005). The distribution of sediment contaminants is generally similar to that of surface waters. In coastal areas, sediment contamination can occur through anthropogenic run-off into rivers, sewage effluent, or industrial discharge (RWE Renewables, 2021). It can also occur due to contamination and pollution from offshore industries, such as oil and gas activity and shipping, which have historically been substantial in Liverpool Bay.

Sediment type is an important factor to consider when considering contamination levels. For example, those with a finer particle size (such as clays and muds) can adsorb contaminants that are released into the water column during sediment disturbance (Cefas, 2001). Inversely, sediments with larger particle sizes (such as sands) are not typically associated with elevated anthropogenic contaminant concentrations. As noted in section 6.7.7 above, the sediments within the Eni Development Area have largely been characterised as sand and coarse sediments, and as such, would not be expected to contain elevated anthropogenic contaminant concentrations.

The grab samples collected during the site-specific benthic survey (see Table 6.5) were assessed for various contaminants: heavy and trace metals, Polycyclic Aromatic Hydrocarbons (PAHs), Total Hydrocarbon Content (THC), Polychlorinated Biphenyls (PCBs), and organotins. These were compared to national and international reference levels (e.g. Cefas Action Level 1 (AL1), Oslo Paris Convention (OSPAR) levels, etc.), where relevant. The results are summarised below and presented in full in Marine Biodiversity Subtidal Survey Report (Ocean Ecology and RPS Group, 2023).

6.7.8.1 Metals

Concentrations of metals in sediments are typically higher in the coastal zone and estuaries but decrease offshore. This indicates that riverine input and run-off from land are significant contamination sources. The site-specific survey tested for a total of eight heavy and trace metals: Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Lead (Pb), Mercury (Hg), Nickel (Ni) and (Zn). The results of the site-specific survey indicated that the Cefas AL1 was exceeded for As and Cd at one sampling station each, but not for any of the other metals assessed. Both the sampling stations where As and Cd exceeded Cefas AL1 were in areas surrounding oil and gas infrastructure that is proposed to be partially decommissioned. Hg was above the OSPAR level in seven sampling stations but did not exceed Cefas AL1. Zn was the most abundant metal recorded but was always measured below reference levels at all sampling stations.

Overall, all metals occurred in concentrations comparable to existing background data or in line with the range of concentrations expected for areas located in the proximity of active oil and gas platforms.

6.7.8.2 Polycyclic Aromatic Hydrocarbons

PAHs are a group of structurally related hydrocarbons. Generally, they are not released into the environment intentionally but are naturally present in fossil fuels and other hydrocarbon-based materials associated with development (RWE Renewables, 2021). PAHs persist in the environment and have the potential to bioaccumulate with consequential adverse effects on aquatic and human life (Environment Agency, 2019).

The results of the site-specific survey indicated that Cefas AL1 was only exceeded at one sampling station for both Chrysene and Benzo[a]pyrene. The OSPAR reference levels were exceeded at six sampling stations for Naphthalene, four for Pyrene and Benzo[a]anthracene, three for Anthracene, and one for Benzo[k]fluoranthene and Benzo[a]pyrene. The most abundant PAH recorded was Benzo[b]fluoranthene.

A positive correlation was observed between chrysene, Benzo[a]pyrene and mud content, with higher PAHs concentrations in muddier sediments; this aligns with expectations, due to the higher likelihood of contaminants adsorbing onto sediment fines (i.e. the mud and clay components). No relationship was observed between the concentration of PAHs and proximity to platforms that could have indicated dispersal of drill cuttings.

6.7.8.3 Total Hydrocarbon Concentrations

THC is used to describe the quantity of measured hydrocarbon impurities present in the sediment samples. The THC in sediment samples collected during the site-specific survey ranged from 1,320 µg/kg to 30,600 µg/kg. In the North Sea, THC concentrations at locations between 1 to 2 km from an active platform range between 32,710 µg/kg to 33,810 µg/kg, in line with the maximum value recorded, which was located in the proximity of a platform.

6.7.8.4 PCBs

PCBs are man-made chemical compounds that were banned in the mid-1980s due to concerns about their toxicity, persistence, and potential to bioaccumulate in the environment. They do not break down easily and are extremely toxic to marine and human life (OSPAR, 2023).

The site-specific survey tested for seven PCB congeners (PCB28, PCB52, PCB101, PCB118, PCB138, PCB153 and PCB180, described as the International Council for Exploration of the Seas (ICES) Seven), which are widely used in environmental monitoring as they cover the range of toxicological properties of the group. Most PCBs had concentrations below the detection limit of 0.08 µg/kg across the survey area. No Cefas Action Levels exist for each individual PCB, but for the sum of the seven PCBs (ΣICES7), the AL1 is 10 µg/kg.

PCB138 had the highest concentrations, ranging from below the limit of detection at 39 sampling stations, to a maximum of 0.41 µg/kg. ΣICES7 was below Cefas AL1 at all sampling stations.

6.7.8.5 Organotins

Organotins (dibutyltin and tributyltin) have been used as biocides, polymer stabilisers, preservatives, and catalysts in various industrial processes. They typically enter the marine environment through antifouling paint on vessels and infrastructure, and via wastewater and sewage sludge discharged from water treatment facilities (Diez *et al.,* 2002). Both dibutyltin and tributyltin were below the limit of detection at all sampling stations.

6.7.8.6 Bacterial contaminants

Suspended sediments can also transport biotic contaminants, such as *Escherichia coli* bacteria (Jamieson *et al.,* 2005; Russo *et al.,* 2011; Bradshaw *et al.,* 2021). There are classified shellfish waters present within Liverpool Bay, which are regularly monitored by Cefas for *E. coli* contamination. *E. coli* levels are used as an indicator for microbiological contamination in shellfish, as this bacterium is present in animal and human faeces in large numbers. It can, therefore, indicate contamination of faecal origin, and that other harmful faecal bacteria may be present. *E. coli* levels in common cockle *Cerastoderma edule* have been regularly monitored at four locations in the mouth of the Dee Estuary since 2013 (Cefas, 2023). There are currently 383 samples available, which range from <18 *E.coli* per 100 g (minimum threshold) to 35,000 *E. coli* per 100 g (Cefas, 2023). The average contamination value is 462 *E. coli* per 100 g (standard deviation ± 1,917), and the median value is 140 *E. coli* per 100 g (Cefas, 2023). These median and average *E. coli* contamination levels fall under Class A and Class B, respectively, with Class A suitable for harvesting for direct human consumption and Class B requiring purification processes before being suitable for human consumption (Cefas, 2023).

6.7.9 Sediment transport

Residual currents are the net flow over a full tidal cycle and drive the sediment transport. Residual current flow into the east Irish Sea from the north of the Isle of Man and west around Anglesey correlates with this region being a sediment sink (Figure 6.12). The greatest residual current speeds within the physical processes study area occur along headlands and within the Dee Estuary where finer sand fractions are present and where tidal currents are strongest, corresponding with the largest rates of sediment transport which too occur within the Dee Estuary.

Sediment transport rates are greatest during spring tides and specifically the dominant flood tide, with total sediments loads of up to 0.001 $m^3/s/m$, and 0.0005 $m^3/s/m$ on the ebb of the spring tide. Net sediment transport rates are generally <2.00 $m^3/d/m$ across the physical processes study area, however, can reach as high as 200 $m^3/d/m$ in localised areas, such as within the Dee Estuary. The mechanism is more clearly illustrated in Figure 6.13 and Figure 6.14 for flood and ebb tides respectively. It is evident that transport rates are highest during the dominant flood tide and the region is a sediment sink.

The coastline of Liverpool Bay is for the most part experiencing gradual erosion and coastal retreat, the greatest of which occurs on the coastline of the sediment subcell Formby Dunes (Halcrow Group Limited, 2010). Localised areas defended by seawalls experience little to no retreat, however naturally defended shorelines and those defended by revetments are expected to experience drawback.

The physical processes study area coincides with the Solway Firth sediment cell and sub-cell 11a Great Orme's Head to Southport Pier. In the sub-cell 11a the general direction of sediment transport is west to east. This direction of travel supplies the southeast shoreline with sediment (Price *et al.,* 2010).

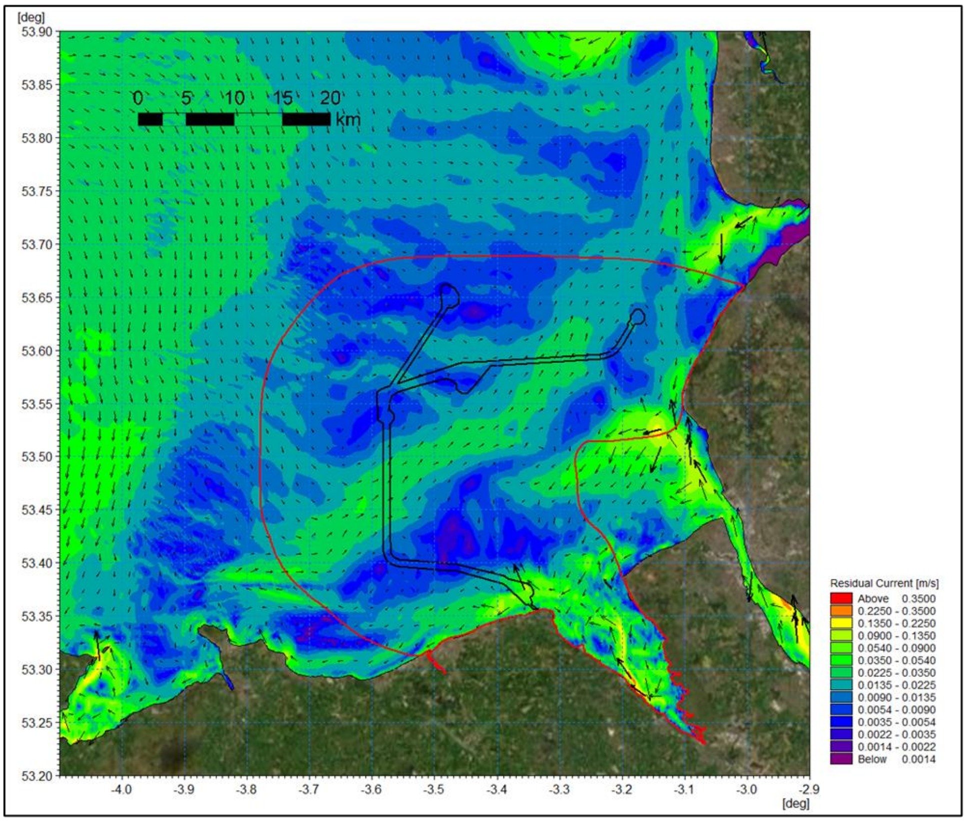

Figure 6.12: Residual Current Spring Tide

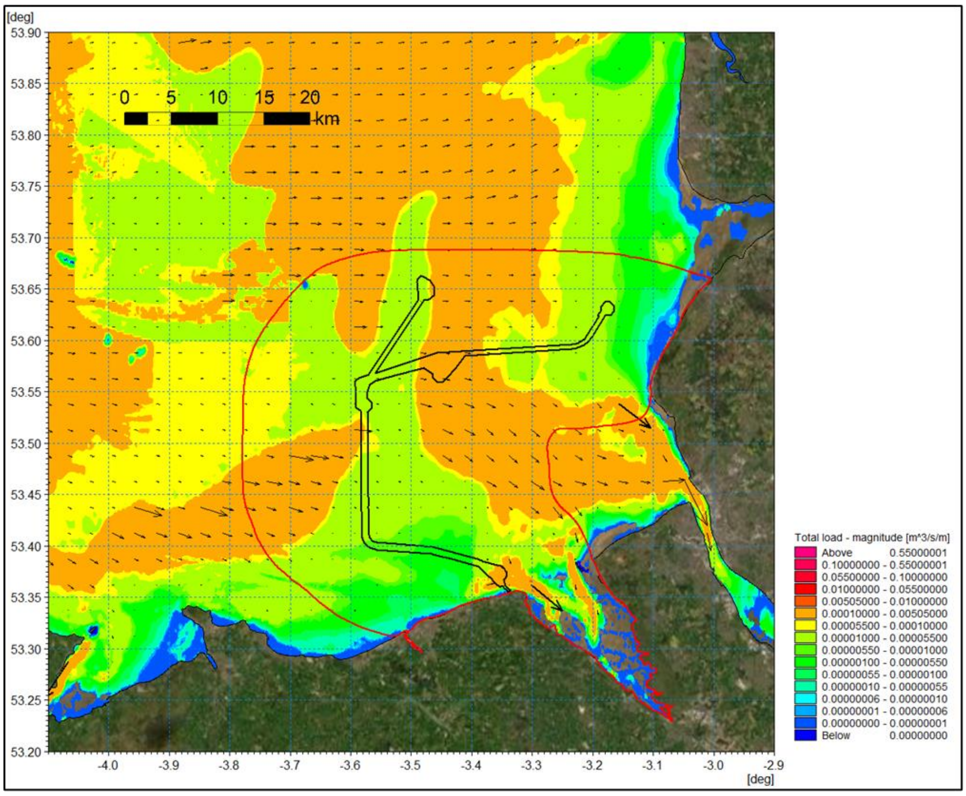

Figure 6.13: Sediment Transport – Flood Tide

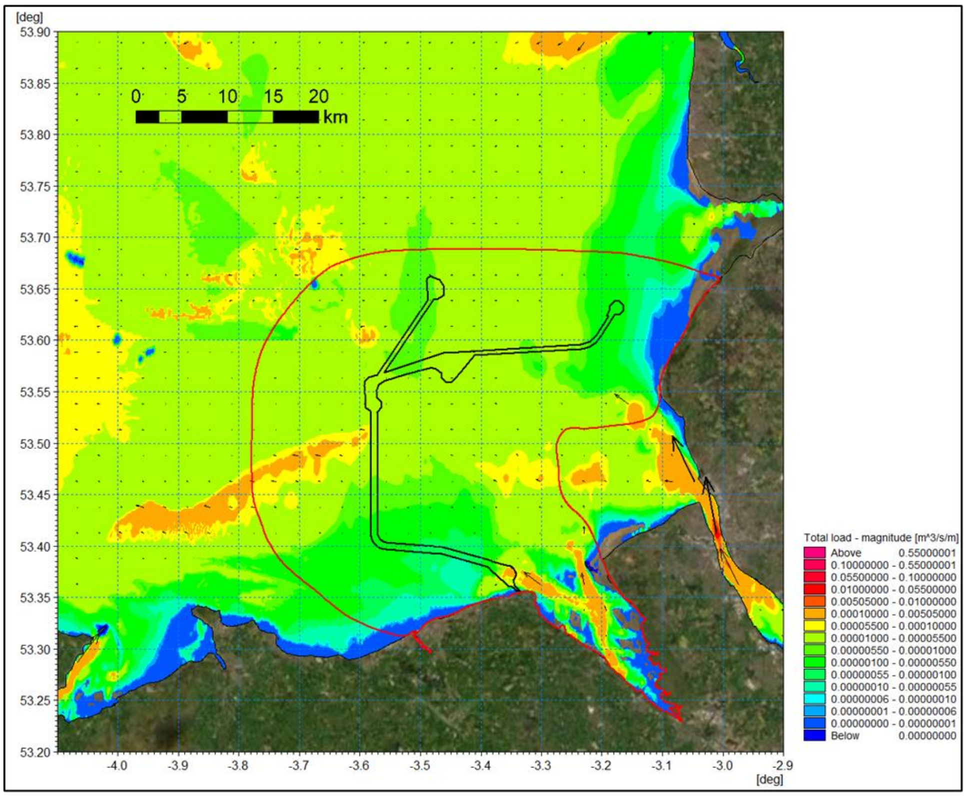

Figure 6.14: Sediment Transport – Ebb Tide

6.7.10 Suspended sediments

CEFAS Climatology Report 2016 (CEFAS, 2016) and associated dataset provides the spatial distribution of average non-algal Suspended Particulate Matter (SPM) for the majority of the UK Continental Shelf (UKCS), the distribution of which is shown for Liverpool Bay in Figure 6.15. SSC are regulated by tidal currents and intensify during wind-driven storm events throughout the water column. SSC levels have a seasonal pattern due to the seasonality of storm events. Mean annual SSC values along the coastline can be in excess of 30 mg/l in areas such as Liverpool Bay due to the discharge of large rivers such as The Dee and The Mersey. Thus, the more turbid and shallower nearshore development area experiences higher average concentrations than that offshore, with mean concentrations of up to *c*.20 mg/l adjacent to the PoA, and concentrations between 2 mg/l and 10 mg/l further offshore.

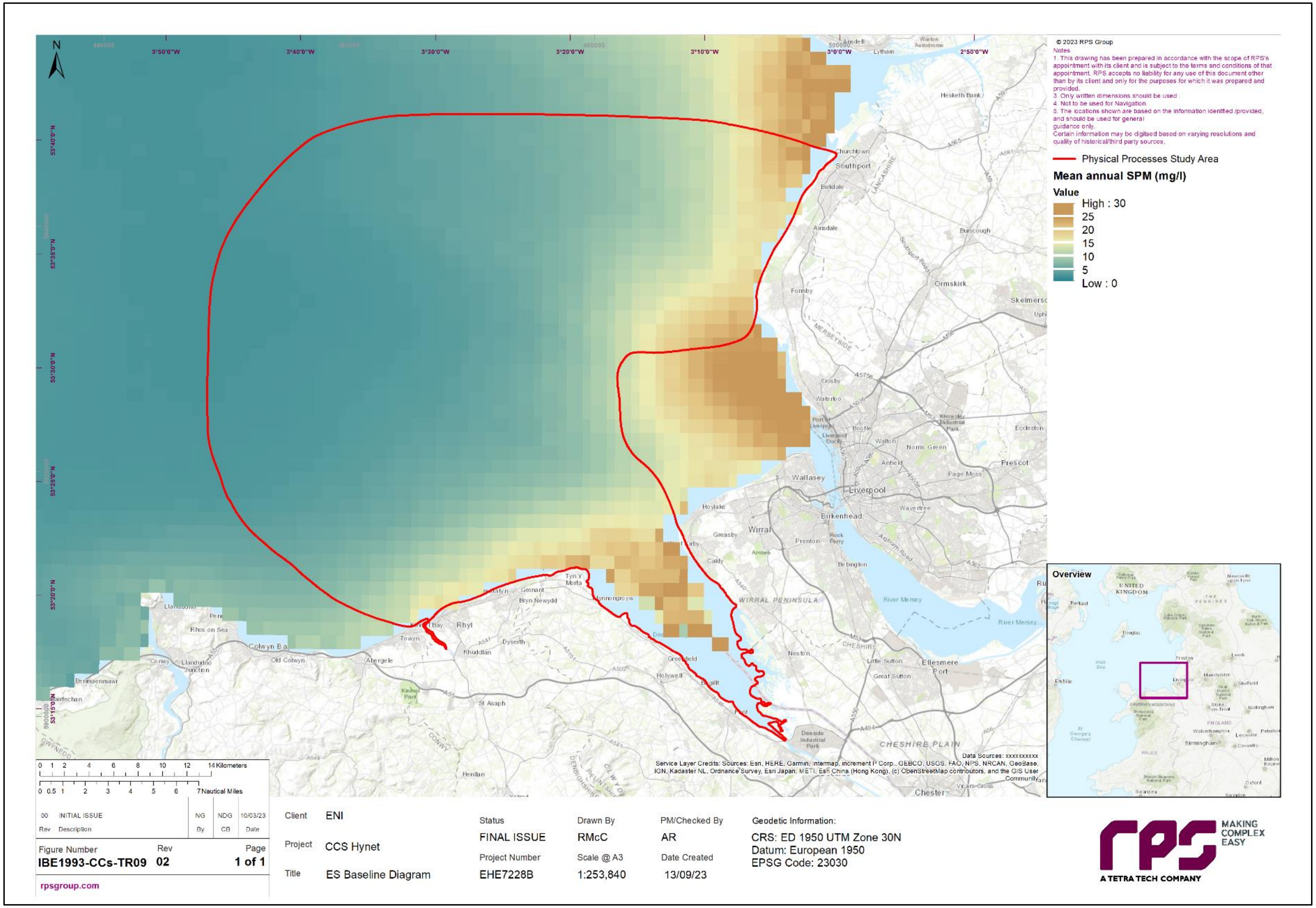

Figure 6.15: Distribution Of Average Non-Algal Suspended Particulate Matter – CEFAS

6.7.11 Water quality

The concentrations of dissolved contaminants in seawater samples are often low or below detection limits (Cefas, 2005). This is due to the hydrophobic nature of many organic contaminants and the partitioning of metals to suspended particles in the water column (Cefas, 2005). Within the Irish Sea, and more specifically within Liverpool Bay, water quality is predominantly affected by contamination from rivers, sewage effluent, or industrial discharge (RWE Renewables, 2021). Within Liverpool Bay, anthropogenic sources of contamination predominantly originate from rivers, as opposed to direct input (Cefas, 2005).

A range of contaminants can be present in seawater, such as: radioactive isotopes, hydrocarbons, trace metals, and bacteria. Radioactive isotopes are relatively soluble in seawater. Within the eastern Irish Sea, they are dispersed from the Sellafield reprocessing plant (Cumbria), which represents the largest single input of radioactive material in the area (DEFRA, 2005). However, the resulting exposure to radioactive material remains well below levels known to cause adverse effects for marine species (Npower, 2005).

Metal contamination is typically highest within estuarine and coastal waters, which are subject to industrial and wastewater inputs (Cefas, 2005). Liverpool Bay has historically been contaminated with Hg (Ministry of Agriculture, Fisheries and Food (MAFF), 1991), which is attributed to inputs of industrial effluents from the Mersey Estuary. The Irish Sea also receives the largest single input of Pb from the River Mersey (DEFRA, 2005). Elevated Cu level in the Liverpool Bay region (in comparison to the rest of the Irish Sea) are attributed to the River Dee and River Mersey (Marine Pollution Monitoring Management Group (MPMMG), 1998). Discharge from rivers is also a major source of Cd and Zn in the region (Norton *et al.,* 1984).

Liverpool Bay has also historically been the site of oil and gas industry, which can cause water contamination through the discharge of chemicals used for production and drilling and residual oil (Cefas, 2005).

6.7.12 Designated sites

Using the Joint Nature Conservation Committee (JNCC, 2023) database (https://jncc.gov.uk/our-work/marine-protected-area-mapper/) Ramsar (2023) and DEFRA databases, designated sites identified for the physical processes study area are described in Table 6.8 and illustrated in Figure 6.16.

Table 6.8: Designated Sites and Relevant Qualifying Interests for the Physical Processes Chapter.

Designated Site	Closest Distance to the Area of Project Physical Work (km)	Relevant Qualifying Interest
Marine Conservation Zones (MCZs)		
Flyde MCZ	1.80	Qualifying Features: • Subtidal sands and subtidal muds that are highly productive and evidenced to support an abundance of animals such as crustacean, starfish, and bivalve species including: nut-shell *Nucula nitidosa*, razor shell *Pharus legumen* and the white furrow shell *Abra alba*. Flatfish, including sole *Solea solea* and plaice *Pleuronectes platessa*, in addition to whiting *Merlangius merlangus* are also supported by the habitat within the site.
Special Areas of Conservation (SACs), Ramsar Sites and Special Protection Areas (SPAs)		
Ribble and Alt Estuaries SPA and Ramsar Site	6.10	Qualifying Features: • The site consists of extensive areas of sandflats and mudflats, as well as large areas of

Designated Site	Closest Distance to the Area of Project Physical Work (km)	Relevant Qualifying Interest
		saltmarsh, particularly in the Ribble. There are also areas of coastal grazing marsh. • The site supports breeding ruff *Philomachus pugnax*, common tern *Sterna hirundo* and lesser black-backed gull *Larus fuscus graellsii*. The site also supports wintering Bewick's swan *Cygnus columbianus bewickii*, whooper swan *Cygnus cygnus*, golden plover *Pluvialis apricaria*, bar-tailed godwit *Limosa lapponica*, pink-footed goose *Anser brachyrhynchus*, shelduck *Tadorna tadorna*, wigeon *Anas penelope*, teal *Anas crecca*, pintail *Anas acuta*, oystercatcher *Haematopus ostralegus*, grey plover *Pluvialis squatarola*, knot *Calidris canutus islandica*, sanderling *Calidris alba*, dunlin *Calidris alpina alpine*, black-tailed godwit *Limosa limosa islandica*, redshank *Tringa tetanus*. The Ribble and Alt Estuaries SPA also supports passage populations of ringed plover *Charadrius hiaticula*, sanderling *Calidris alba*, and redshank *Tringa tetanus*.
Mersey Narrows and North Wirral Foreshore SPA and Ramsar Site	9.0	Qualifying Features: • The site comprises of intertidal habitats, man-made lagoons, and extensive intertidal flats. • The site supports non-breeding bar-tailed godwit, little gull *Hydrocoloeus minutus*, and knot. The site also supports breeding common tern and an internationally important waterbird assemblage.
The Dee Estuary SAC, Ramsar Site and SPA	0.0	Qualifying Features: • Mudflats and sandflats not covered by seawater at low tide; Salicornia and other animals colonizing mud and sand; Atlantic Sea meadows *Glauco-Puccinellietalia maritimae*, embryonic shifting dunes, shifting dunes along the shoreline, fixed dunes with herbaceous vegetation and humid dune slacks, and estuaries. • Internationally important populations include oystercatcher, knot, curlew *Numenius arquata*, redshank, bar-tailed godwit, black-tailed godwit, grey plover and dunlin.
Sites of Scientific Interest (SSSI) (DEFRA, 2023)		
Dee Estuary SSSI	5.0	Qualifying Features: • The Dee Estuary is of special interest for its populations of internationally important wintering waterfowl *Anseriformes sp.*, term species, intertidal mud and sandflats, saltmarsh and transitional habitats. • Internationally important populations include oystercatcher, knot, curlew, redshank, bar-tailed godwit, black-tailed godwit, grey plover and dunlin.
North Wirral Foreshore SSSI	8.80	Qualifying Features: • Intertidal sand and mudflats and embryonic saltmarsh of considerable importance.

Designated Site	Closest Distance to the Area of Project Physical Work (km)	Relevant Qualifying Interest
Ribble Estuary SSSI	6.80	Qualifying Features: • Extensive intertidal sand-mud flats and areas of reclaimed saltmarsh, supporting internationally important populations of wildfowl.
Sefton Coast SSSI	6.20	Qualifying Features: • Intertidal mud, sandflats, embryonic shifting dunes, mobile dunes, dunes creeping with willow *Salix arenaria*, humid dune slacks, fixed dunes, dune grasslands and dune heath. • Assemblages of vascular and non-vascular plants, in particular the nationally rare grey hair grass *Corynephorus canescens*, nationally scarce liverwort *Pentalophyllum ralfsii* and nationally rare moss *Bryum neodamense*.
Bathing Water Locations		**Bathing Water Quality Classification**
Rhyl	2.10	Sufficient
Ainsdale	6.0	Good
West Kirby	7.60	Excellent
Southport	6.40	Good

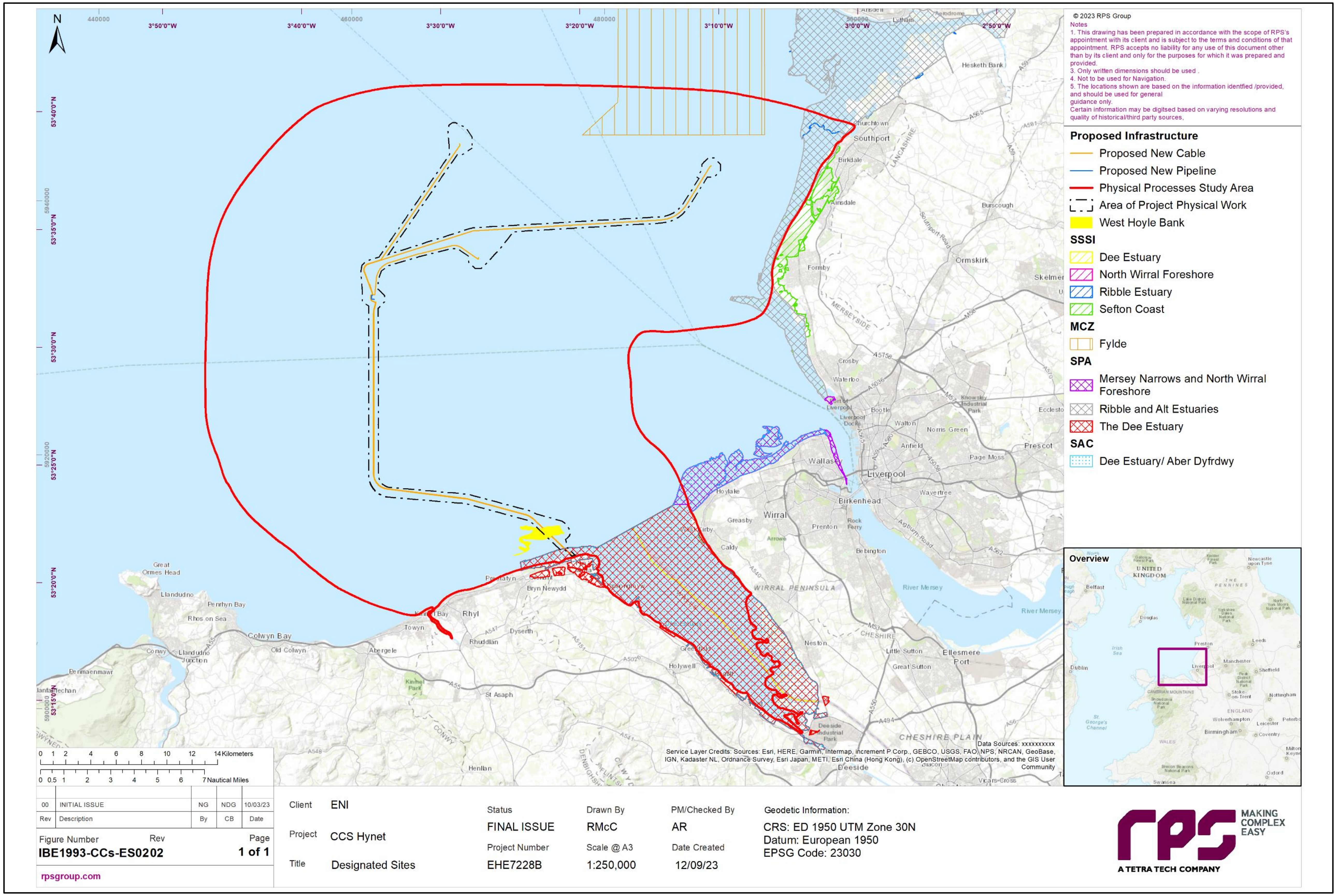

Figure 6.16: Designated Sites and Relevant Qualifying Interests for the Physical Processes Chapter

6.7.13 Future baseline scenario

The ‘2020 EIA Regulations’, require that a “*a description of the relevant aspects of the current state of the environment (baseline scenario) and an outline of the likely evolution thereof without implementation of the project as far as natural changes from the baseline scenario can be assessed with reasonable effort, on the basis of the availability of environmental information and scientific knowledge*” is included within the ES.

The baseline environment for physical processes is not static and will exhibit a degree of natural change over time. Such changes will occur with or without the proposed development in place due to natural variability. Future baseline conditions would be altered by climate change resulting in sea level rise and increased storminess. This is unlikely to have the effect of significantly altering tidal patterns and sediment transport regimes offshore in the development area. The return period of the wave climates would be altered (e.g. what is currently defined as a 1 in 50 year event may become a 1 in 20 year event) as deeper water would allow larger waves to develop. Although increased water depth would potentially increase the wave climate, sandbank development is driven by tides and sediment source rather than waves (Kenyon and Cooper, 2005). Therefore, shallow water and drying features, such as West Hoyle Bank would continue to develop. There is, however, a notable degree of uncertainty regarding how future climate change will impact prevailing wave climates within the Irish Sea and beyond.

6.8 Key parameters for assessment

6.8.1 Maximum design scenario

A range of potential impacts on physical processes have been identified which could potentially occur during the construction, operation and maintenance, and decommissioning phases of the Proposed Development.

Impacts that have been scoped into the assessment are outlined in Table 6.9 along with the identified maximum design scenarios. The maximum design scenarios have been selected as those having the potential to result in the greatest effect on an identified receptor or receptor group. These scenarios have been selected from the details provided in volume 1, chapter 3. Effects of greater adverse significance are not predicted to arise should any other development scenario, based on details within the Project Design Envelope (PDE) (e.g. different infrastructure layout), to that assessed here, be taken forward in the final design scheme.

Table 6.9: Maximum Design Scenario Considered for Each Impact as Part of the Assessment of Likely Significant Effects on Physical Processes

Potential Impact	Phase[a]			Maximum Design Scenario	Justification
	C	O	D		
Increased suspended sediment concentrations (SSCs) and sediment deposition	✓	✓	✓	**Construction phase** <u>Seabed preparation</u> Sand wave clearance: • South of Douglas OP: sand wave clearance to occur through the use of max flow excavator. Channel cleared through a length of 115 m of sand waves, with a width of 10 m and height of 3 m. Total spoil volume of 3,450 m^3. Sand wave clearance activities undertaken over an approximate duration of 3 days. Dredging: • West Hoyle Bank: Dredged channel to be excavated with a length of 1 km, width of 21 m and height of 7 m, through the use of backhoe dredger. Total spoil volume of 147,000 m^3. Dredging activities to be undertaken over approximate duration of 2 weeks. <u>Cable installation</u> • PoA Terminal to Douglas OP: Installation via trenching of two separate cable lengths of *c*.33,990 m, with trenches spaced *c*.30 m apart. Trench width of up to 3 m and a depth of up to 3 m. Trenching rate of 450 m/h. Total spoil volume of c.153,000 m^3 per cable. Inter-OP cables: • Doulas to Lennox: Installation via trenching of *c*.32.34 km of cabling. Trench width of up to 3 m and a depth of up to 3 m. Trenching rate of 450 m/h. Total spoil volume of 145,530 m^3. • Douglas to Hamilton North: Installation via trenching of *c*.14.89 km of cabling. Trench width of up to 3 m and a	**Construction (also applies to decommissioning phase)** • There is potential for increased SSCs and deposition associated with various forms of seabed preparation activities (jetting, ploughing, mechanical cutting, drilling) and cable installation activities. Therefore, smaller particles located within the sediment could potentially be raised into suspension during the construction phase of the Proposed Development. **Operation and maintenance phase** • There is potential for increases in SSCs and deposition from activities related to cable repair and/or removal. These effects are likely to be similar to those exhibited during cable installation during the construction phase of the Proposed Development. **Decommissioning phase** • There is potential for increased SSCs and deposition associated with the removal of the Proposed Developments infrastructure/equipment. In a worst-case scenario, the effects are likely to be similar to those exhibited during the construction phase.

Potential Impact	Phase[a]			Maximum Design Scenario	Justification
	C	O	D		
				depth of up to 3 m. Trenching rate of 450 m/h. Total spoil volume of 67,005 m^3. • Douglas to Hamilton: Installation via trenching of *c*.10.87 km of cabling. Trench width of up to 3 m and a depth of up to 3 m. Trenching rate of 450 m/h. Total spoil volume of 48,915 m^3. Drill cuttings dispersion • Monitoring wells: Two drilled monitoring wells at Hamilton and Hamilton North. 26" section drilled over a vertical distance of 118.90 m. 17" section drilled over a vertical distance of 518.16 m. 100% hole washout assumed to account for released drilling muds. Total spoil volume of 340.08 m^3 per monitoring well. **Operation and maintenance phase** • PoA Terminal to Douglas OP: The repair/ replacement and/or reburial of damaged or exposed cable sections/ whole cable will may be required over the proposed development lifetime, to occur as required from inspection. • Inter-OP cables: The repair/ replacement and/or reburial of damaged or exposed cable sections/ whole cable will may be required over the proposed development lifetime, to occur as required from inspection. **Decommissioning phase** • All injection facilities, cabling and cable protection in the form of cable crossings, associated with the Proposed Development are to be removed at the end of the operation and maintenance phase.	

Potential Impact	Phase[a]			Maximum Design Scenario	Justification
	C	O	D		
Changes to seabed morphology due to sand wave clearance and cable protection measures	✓	✓	✓	**Construction phase** Seabed preparation Sand wave clearance: • South of Douglas OP: sand wave clearance to occur through the use of max flow excavator. Channel cleared through a length of 115 m of sand waves, with a width of 10 m and height of 3 m. Total spoil volume of 3,450 m^3. Sand wave clearance activities undertaken over an approximate duration of 3 days. Dredging: • West Hoyle Bank: Dredged channel to be excavated with a length of 1 km, width of 21 m and height of 7 m, through the use of backhoe dredger. Total spoil volume of 147,000 m^3. Dredging activities to be undertaken over approximate duration of 2 weeks. **Operation and maintenance phase** Cable protection: • PoA Terminal to Douglas OP: Cable protection in the form of third party cable crossings, to be utilised in up to 10 locations along the cable route, with a height of up to 0.8 m and width of up to 7 m. Cable crossings to be located between 5.8 m and 30.8 m water depth to CD Inter-OP cables: • Douglas to Lennox: Cable protection in the form of third party cable crossings, to be utilised in up to 6 locations along the cable route, with a height of up to 0.8 m and width of up to 7 m. Cable crossings to be located between 25 m and 30 m water depth to CD.	**Construction phase** There is potential for seabed preparation activities relating to sand wave clearance activities and the dredged channel through West Hoyle Bank to impact upon seabed morphology during the construction phase. During the construction phase there will be gradual changes as infrastructure is introduced into the environment. With changes and therefore potential impacts ranging from the baseline environment (no presence of infrastructure) to the operation and maintenance phase (MDS) assessed in the following section below. **Operation and maintenance phase** There is potential for the cable protection installed at cable crossings during the construction phase to impact upon seabed morphology during the operation and maintenance phase, along all cable routes. **Decommissioning phase** The decommissioning phase will involve removal of all infrastructure from the seabed in line with the Government's aim to achieve a clear seabed.

Potential Impact	Phase[a] C	O	D	Maximum Design Scenario	Justification
				• Douglas to Hamilton North: Cable protection in the form of third party cable crossings, to be utilised in up to 8 locations along the cable route, with a height of up to 0.8 m and width of up to 7 m. Cable crossings to be located between 25 m and 30 m water depth to CD. • Douglas to Hamilton: Cable protection in the form of third party cable crossings, to be utilised in up to 8 locations along the cable route, with a height of up to 0.8 m and width of up to 7 m. Cable crossings to be located within 25 m and 30 m depth to CD.	
Activities affecting surrounding water quality	✓	✓	✓	**Construction Phase** Increased SSCs, release of sediment bound contaminants and bacteria The MDS is as described for increased suspended sediment concentrations SSCs and sediment deposition, as resuspension of sediments is the most likely to influence water quality through potential release of sediment bound contaminants and bacteria. Construction vessels causing accidental spills and pollution There will be a total of 236 round trips of vessels associated with the construction phase. This includes a total of 219 round trips of vessels associated with installation of the new Douglas platform and wells (return trips are presented as total across construction period). The remaining 17 round trips of vessels will be associated with installation of the cables. **Operation and Maintenance Phase**	**Construction (also applies to decommissioning phase)** • Construction activities conducted near the shoreline (e.g., trenching for the cable route) could impact water quality in proximity to the coastline through increased SSC. • Construction activities could cause toxicity effects through mobilisation of contaminated sediments through sediment disturbance during cable installation which would potentially affect the surrounding water quality through the local tidal regime and wave climate. • Construction vehicles and vessels have the potential to cause accidental spills and pollution within the development area and the surrounding footprint. • Bacterial release from sediments due to the proximity of designated bathing and shellfish waters. **Operation and maintenance phase** • Operation and maintenance activities could cause toxicity effects through mobilisation of contaminated sediments through sediment disturbance during cable repair activities during operation which could potentially affect the

Potential Impact	Phase[a]			Maximum Design Scenario	Justification
	C	O	D		
				Increased SSCs, release of sediment bound contaminants and bacteria The MDS is as described for increased SSCs and sediment deposition as resuspension of sediments is the most likely to influence water quality through release of sediment bound contaminants and bacteria. Construction vessels causing accidental spills and pollution There will be a total of 750 vessel round trips over the entire operation and maintenance phase. This encompasses vessels used during routine inspections, geophysical surveys, removal of marine growth, replacement of corrosion protection anodes, replacement of access ladders and boat landings, modification to/replacement of J tubes at platforms, topsides, inter-platform cables/pipelines and PoA terminal to the new Douglas platform cables/pipelines. Changes to water quality due to cable protection measures The MDS is as described for changes to seabed morphology due to sand wave clearance and cable protection measures, during the operation and maintenance phase. **Decommissioning Phase** Increased SSCs, release of sediment bound contaminants and bacteria. The MDS is as described for increased suspended sediment concentrations SSCs and sediment deposition, as resuspension of sediments is the most likely to influence water quality through potential release of sediment bound contaminants and bacteria. Construction vessels causing accidental spills and pollution	surrounding water quality. However, no cable repairs are anticipated, as the cable will be buried, and installed as a single, unjointed length offshore. General inspection works will be carried out, including using high resolution Multibeam Echosounder, and Side Scan Sonar, and drop-down camera of the entire cable length cable in one event every two years. • There is potential for the cable protection installed at cable crossings during the construction phase to impact upon seabed morphology and associated water quality during the operation and maintenance phase, along all cable routes. However, it is anticipated that the external cable protection at existing cable crossings is unlikely to require maintenance, as the rock and concrete mattresses are expected to remain in place. Maintenance or repairs are only anticipated should the cable protection be impacted by either fishing activity, or anchor snagging. Any movement of the rock and mattresses from these external interventions would be identified through the annual asset integrity surveys, and the necessary repairs carried out accordingly. These repairs would be carried out within the maximum design envelope described for the cable crossings external protection in Table 3.4. **Decommissioning phase** • Removal of infrastructure in the decommissioning phase could cause toxicity effects through mobilisation of contaminated sediments. In a worst-case scenario, the effects are likely to be similar to those exhibited during the construction phase. • Fewer vessels and vessel trips are predicted during the decommissioning phase when compared to the

Potential Impact	Phase[a]			Maximum Design Scenario	Justification
	C	O	D		
				There will be a total of 128 round trips of vessels associated with the decommissioning phase, with a maximum of 17 vessels on site at any one time.	construction and operation and maintenance phases. Effects are considered to be less than or similar to those during the construction phase.

[a] C=construction, O=operation and maintenance, D=decommissioning

6.8.2 Impacts scoped out of the assessment

On the basis of the baseline environment and the proposed development description outlined in volume 1, chapter 3, three impacts are proposed to be scoped out of the assessment for physical processes. This was either agreed with key stakeholders through consultation as discussed in volume 1, chapter 5, or otherwise, the impact was proposed to be scoped out in the HyNet Carbon Dioxide transportation and Storage Project – Offshore Scoping Report (RPS, 2022a) and no concerns were raised by key consultees. These impacts are outlined, together with a justification for scoping it out, in Table 6.10.

Table 6.10: Impacts Scoped Out of the Assessment for Physical Processes (Tick Confirms the impact is Scoped Out)

Potential Impact	Phase[a]			Justification
	C	O	D	
Presence of infrastructure may lead to changes in the local tidal regime, wave climate, and sediment transport	✓	✓	✓	• The proposed platform at Douglas consists of four legs *c.*2 m in diameter at a spacing of 17 m. Given the diminutive nature of this structure compared to neighbouring wind turbine structures for which published information is available, the impacts on physical processes would be negligible. • The presence of infrastructure potentially leading to changes in the local tidal regime, wave climate, and sediment transport can therefore be scoped out of the assessment based on these preliminary design parameters and scale of infrastructure proposed. No permanent infrastructure is placed on the seafloor within the intertidal zone. The new electrical cables will be buried to a target depth of 2-3m. • The decision to scope the potential impact pathway out can be supported by the fact that the resultant impact on physical processes such as the sediment transport regime has been included in the assessment of changes to seabed morphology due to sand wave clearance and cable protection measures.
Changes to seabed morphology and water quality due to the utilisation of jack-up vessels	✓	✓	✓	• The utilisation of jack-up vessels during the construction and decommissioning phases within the Project area will only be temporary and any potential disturbances on the subsea surface, potentially increasing SSCs and/or causing toxicity effects through the mobilisation of contaminated sediments would likely infill over time and be brief. Therefore, it is not expected that jack-up vessels would have any implications on the surrounding seabed morphology or water quality and this impact is to be scoped out of the physical processes assessment.

[a] C=construction, O=operation and maintenance, D=decommissioning

6.9 Methodology for assessment of effects

The physical processes impact assessment has followed the methodology set out in volume 1, chapter 5. Specific to the physical processes impact assessment, the following guidance documents have also been considered.

- Guidelines in the use of metocean data through the lifecycle of a marine renewable's development (Cooper *et al.*, 2008).
- Physical processes guidance to inform EIA baseline survey, monitoring and numerical modelling requirements for major development projects with respect to marine, coastal and estuarine environments (Natural Resources Wales, Marine Programming and Delivery Group, 2020).
- Guidance on Best Practice for Marine and Coastal Physical Processes Baseline Survey and Monitoring Requirements to inform EIA or Major Development Projects (Brooks *et al.,* 2018).

- Guidance on EIS and NIS Preparation for Offshore Renewable Energy Projects, Department of Communications, Climate Action and Environment (Barnes, 2017).
- Guidance on Marine Baseline Ecological Assessments and Monitoring Activities for Offshore Renewable Energy Projects Parts 1 and 2, Department of the Environment, Climate and Communications (Department of the Environment, 2018).
- Collaborative Offshore Wind Energy Research into the Environment – Coastal Process Modelling for Offshore Wind Farm Environmental Impact Assessment (Lambkin *et al.,* 2009).
- Advice to Inform Development of Guidance on Marine, Coastal and Estuarine Physical Processes Numerical Modelling Assessments (Pye *et al.,* 2017).
- Guidance on Best Practice for Marine and Coastal Physical Processes Baseline Survey and Monitoring Requirements to inform EIA of Major Development Projects (NRW, 2018)

Physical processes are not generally receptors in themselves; they may be a pathway by which coastal features may be impacted or form a pathway for indirect impacts on other receptors (NRW, 2018). In this context the term 'coastal features' is used to describe any morphological feature within the physical processes study area. By determining any changes in sediment transport to understand the impact upon coastal features, by default, requires the modelling of other physical processes such as tidal current and wave climate. For example, increases in suspended sediments during the construction phase may lead to the deposit of these sediments and smothering of benthic habitats. For this impact, the magnitude of the potential changes has been assessed, with the sensitivity of the receptors to these changes and the significance of effects assessed within volume 2, chapter 7.

The criteria for determining the significance of effects is a two-stage process that involves defining the magnitude of the impacts and the sensitivity of the receptors. This section describes the criteria applied in this chapter to assign values to the magnitude of potential impacts and the sensitivity of the receptors. The terms used to define magnitude and sensitivity are based on those which are described in further detail in volume 1, chapter 5.

The criteria for defining the magnitude of impact for physical processes are outlined in Table 6.11 below.

Table 6.11: Definition of Terms Relating to the Magnitude of an Impact

Magnitude of impact	Definition
High	Change in physical processes which results in the loss of a coastal feature (e.g. reduction in tidal flows altering sediment loads to coastal sand banks (Adverse)).
	Change in physical processes which results in the creation of a coastal feature (e.g. increase in tidal flows altering sediment loads to coastal sand banks (Beneficial)).
Medium	Alteration of physical processes which effects the rate at which a coastal feature is maintained (e.g. reduction in bed load transport within the sediment transport regime, which is detrimental to the development of sand waves (Adverse)).
	Alteration of physical processes which effects the rate at which a coastal feature is developing (e.g. increase in bed load transport within the sediment transport regime, which supports the development of sand waves (Beneficial)).
Low	Variation in physical processes which maintains the coastal feature (e.g. localised change in sediment pathway which does not destabilise bank).
Negligible	Imperceptible variation in physical process (e.g. in the order of natural variability).
No change	No loss or alteration of characteristics, features or elements; no observable impact either adverse or beneficial.

The criteria for defining sensitivity of the receptor are outlined in Table 6.12 below.

Table 6.12: Definition of Terms Relating to the Sensitivity of the Receptor

Sensitivity	Definition
Very High	Coastal feature or physical process forms vital part of a wider scale system which is scarce and non-recoverable.
High	Coastal feature or physical process forms part of a wider scale system and is non-recoverable.
Medium	Coastal feature or physical process has limited potential for re-creation.
Low	Coastal features or physical processes of local scale and recoverable.
Negligible	Coastal feature or physical process adaptable to changes in physical processes.

The significance of an effect on physical processes is determined by correlating the magnitude of the impact and the sensitivity of the receptor. The particular method employed for this assessment is presented in Table 6.13. Where a range of significance of effect is presented in Table 6.13, the final assessment for each effect is based upon expert judgement.

For the purposes of this assessment, any effects with a significance level of **minor** or less have been concluded to be not significant in terms of the 'EIA Regulations'.

Table 6.13: Matrix Used for the Assessment of the Significance of the Effect

Sensitivity of receptor	Magnitude of Impact				
	No Change	Negligible	Low	Medium	High
Negligible	No change	Negligible	Negligible or Minor	Negligible or Minor	Minor
Low	No change	Negligible or Minor	Negligible or Minor	Minor	Minor or Moderate
Medium	No change	Negligible or Minor	Minor	Moderate	Moderate or Major
High	No change	Minor	Minor or Moderate	Moderate or Major	Major
Very High	No change	Minor	Moderate or Major	Major	Major

6.10 Embedded mitigation

As part of the project design process, a number of mitigation measures have been proposed to reduce the potential for impacts on Physical Processes (see Table 6.14). As there is a commitment to implementing these measures, they are considered inherently part of the design of the proposed development and have therefore been considered in the assessment presented in section 0 below (i.e. the determination of magnitude and therefore significance assumes implementation of these measures). These measures are considered standard industry practice for this type of development.

Table 6.14: Mitigation Measures Adopted as Part of the Proposed Development

Mitigation Measures Adopted as Part of the Proposed Development	Justification
Development and adherence to a Cable Specification and Installation Plan which will include cable burial where possible and cable protection. To minimise potential impact from the cables and removal of cables a commitment to bury cables where possible has been made in accordance with the specific policies set out in the North West Inshore and North West Offshore Coast Marine Plans (MMO, 2021).	The CSIP will set out appropriate cable burial depth in accordance with industry good practice, minimising the risk of cable exposure. The CSIP will also ensure that cable crossings are appropriately designed to mitigate environmental effects, these crossings will be agreed with relevant parties in advance of CSIP submission. The CSIP will include a detailed Cable Burial Risk Assessment (CBRA) to enable informed judgements regarding burial depth to maximise the chance of cables remaining buried whilst limiting the amount of sediment disturbance to that which is necessary. There is a potential for cable exposure to occur due to interactions between Metocean regime (wave, sand and currents). The sediment transport can lead to exposure of cables and infrastructure, the use of a cable burial depth alongside the cable installation strategy should provide sufficient depth to avoid exposure
Scour protection limited to use as third-party cable crossings and monitored in line with Cable Specification and Installation Plan.	To reduce the potential for scouring of seabed sediments to occur. Limited in use in order to reduce interactions between the metocean regime (wave, sand and currents) and seabed structures.
No external cable protection in the intertidal area	To minimise potential impacts on intertidal habitats within the Dee Estuary SAC and SPA.
Cable protection to have a profiled cross section and height mitigated to < 1 m.	To minimise changes to seabed morphology and physical processes such as tidal current, wave regime and sediment transport pathways, particularly if located in shallow water.
Material arising from drilling and/or sand waves and wave clearance will be deposited in close proximity to the works	To retain material within sediment cell, reduce changes to seabed morphology and maintain sediment transport regimes.
The Horizontal Directional Drilling (HDD) exit pit will be 3 m below beach level (just above the MHWS line).	HDD exit pit will be located above MHWS at approximately 3m below current beach level, and due to this depth, will not require any external protection.
Development of and adherence to an Environmental Management Plan (EMP) that will be prepared and implemented during the construction, operational and maintenance and decommissioning phases of the proposed development. The EMP will include appendices detailing actions to minimise INNS (the INNSMP), and a MPCP will be developed which will include planning for accidental spills, address all potential contaminant releases and include key emergency contact details	Measures will be adopted to ensure that the potential for release of pollutants from construction, operational and maintenance and decommissioning plant is minimised. These will likely include: designated areas for refuelling where spillages can be easily contained, storage of chemicals in secure designated areas in line with appropriate regulations and guidelines, double skinning of pipes and takes containing hazardous substances, and storage of these substances in impenetrable bunds. All vessels will be required to comply with the standards set out in the International Convention for the Prevention of Pollution from Ships (MARPOL).
Suitable implementation and monitoring of cable protection	Minimises the risk of underwater allision with cable protection, anchor or fishing gear interaction with subsea cables and interference with magnetic position fixing equipment, as well as monitoring any secondary scour which may occur over time.

6.11 Assessment of significance

The ES considered the potential impacts of the construction, operation and maintenance, and decommissioning phases of the Proposed Development within the physical processes study area and followed the methodology outlined in volume 1, chapter 5. The numerical modelling used to inform the following assessment is found in Physical Processes Technical Report (RPS Group, 2024a) .

A description of the potential effect on physical processes receptors caused by each identified impact is given below.

6.11.1 Increased suspended sediment concentrations and sediment deposition

There is potential for increased SSC and deposition associated with various forms of seabed preparation activities (jetting, ploughing, mechanical cutting, drilling) and cable installation activities. The following scenarios were modelled to provide quantitative information for assessment of all activities:

- Site preparation activities – sand wave clearance to facilitate cable installation.
- Drill cuttings – associated release of two monitoring well drilling events.
- PoA Terminal to Douglas OP Cable – associated release of one cable representing maximum installation scenario.
- Inter-OP Cables – largest Inter-OP cable installation event modelled (i.e., Douglas to Lennox).

6.11.1.1 Construction phase

Magnitude of impact

The preparation of the seabed involves sand wave clearance activities within the area of project physical work which may lead to suspended sediment concentrations and associated deposition. The maximum design scenario for seabed preparation consists of the sand wave clearance of a length of 115 m, with a width of 10 m to an average depth of 3 m, South of Douglas OP. The potential PoA to Douglas cable route may avoid dredging through West Hoyle Bank, instead utilising an existing channel in the bank, however due to the active nature of the bedform this may not be possible. Therefore, the worst case scenario has been assessed which includes a cable route that may require dredging through the Bank, over a length of 1 km, with a width of 21 m and to an average depth of 7 m.

The sand wave clearance South of Douglas OP is anticipated to generate a plume with an average suspended sediment level of 100 mg/l. These levels would be localised and only persist for a short period. Concentrations within the plume envelope are much lower, typically <5 mg/l a short distance from the discharge location. The fine sediment is more widely dispersed, however even peak deposition values that extend beyond the area of project physical work do so at <1 mm. The coarser material settles at the release point itself with average values of <30 mm (*c*.14 mm peak). Some of the finer material associated with the excavation process is re-suspended during successive tides, so that sediment may still be suspended a day after cessation of excavation activities.

A much larger plume is generated by seabed preparation activities at West Hoyle Bank, with average suspended sediments extending close to the mouth of the River Dee, however they do so at concentrations negligible compared to background levels, i.e., <3 mg/l. SSC are greatest along the dredge path and West Hoyle Bank itself, which can be particularly shallow and in some areas dry during low water, under these conditions the average concentrations may be up to 3,000 mg/l. Elsewhere more generally across the area of project physical work SSC values are typically less than 10 mg/l. Deposition is restricted to the physical process study area, with the greatest sedimentation values *c*.3 m occurring adjacent to the dredged channel, this would then form backfill material. Sedimentation one day after the cessation of dredging activity further demonstrates that deposited material is focussed in close proximity to the dredge path, beyond which deposition is generally below <100 mm.

Two drilling events were modelled to simulate releases incurred from the drilling of two new monitoring wells at Hamilton Main and Hamilton North. Both wells are to be drilled with the same parameters with a 26” section drilled over a vertical distance of 118.90 m, and below that a 17” section drilled over a vertical distance of 518.16 m. The materials generated by the 26” section are released at the seafloor and those generated by the 17” section at the sea surface in accordance with the proposed drilling techniques to be implemented. A 100% washout of both monitoring well holes is assumed, this release accounts for the release of fine drilling muds which will create the largest spatial plume i.e. travel furthest. This means well drilling events were modelled with twice the volume of the hole size (with 50% being the drilled sediment and 50% being the drilling mud/fluid).

For both drilling operations maximum SSC and sedimentation values occurred in the direct vicinity of the drill sites. At Hamilton Main peak SSC values experienced at the drill site are limited to *c.*360 mg/l, however peak values are limited in time and extent, average values are typically <30 mg/l. The plume itself extends c.8 km to the east and west. Average deposition across the area can be up to *c*.30 mm at the drill site but is generally less than a tenth of a millimetre across the tidal ellipse. One day after the cessation of drilling, deposition values around the drill site can be in excess of 50 mm however a vast majority of deposition due to released sediment is under 0.03 mm. This is explained by the coarser material remaining at the drill site whilst the finer mud particles are dispersed on successive tides. A similarly sized plume of suspended sediments is produced at Hamilton North, with slightly more northward/southward dispersion. Mean concentrations around the drill site are <30 mg/l and further from the source <0.30 mg/l. Mean sedimentation in direct vicinity to the drill site can reach as high as *c*.60 mm but across the plume is generally <0.10 mm. One day after the cessation of drilling, deposition can be 100 mm in the direct vicinity of the drill site however again quickly decreases to negligible levels with distance from the discharge point.

For the installation of both the PoA Terminal to Douglas OP (33.99 km) and the Douglas to Lennox Inter-OP cable (32.34 km) a trench of up to 3 m in width and 3 m in depth with a triangular cross section may be excavated. The plumes produced by other Inter-OP cables can be assessed using the results of modelling completed for the Douglas to Lennox cable. The Douglas to Hamilton Main Inter-OP cable shares a largely similar cable route as the Douglas to Lennox cable, with a much reduced cable length. The Douglas to Hamilton North cable also features a reduced cable length and reduced residual current speeds, therefore both can be expected to demonstrate similar if not reduced SSC plumes and associated deposition.

The largest plumes are generated by cable installation activities given the magnitude of sediment disturbed and length of works. For the PoA Terminal to Douglas cable, during peak concentrations over the course of trenching, the plume may extend up to 15 km to the west leaving the physical processes study area by *c*.1 km however even at peak values do so at background levels (<1 mg/l). Average SSC values are greatest around the cable route, particular over the shallow waters of West Hoyle Bank, these values may reach 1,000 mg/l in the shallowest water but are quickly reduced to background levels a short distance from the cable path. Average sedimentation is greatest at the location of the trenching and may be up to *c*.160 mm in depth where the coarser material has settled within close proximity to the cable path. An analysis of sedimentation at slack water one day after the cessation of trenching, shows that some of the previously sedimented material has been re-suspended, only to settle again at slack water.

A larger plume again is seen from the trenching of the Douglas to Lennox, which is anticipated to leave the physical processes study area on the western extent, however, again does so at background levels. Average concentrations are <1,000 mg/l and are greatest in the direct vicinity of the cable path, and <10 mg/l at the extent of the physical processes study area. Average sedimentation is limited to <100 mm with peak values of *c*.70 mm, however outside the area of project physical work deposition is limited to negligible levels of <3 mm. Sedimentation one day after the cessation of trenching shows that fine sands and resuspended sediment settle during slack water.

The Douglas to Hamilton Main Inter-OP cable plume can be largely characterised by the Douglas to Lennox cable results, due to a highly similar route that diverges only slightly to reach the Hamilton Main OP. Similar average SSC values can be expected, with the greatest again occurring along the cable route itself. Likewise similar sedimentation values will be very similar and limited to <100 mm.

The Douglas to Hamilton North Inter-OP cable plume will differ slightly spatially, extending further to the north and reaching the extents of the physical processes study area, in some cases potentially leaving the boundary by small distances. Similar average SSC values can be expected, with the greatest again occurring along the cable route itself. Again, similar sedimentation values will be very similar to those experienced for the modelled cable routes.

The impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the West Hoyle Bank, and Dee Estuary Special Area of Conservation (SAC), Special Protection Area (SPA) and Site of Special Scientific Interest (SSSI) receptor directly whilst affecting the remaining receptors indirectly. The magnitude is therefore considered to be low for the West Hoyle Bank feature and the Dee Estuary designations, and of negligible magnitude to other receptor groups.

Sensitivity of receptor

The Dee Estuary SAC, SPA, and SSSI overlap with the proposed cable route and experiences suspended sediments and deposition as a result of seabed preparation and cable installation activities. The Dee Estuary is considered to be of high ecological value given its numerous international and national designations. The site is designated for its mudflats and sandflats not fully covered by seawater at low tide, saltmarsh habitat, estuaries, and embryonic, shifting, and fixed dunes. These habitats support a wide range of both nationally and internationally important wintering species as well as breeding populations if common tern *Sterna hirundo* and little tern *Sternula albifrons*, the site regularly supports at least 20,000 waterfowl *Anseriformes sp*. The sedimentation identified is localised and composed of native material therefore the structure and function of the designated features are of low vulnerability and recoverable. The sensitivity of the receptor is therefore considered to be low**.**

West Hoyle Bank is not a designated site but supports sandbanks which are an Annex 1 habitat of the EC Habitats Directive. West Hoyle Bank is an area of shallow water creating rougher areas of wave stress, shifting sand creating sandbanks. The sedimentation identified is localised and composed of native material, furthermore as an active sandbank the site is characterised by sediment redistribution and therefore the structure and function of the features are of low vulnerability and recoverable. The sensitivity of the receptor is therefore considered to be low**.**

The Ribble and Alt Estuaries SPA and Ribble Estuary SSSI is designated for its extensive areas of sandflats and mudflats, as well as large areas of saltmarsh. Ribble and Alt Estuaries is considered to be of high ecological value given these designations. These habitats support breeding populations of ruff *Philomachus pugnax*, common tern, and lesser black-backed gull *Larus fuscus graellsii* as well as a large number of winter bird, waterbird, and seabird assemblages. SSC is not a pathway to affect the designations and given the adaptability to low levels of sedimentation is considered to be of low vulnerability. The sensitivity of the receptor is considered to be negligible.

The Sefton Coast SSSI overlaps with the Ribble and Alt Estuaries SPA and Ribble Estuary SSSI, sharing the areas of sandflats and mudflats, as well as embryonic shifting dunes. As an SSSI the Sefton Coast is nationally designated and can be considered of high value. It is for these dunes and multiple sand bars occurring on the foreshore that the Sefton Coast is of special interest for coastal geomorphology. The site, as an active seabed feature, is characterised by sediment redistribution and therefore the structure and function of the features are of low vulnerability and recoverable. The sensitivity of the receptor is considered to be negligible.

Mersey Narrows and North Wirral Foreshore SPA and North Wirral Foreshore SSSI are overlapping sites designated for its extensive intertidal flats which support large numbers of feeding waders. Mersey Narrows and North Wirral Foreshore SPA and North Wirral Foreshore SSSI are considered to be of high ecological value given its international and national designations. The site supports breeding common tern and an internationally important waterbird assemblage. The sites, as active seabed features, are characterised by sediment redistribution and therefore the structure and function of the features are of low vulnerability and recoverable. The sensitivity of the receptor is considered to be negligible.

The Flyde Marine Conservation Zone (MCZ) is designated due to its extensive areas of subtidal sediment habitats (sands and muds) which host plant and animal communities. MCZs are nationally designated sites and as such are of high value. Communities of flat fish, rays, crustaceans and bivalve species, are supported, and act as a food source for bird species such as the red throated diver *Gavia stellata*. The site, as an active seabed feature, is characterised by sediment redistribution and therefore the structure and function of the features are of low vulnerability and recoverable. The sensitivity of the receptor is considered to be negligible.

Significance of the effect

During the sand wave clearance across West Hoyle Bank, large plumes are produced, and likewise significant sedimentation is experienced, however it should be noted that the bank is an active bed feature which regularly undergoes change due to sediment redistribution. The vast majority of sediment that is mobilised at West Hoyle Bank is deposited adjacent to the seabed preparation and cable trenching pathway, and thus will be native material. Suspended sediment concentration increases are greatest along West Hoyle Bank itself with significant values up to *c*.1,400 mg/l directly adjacent to the dredge path. Average deposition along the immediate dredge path across the bank is up to *c*.3 m, however deposition across the physical processes study area more widely is negligible. Sediment plumes associated with the PoA Terminal to Douglas OP cable installation will also result in increased SSC over West Hoyle Bank. Concentrations are increased significantly however are highly localised along the cable path (mean SSC <1,000 mg/l, peak of *c*.750 mg/l), due to shallow waters, and are expected to be of a short duration.

The magnitude of the impact is deemed to be low due to limited and temporary nature of sediment plumes, and the sensitivity of the receptors are considered to be low due to the active and recoverable nature of the West Hoyle Bank bedform. The effect will, therefore, be of **minor** adverse significance, which is **not significant** in EIA terms.

Suspended sediments from sand wave clearance over West Hoyle Bank are also projected to be carried into the Dee Estuary SAC/SPA/SSSI, where they are deposited as far as 8 km into the designated sites but at negligible depths. The SSC rapidly decrease with distance from the sandbank, and within the Dee Estuary drop below 3 mg/l falling within background levels, likewise sedimentation values in the estuary are <3 mm.

Sediment plumes associated with the PoA Terminal to Douglas OP will result in increased SSC within the Dee Estuary SAC/SPA/SSSI. Average SSC values within the Dee Estuary incurred from cable installation are greatly reduced from those along the cable route, falling in the region of background concentrations (<3 mg/l). The sites mudflats and sandflats would remain stable and continue to support hydrodynamic processes, as well as the communities which utilise these habitats.

The magnitude of the impact is deemed to be low due to limited and temporary nature, and the sensitivity of the receptors are considered to be low due to the recoverable nature of the Dee Estuary designations. The effect will, therefore, be of **minor** adverse significance, which is **not significant** in EIA terms.

Due to the lack of SSC plume overlap and sedimentation with the Ribble and Alt Estuaries SPA, Ribble Estuary SSSI, Sefton Coast SSSI, Mersey Narrows and North Wirral Foreshore SPA, North Wirral Foreshore, and Flyde MCZ, there is no pathway for effect. Therefore, the magnitude of the impact is deemed to be no change, and the sensitivity of the receptors are considered to be negligible due to the recoverable nature of the designations. The effect will, therefore, be **no change**, which is **not significant** in EIA terms.

Processes such as sand wave clearance South of Douglas OP and monitoring well drilling, are deemed not to be significant to receptors given the limited spatial nature of plumes generated and sedimentation experienced, and distance from the various designated sites. Likewise, the Douglas to Lennox/Hamilton Main/Hamilton North Inter-OP cable installation is not foreseen to impact any receptor, given significant distance between designated sites and cable path.

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor** adverse significance, which is **not significant** in EIA terms.

Secondary mitigation and residual effect

No Physical Processes mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in section 6.10) is **not significant** in EIA terms.

6.11.1.2 Operation and maintenance phase

Magnitude of impact

There is potential for increases in SSCs and deposition from activities related to cable repair and/or removal. These effects are likely to be similar to those exhibited during the cable installation activities of the construction phase of the Proposed Development.

The MDS for maintenance activities that may affect physical processes relates only to potential maintenance works for the PoA Terminal to Douglas cables and Inter-OP cables. Repairs, reburial and replacement activities for sections or entire cable lengths may be undertaken as required from inspections. The sediment plumes and sedimentation footprints would be dependent on which section of the cable is being repaired however the most onerous cable lengths have been quantified under the construction phase scenario discussed above.

The impact is predicted to be of local spatial extent, short term duration, intermittent and with high reversibility. As seen in the construction phase assessment, it is predicted that the impact may directly affect the Dee Estuary SAC, SPA, SSSI, and West Hoyle Bank if cable maintenance is required in the nearshore area, however, is not expected to affect any other receptors. The magnitude is, therefore, considered to be low for the receptors within the Dee Estuary SAC, SPA, SSSI.

Sensitivity of the receptor

The sensitivity of receptors to changes in suspended sediments concentration and sedimentation remains the same as for all proposed development phases.

The Dee Estuary site would recover from the sedimentation which may occur due to maintenance activities. The material released is native to the sediment cell and the minimal sedimentation would be localised. The sensitivity of the receptor to changes as a result of maintenance activities is therefore considered low and is impacted to a much lesser degree than the construction phase.

West Hoyle Bank is an active bedform feature characterised by sediment redistribution and would recover from the sedimentation which may occur due to maintenance activities. The material released is native to the sediment cell and the minimal sedimentation would be localised. The sensitivity of the receptor to changes as a result of maintenance activities is therefore considered low and is impacted to a much lesser degree than the construction phase.

Significance of the effect

For West Hoyle Bank the magnitude of the impact is deemed to be low due to limited and temporary nature of sedimentation, and the sensitivity of the receptors are considered to be low for the West Hoyle Bank bedform. The effect will, therefore, be of **minor** adverse significance, which is **not significant** in EIA terms.

The impact within the Dee Estuary is deemed to be low due to limited and temporary nature of sedimentation, and the sensitivity of the receptors are considered to be low due to the recoverable nature of the Dee Estuary designations. The effect will, therefore, be of **minor** adverse significance, which is **not significant** in EIA terms.

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor** adverse significance, which is **not significant** in EIA terms.

Secondary mitigation and residual effect

No Physical Processes mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in section 6.10) is **not significant** in EIA terms.

6.11.1.3 Decommissioning phase

Magnitude of impact

The MDS for decommissioning activities that may affect physical processes relates to the full removal of project infrastructure and equipment for disposal onshore. The expected magnitude of impact is therefore assumed at a worst-case equal to that of the construction phase as cables may be removed using a similar trenching process as that implemented for installation.

Therefore, the impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the West Hoyle Bank, and Dee Estuary Special Area of Conservation (SAC), Special Protection Area (SPA) and Site of Special Scientific Interest (SSSI) receptor directly whilst affecting the remaining receptors indirectly. The magnitude is therefore considered to be low for the West Hoyle Bank feature and the Dee Estuary designations, and of negligible magnitude to other receptor groups.

Sensitivity of the receptor

The sensitivity of receptors to changes in suspended sediments concentration and sedimentation remains the same as for all proposed development phases.

The Dee Estuary site would recover from the sedimentation which may occur due to maintenance activities. The material released is native to the sediment cell and the minimal sedimentation would be localised. The sensitivity of the receptor to changes as a result of maintenance activities is therefore considered low and is impacted to a much lesser degree than the construction phase.

West Hoyle Bank is an active bedform feature characterised by sediment redistribution and would recover from the sedimentation which may occur due to decommissioning activities. The material released is native to the sediment cell and the minimal sedimentation would be localised. The sensitivity of the receptor to changes as a result of decommissioning activities is therefore considered low and is impacted to a much the same degree than the construction phase.

Significance of the effect

For West Hoyle Bank the magnitude of the impact is deemed to be low due to limited and temporary nature of sedimentation, and the sensitivity of the receptors are considered to be low for the West Hoyle Bank bedform. The effect will, therefore, be of **minor** adverse significance, which is **not significant** in EIA terms.

The impact within the Dee Estuary is deemed to be low due to limited and temporary nature of sedimentation, and the sensitivity of the receptors are considered to be low due to the recoverable nature of the Dee Estuary designations. The effect will, therefore, be of **minor** adverse significance, which is **not significant** in EIA terms.

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor** adverse significance, which is **not significant** in EIA terms.

Secondary mitigation and residual effect

No Physical Processes mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in section 6.10) is **not significant** in EIA terms.

6.11.2 Changes to seabed morphology due to sand wave clearance and cable protection measures

6.11.2.1 Construction phase

There is potential for changes to seabed morphology associated with various forms of seabed preparation activities, particularly sand wave clearance and dredging activities along the cable route. During the construction phase there will be gradual changes as infrastructure, in the form of cable crossings, is introduced into the environment. With changes and therefore potential impacts ranging from the baseline environment (no presence of infrastructure) to the operation and maintenance phase (MDS) assessed in 6.11.2.2.

Magnitude of impact

In order to facilitate the laying of the POA to Douglas OP cable, the clearance of a number of sand waves south of the Douglas OP is required. This will take the form of two channels with lengths of 100 m and 15 m respectively, widths of 10 m, and depth of 3 m, created in the sand wave field through the use of a max flow excavator. The rate of reformation of sand waves is dependent on a range of factors including the size, location and alignment of any breach with respect to the sediment transport pathways and available recharge material. It has been shown that the region has active sediment transport systems with net sediment transport rates of circa 2 m^3/d/m within the physical processes study area and rates more than double this at sand wave crests. Increases in littoral currents during storm events would also significantly increase transport rates. The sand wave features themselves are also mobile, typically moving 1 to 4 m in an easterly direction each year (ABPmer, 2023b). The material which is cleared from the sand waves during seabed preparation will not be removed from the site, it will be relocated in close proximity to the sand wave such that it is readily available for recharge for the sand wave field south of Douglas OP.

The impact due to seabed preparation activities involving sand wave clearance within the sand wave field south of Douglas OP, is considered to be of local spatial extent, short term duration, intermittent and of high reversibility. The impact will directly affect the sand wave field along the cable route. Given the material removed from the sites will be deposited in the direct vicinity of the clearance operation, the magnitude of the impacts due to the seabed preparation activity is considered to be **low**.

To allow the laying of cable across West Hoyle Bank, a dredged channel will be required. Although an existing channel through West Hoyle Bank exists and offers a natural path within the area of project physical work for cable laying as can be seen in Figure 6.4, this channel is however not stationary, instead migrating east, which may make it unviable when the construction phase begins, the dredged channel is therefore considered as the worst-case scenario. As described in the Physical Processes Technical Report (RPS Group, 2024a), the dredged channel which is set to be 1 km in length, 7 m in depth, and 21 m in width, would see material removed from the bank within a 14 day period. Despite the volume of material being dredged from the bank, modelled scenarios of sediment suspension and deposition during the dredging operation, demonstrated that much of the material is deposited along the dredge path itself, supporting the fact the sediment will remain within the sediment cell and minimising loss to the feature (Section 6.11.1). Taking into account the eastward migration of the existing channel through West Hoyle Bank it is recommended as a mitigating measure that the placement of dredged material directly to the west of seabed preparation operations would aid in the recovery of morphological features such as West Hoyle Bank, and further encourage the feature to naturally infill. The temporary change to the morphology of the bank will have minimal impact on the feature’s ability to act as a natural breakwater for waves propagating towards the Dee Estuary. Given the location and orientation of the channel, cutting through the middle of the bank from its southern face to its northern face, there will be no change to the waves breaking on the west of the sand bank which is the principle direction from which larger storm events approach, as outlined in section 6.7.6.

The impact on seabed morphology due to the proposed dredged channel across West Hoyle Bank, is considered to be of local spatial extent, short term duration, intermittent and of high reversibility. The impact will directly affect West Hoyle Bank, along the cable route. Given the material removed from the bank will be deposited in the direct vicinity of the dredging works, the magnitude of the impacts due to seabed preparation activity is considered to be low.

Sensitivity of the receptor

The zone of influence of the prepared works encompasses a sand wave field to the south of the Douglas OP, along the cable path. The sand waves within Liverpool Bay have a highly mobile and dynamic nature. Sand wave features are predominately aligned perpendicular to the net sediment transport which is to the east and are characterised by gradual east ward migration (ABPmer, 2023b), as supported by a number of sediment transport studies in the region (Kenyon and Cooper, 2005; ABPmer, 2022a; ABPmer, 2022b). The direction of sandwave movement is also evident in Figure 6.3. The alteration to the coastal feature identified is localised and sediment displaced is expected to be deposited in the immediate vicinity of the sand wave features, providing material for sand wave regeneration. This deposition would be composed of the native material furthermore as active seabed features the sand waves are characterised by sediment redistribution, therefore the structure and function of the coastal feature are of low vulnerability and highly recoverable. The sensitivity of the receptor is therefore considered to be low.

West Hoyle Bank is an area of shallow water creating rougher areas of wave stress and shifting sand creating sandbanks. The site is of high value given the local importance of the bank to physical processes, acting as a natural breakwater to the Dee Estuary. A natural channel currently exists within the sand bank suitable for the laying of cable, intersecting from the north to south, however a worst-case scenario would see a channel dredged through the bank. The changes to seabed morphology are localised and composed of native material, furthermore as an active sandbank the site is characterised by sediment redistribution and therefore the structure and function of the features are of low vulnerability and recoverable. The sensitivity of the receptor is therefore considered to be low.

Significance of the effect

Due to the method of sand wave clearance, i.e., via the use of a max flow excavator, the sediment mobilised during the operation will predominantly settle in the immediate vicinity of the cleared channels, thus supplying ready sediment for the regeneration of cleared sand waves. This represents a short-term change in seabed morphology through altered bed levels, the changes to which fall within the areas range of natural variability (ABPmer, 2023b), due to the highly mobile nature of the sand waves and the eastward migration resultant from a flood dominated tide and the directionality of west to east sediment transport. The magnitude of the impact is deemed to be low due to the limited and temporary nature of the clearance operation, and the sensitivity of the receptor is considered to be low due to the active and recoverable nature of sand wave features across Liverpool Bay. The effect will, therefore, be of **minor** adverse significance, which is **not significant** in EIA terms.

During seabed preparation operations, in particular the dredging of a channel suitable for cable laying should this be undertaken through West Hoyle Bank a volume of sediment is to be mobilised, temporarily altering the morphology of the bank. However, this material is expected to remain within the sediment cell and settle in the direct vicinity of the dredged channel, as discussed in Section 6.11.1. The magnitude of the impact is deemed to be low due to the limited and temporary nature of the dredging operation, and the sensitivity of the receptor is considered to be low due to the active and recoverable nature of the West Hoyle Bank bedform. This could be further mitigated in line with the recommendation that dredged sediment be deposited to the immediate west of the dredged channel in order to facilitate natural infilling, in line with the dominant flood tide that drives sediment transport eastward. The effect will, therefore, be of **minor** adverse significance, which is **not significant** in EIA terms.

Secondary mitigation and residual effect

No Physical Processes mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in section 6.10) is **not significant** in EIA terms.

6.11.2.2 Operation and Maintenance

Cable protection will be installed during laying of the cables during the Construction phase. There is no requirement for additional cable protection to be placed during the Operation and Maintenance phase. This section discusses any long term impact associated with the placement of cable protection during construction (i.e. any impacts that arise during the operation of the Proposed Development). The placement of cable crossings with other developments can be seen in Figure 6.17, the remaining crossings outlined within the maximum design scenario presented in Table 6.9 relate to the crossings at pipelines in the vicinity of the Douglas OP.

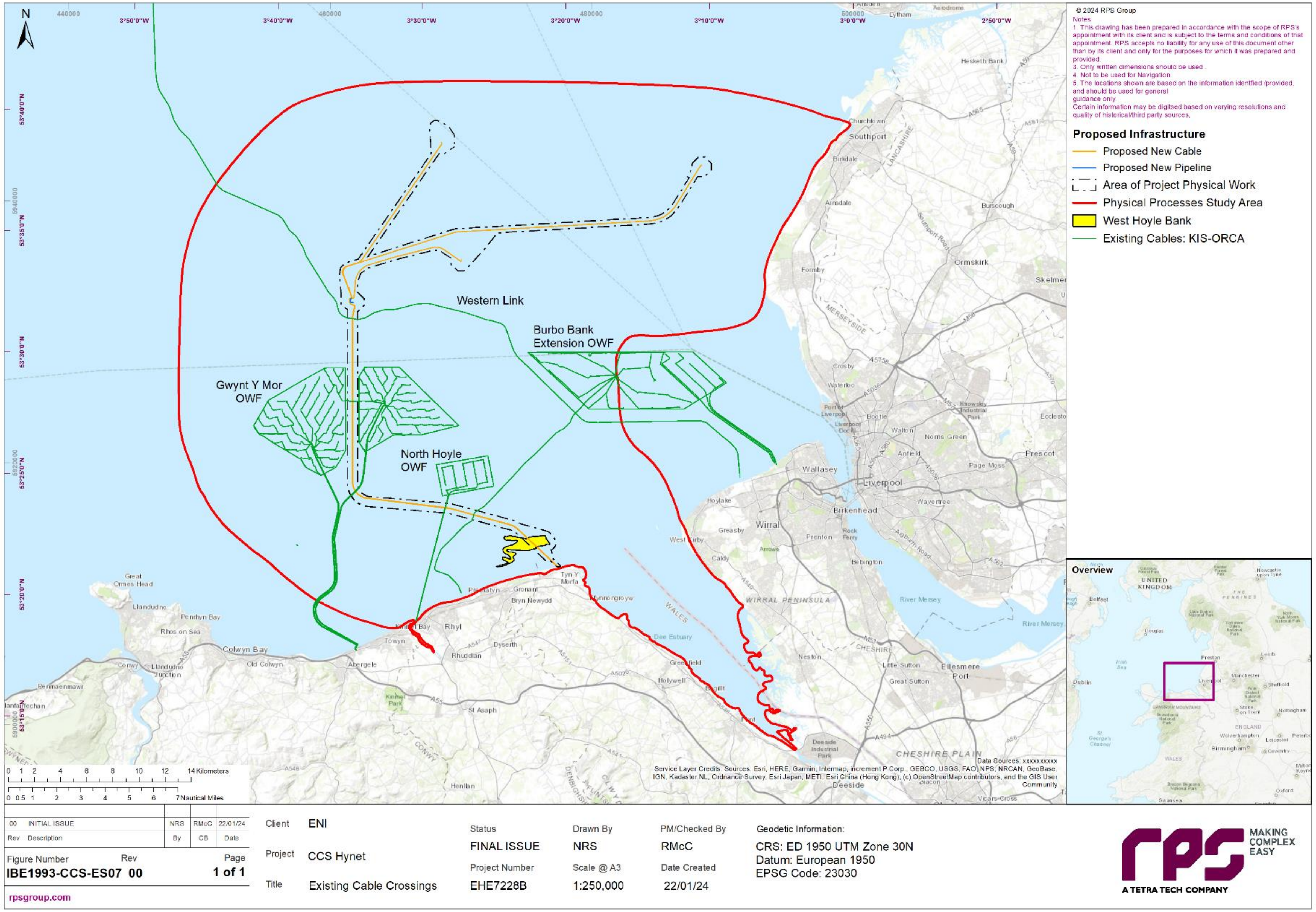

Figure 6.17: Location of Cable Crossings with respect to Other Developments in Liverpool Bay

Magnitude of impact

The only cable protection measures to be utilised by the project occur in the form of cable crossings as the nature of the seabed sediment accommodates cable burial to the required depth. In total up to 32 cable crossings may be required, 10 of which relate to the POA to Douglas OP Cable, eight for the Douglas to Hamilton Inter-OP cable, eight for the Douglas to Hamilton North Inter-OP cable, and six for the Douglas to Lennox Inter-OP cable. Depending on the heights of such cable crossings, and the depth of water they are located in, there can be potential for changes to tide, wave and sediment transport processes due to a changed seabed morphology through altered bed levels. In this case however cable crossings will be up to a maximum height of up to 0.8 m, with widths of 7 m and tapered profiles to reduce the impacts to physical processes and seabed morphology. The cable crossings will be required in a range of depths from *c*. 5.8 m to *c*. 30.3 m (CD).

This includes the POA to Douglas OP cable crossing with the Burbo Bank Offshore Wind Farm Extension Export Cable, and further offshore POA to Douglas OP cable crossing with the Western HDVC Link Transmission Cable. Where practicable the requirements will be compliant with the Maritime and Coastguard Agency (MCA) navigation guidance which includes that there will be no more than a 5% reduction in water depth (referenced to Chart Datum) at any point along the cable route (MCA, 2021), without prior written approval from the Licensing Authority in consultation with the MCA. To exemplify just how minor changes to physical processes due to the presence of cable protection and altered seabed morphology would be, potential changes to the wave climate may be considered. Although this did not form part of the modelling study to assess changes to the wave climate within the assessment for the Proposed Development, a number of such studies have been carried out within close vicinity. One such being the Mona Offshore Wind Project PEIR (RPS Group, 2023b) and its associated modelling. The outcome of which indicated that where the cable protection height was less than circa 15% of the water depth there was no change in wave climate. In compliance with the MCA navigation guidelines discussed above, the maximum height of the shallowest cable crossing would be restricted to 5% of the water depth and therefore exhibit no change in wave climate, however, given a majority of cable crossings fall in waters deeper than 25 m (CD) they will change water depths to a much lesser degree than the 5% limit. With most of the crossings falling waters of c. 25 m (CD) which equates to 28 m mid tide, the introduction of 0.8 m cable crossing represents less than a 3% change in water depth and therefore likely < 3% change to tidal currents, which is a change a quarter of the size as exhibited in the natural variation between peak spring and peak neap tidal flows.

The impact due to cable crossings is considered to be of local spatial extent, long term duration, continuous and of high reversibility. Given the small scale of cable crossings to be implemented and further mitigating measures such as tapered profiles and compliance with the MCA navigation guidance, it is not expected that impacts from cable crossings would be sufficient to disrupt offshore bank morphological processes, experience significant secondary scour or destabilise coastal features, the magnitude of impact is therefore considered to be negligible.

Sensitivity of the receptor

Locations of the cable protection for the proposed development vary in water depths and seabed morphology. For the most part these locations will fall in depth ranges wherein the bed level change due to the addition of cable crossings, will fall within the natural variability of water depths in the area, given the dynamic nature of seabed features such as sand waves and mega ripples within Liverpool Bay. The sensitivity of coastal features in these areas are of low vulnerability and recoverable. The sensitivity of the receptor is therefore considered to be low.

Significance of the effect

The magnitude of the impact is deemed to be negligible due to the imperceptible change to physical processes and the limited change to seabed morphology in the vicinity of the cable crossings associated with the Proposed Development. The sensitivity of the receptor is considered to be low due to the active and dynamic nature of the seabed in Liverpool Bay. The potential impact is further reduced through mitigation measures such as a maximum height of 0.8 m, a tapered profile, and compliance with MCA navigation guidance. The effect will, therefore, be of **minor** adverse significance, which is **not significant** in EIA terms.

Secondary mitigation and residual effect

No Physical Processes mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in section 6.10) is **not significant** in EIA terms. It should be noted that procedural monitoring will be able to identify any changes to cable protection and seabed morphology during the operation phase (Section 6.10).

6.11.2.3 Decommissioning phase

Magnitude of impact

During decommissioning all project infrastructure will be removed from the seabed in accordance with existing UK legislative aims. The nature of the impact will depend on the method used to remove cables but, as a worst cases, removal will be undertaken using similar techniques as installation. Thus, in the decommissioning phase impacts to seabed morphology will take a similar form as those experienced in the construction phase, with bedforms such as sand waves and West Hoyle Bank requiring (in a worst-case scenario) sand wave clearance before removal. Given the dynamic nature of the seabed within the physical processes study area it is possible that a greater or lesser number of sand waves will require clearance in order to remove cables, it can be considered however in line with the construction phase that the temporary clearance of these features represents a temporary change to an already dynamic seafloor, and thus can be considered to be of local spatial extent and recoverable. The magnitude of impacts associated with decommissioning activities are therefore considered to be low.

Sensitivity of the receptor

The sand waves within Liverpool Bay have a highly mobile and dynamic nature. Sand wave features are predominately aligned perpendicular to the net sediment transport, which is to the east, and are characterised by gradual eastward migration (ABPmer, 2023b), as supported by a number of sediment transport studies in the region (Kenyon and Cooper, 2005; ABPmer, 2022a; ABPmer, 2022b). The direction of sandwave movement is also evident in Figure 6.3. The alteration of coastal features from decommissioning activities much like the construction phase would be localised and sediment displaced expected to be deposited in the immediate vicinity of the sand wave features, providing material for sand wave regeneration. This deposition would be composed of the native material furthermore as active seabed features the sand waves are characterised by sediment redistribution, therefore the structure and function of the coastal feature are of low vulnerability and highly recoverable. The sensitivity of the receptor is therefore considered to be low.

A worst-case scenario would see a channel similar to that created in the construction phase, dredged through the bank. The changes to seabed morphology would again be localised and composed of native material, furthermore as an active sandbank the site is characterised by sediment redistribution and therefore the structure and function of the features are of low vulnerability and recoverable. The sensitivity of the receptor is therefore considered to be low.

Significance of the effect

Given that cable removal techniques will likely be similar to those used for installation, it can be expected that sediment suspended during decommissioning activities will follow a similar trend in deposition and settle within the direct vicinity of the works, providing ample sediment for bedform regeneration or infilling. Again, resulting impacts would represent a short-term change in seabed morphology through altered bed levels, the changes to which fall within the areas range of natural variability (ABPmer, 2023b). This is due to the highly mobile and dynamic nature of the seabed features within the physical processes study area. The magnitude of the impact is deemed to be low due to the limited and temporary nature of decommissioning activities, and the sensitivity of receptors are considered to be low due to the active and recoverable nature of seabed features across

Liverpool Bay. The effect will, therefore, be of **minor** adverse significance, which is **not significant** in EIA terms.

Secondary mitigation and residual effect

No Physical Processes mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in section 6.10) is **not significant** in EIA terms.

6.11.3 Activities affecting surrounding water quality

6.11.3.1 Construction phase

Construction activities conducted near the shoreline (e.g. trenching for the cable route) could impact water quality in proximity to the coastline through increased SSC which could then impact the local tidal regime and wave climate. Increased SSCs could cause toxicity effects through mobilisation of contaminated sediments which would potentially affect the surrounding water quality through the local tidal regime and wave climate.

Increases in SSCs could also generate sediment plumes, which may decrease the depth to which natural light could penetrate the water column. In turn, this could reduce primary production and/or increase bacterial growth, which could cause contamination to marine species, particularly shellfish.

Construction vehicles and vessels have the potential to cause accidental spills and pollution within the area of project physical work and the surrounding footprint.

Magnitude of impact

As stated in section 6.7.8, sediment contamination within the Eni Development Area was assessed during the site-specific benthic characterisation survey in 2022, and the following results were recorded:

- As and Cd exceeded Cefas AL1 at one sampling station each.
- Hg was above the OSPAR BAC levels in seven sampling stations but did not exceed Cefas ALs.
- Zn was the most abundant metal across all samples but concentrations never exceeded any reference levels. All metals occurred in concentrations comparable to existing background data or in line with the range of concentrations known for areas located in proximity of active platforms.
- Chrysene and benzo[a]pyrene were above Cefas AL1 at one sampling station. A positive correlation was observed between chrysene, benzo[a]pyrene and mud content with higher PAHs concentrations in muddier sediments. No relationship was observed between the concentration of PAHs and proximity to platforms that could have indicated dispersal of drill cuttings.
- THC levels were in line with values associated with oil and gas platforms.
- PCBs and did not exceed Cefas AL1 at any sampling stations.
- Organotins were below the limit of detection at all sampling stations.

Based on these sediment contamination results, it is not likely that significant levels of sediment bound contaminants could be released as a result of the construction activities. Furthermore, the magnitude of impact for 'Increased SSCs and Associated Deposition' was concluded to be negligible to low (section 6.11.1). This low to negligible magnitude of impact further reduces the possibility for the release of sediment bound contaminants and increased bacterial growth to have an effect on water quality.

Water quality could also be affected by accidental pollution from vessels in the construction phase. The MDS for this impact assumes a total of 236 round trips by vessels over the duration of the construction phase (Table 6.9). These include cable installation vessels, jack-ups, and support vessels. There is also potential for accidental pollution through discharges of drill cuttings, drilling mud, and cement, during the drilling of monitoring wells. However, as stated in section 6.10, embedded mitigation (e.g., an EMP) will reduce the likelihood of accidental pollution occurring. The of development and adherence to an EMP (including a MPCP) will include planning for accidental spills, address all potential contaminant releases, and include key emergency details. Measures will also be adopted to ensure that the potential for release of pollutants is reduced so far as reasonably practicable. These will likely include designated areas for refuelling where spillages can be easily contained, storage of chemicals in secure designated areas in line with appropriate regulations and guidelines, double skinning of pipes and tanks containing hazardous substances, and storage of these substances in impenetrable bunds. Finally, all vessels will be required to comply with the MARPOL regulations.

Overall, this impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the West Hoyle Bank, and Dee Estuary SAC, SPA and SSSI receptor directly whilst affecting the remaining receptors indirectly. The magnitude is therefore considered to be low for the West Hoyle Bank feature and the Dee Estuary designations, and of negligible magnitude to other receptor groups.

Sensitivity of receptor

The receptors are described above in section 6.11.1, for the impact of increased SSCs and associated deposition. The receptors include a wide range of habitats, including sandbanks, sandflats, mudflats, estuaries, saltmarsh, and embryonic, shifting and fixed dunes. In turn, these habitats support rich mosaics of biodiversity, and a range of benthic, fish and shellfish, marine mammal, and ornithological species. Many of the receptors are protected under national and international designations, such as SACs, SPAs, SSSIs, and MCZs. The species that rely on the various receptors' habitats are likely to be sensitive to this impact, given the known toxicity and potential for bioaccumulation of many of contaminants (as outlined in sections 6.7.8 and 6.7.11). Therefore, all receptors are deemed to be of high vulnerability and low recoverability, and the sensitivity is considered to be high.

Significance of the effect

Overall, for the West Hoyle Bank and Dee Estuary designations, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be high. As per Table 6.13, this yields a minor or moderate significance. The effect will, be of **minor adverse** significance due to the embedded mitigation measures adopted to minimise the effects of this impact, such as development and adherence to an EMP (including a MPCP), which sets out pollution prevention methods and the requirement for all vessels to comply with the MARPOL regulations.

For all other receptors, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

Secondary mitigation and residual effect

No Physical Processes mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in section 6.10) is **not significant** in EIA terms.

6.11.3.2 Operation and maintenance phase

Operation and maintenance activities could affect water quality through mobilisation of contaminated sediments through sediment disturbance during cable repair activities during operation which could potentially affect the surrounding water quality. In addition, vessels associated with operation and maintenance activities have the potential to cause accidental spills and pollution within the area of project physical work and the surrounding footprint. Changes to water quality due to the presence of cable protection measures may also occur, as a result of secondary scour.

Magnitude of impact

As described above for the construction phase, there Eni Development Area was surveyed for a range of potential contaminants which could be disturbed by increased SSCs and associated deposition. In the operation and maintenance phase, there is potential for increases in SSCs and deposition from activities related to cable repair and/or removal. These effects are likely to be similar to those exhibited during the cable installation activities of the construction phase. The magnitude of impact of increased SSCs and associated deposition in the operation and maintenance phase is as described in section 6.11.1 above and not repeated here.

Furthermore, the MDS for this impact assumes a total of 750 round trips by vessels over the duration of the operation and maintenance phase (Table 6.9). However, as above for the construction phase, embedded mitigation (e.g., an EMP) will reduce the likelihood of accidental pollution occurring and having an effect on water quality.

The MDS for cable protection from the PoA Terminal to Douglas OP includes cable protection at up to 10 locations for cable crossings along the route between 5.8 m and 30.8 m water depth, with a height of up to 0.8 m and a width of up to 7 m. Between Douglas OP and Lennox OP the MDS for cable protection assumes up to six locations, between Douglas OP and Hamilton North OP assumes up to eight locations, and between Douglas OP and Hamilton OP assumes up to eight locations, all with a height of up to 0.8 m and a width of up to 7 m.

Overall, for mobilisation of contaminated sediments and accidental pollution, this impact is predicted to be of local spatial extent, short term duration, intermittent throughout the operation and maintenance phase, and have high reversibility. As seen in the construction phase, it is predicted that the impact may directly affect the Dee Estuary SAC, SPA, SSSI, and West Hoyle Bank if cable maintenance is required in the nearshore area. The magnitude is, therefore, considered to be low for the receptors within the Dee Estuary SAC, SPA, SSSI and of negligible magnitude to other receptor groups.

For changes to water quality due to the presence of cable protection measures, this impact is predicted to be of local spatial extent, long term duration, permanent throughout the operation and maintenance phase, and of high reversibility. As outlined above in section 6.11.2.2, given the small scale of cable crossings to be implemented and further mitigating measures such as tapered profiles and compliance with the MCA navigation guidance, it is not expected that impacts from cable crossings would be sufficient to experience significant secondary scour, the magnitude of impact is therefore considered to be negligible.

Sensitivity of the receptor

The sensitivity of the receptors is as described above for the construction phase: all receptors are deemed to be of high vulnerability and low recoverability. Therefore, the sensitivity is considered to be high.

Significance of the effect

Overall, for the West Hoyle Bank and Dee Estuary designations, the magnitude of the impact is deemed to be negligible to low, and the sensitivity of the receptor is considered to be high. As per Table 6.13, this yields a minor or minor to moderate significance. The effect will, be of **minor adverse** significance due to the embedded mitigation measures adopted to minimise the effects of this impact, such as development and adherence to an EMP (including a MPCP), which sets out pollution prevention methods and the requirement for all vessels to comply with the MARPOL regulations.

For all other receptors, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

Secondary mitigation and residual effect

No Physical Processes mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in section 6.10) is **not significant** in EIA terms.

6.11.3.3 Decommissioning phase

Magnitude of impact

The MDS for decommissioning activities that may affect physical processes relates to the full removal of proposed development infrastructure and equipment for disposal onshore. The expected magnitude of impact is therefore assumed at a worst-case equal to that of the construction phase as cables may be removed using a similar trenching process as that implemented for installation.

Furthermore, the MDS for this impact assumes a total of 128 round trips by vessels over the duration of the decommissioning phase (Table 6.9). However, as above for the construction and operation and maintenance phases, embedded mitigation (e.g., an EMP) will reduce the likelihood of accidental pollution occurring and having an effect on water quality.

Therefore, the impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the West Hoyle Bank, and Dee Estuary SAC, SPA and SSSI receptor directly whilst affecting the remaining receptors indirectly. The magnitude is therefore considered to be low for the West Hoyle Bank feature and the Dee Estuary designations, and of negligible magnitude to other receptor groups.

Sensitivity of the receptor

The sensitivity of the receptors is as described above for the construction phase: all receptors are deemed to be of high vulnerability and low recoverability. Therefore, the sensitivity is considered to be high.

Significance of the effect

Overall, for the West Hoyle Bank and Dee Estuary designations, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be high. As per Table 6.13, this yields a minor or moderate significance. The effect will, be of **minor adverse** significance due to the embedded mitigation measures adopted to minimise the effects of this impact, such as development and adherence to an EMP (including a MPCP), which sets out pollution prevention methods and the requirement for all vessels to comply with the MARPOL regulations.

For all other receptors, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

6.12 Cumulative effect assessment methodology

The Cumulative Effect Assessment (CEA) takes into account the impact associated with the Proposed Development together with other projects and plans. The projects and plans selected as relevant to the CEA presented within this chapter are based upon the results of a screening exercise (CEA – Screening Report (RPS Group, 2024c)). Each project has been considered on a case-by-case basis for screening in or out of this chapter's assessment based upon data confidence, effect-receptor pathways and the spatial/temporal scales involved.

The physical processes CEA methodology has followed the methodology set out in volume 1, chapter 5. This involved taking a tiered approach was adopted. This provided a framework for placing relative weight upon the potential for each project/plan included in the CEA, based upon the project/plan’s current stage of maturity and certainty in the projects’ parameters. The tiered approach to the CEA is as follows:

- Tier 1:
  - under construction;
  - permitted application;

  - submitted application; and
  - those currently operational that were not operational when baseline data were collected, and/or those that are operational but have an ongoing impact.
- Tier 2:
  - the scoping report has been submitted and is in the public domain.
- Tier 3:
  - the scoping report has not been submitted and is not in the public domain;
  - identified in the relevant development plan for the Proposed Development; and
  - identified in other plans or programmes.
- Tier 4:
  - no publicly available information.

The details of specific projects, plans and activities scoped into the CEA, are outlined in Table 6.15 and presented in Figure 6.18.

Table 6.15: List of Other Projects, Plans and Activities Considered within the CEA

Project/Plan	Status	Distance from the Proposed Development (nearest point, km)	Distance from the Area of Project Physical Work (nearest point, km)	Description of Project/Plan	Dates of Construction (if applicable)	Dates of Operation (if applicable)	Overlap with the Proposed Development
Tier 1 - Dredging Act and Dredge Disposal Sites							
Burbo Bank Extension OWF Disposal Site (Ørsted 2013)	Open	0.50	12.80	The disposal of up to 6,800 metres^3 of inert material of natural origin produced during the drilling installation of monopiles or jacket foundations at disposal site reference IS135 Burbo Bank Extension OWF.	N/A	Unknown	Yes
Port of Mostyn Ltd DML1542	Unknown	4	4	Deposit of up to 188,750 m^3 material dredged under licence DML1542 for the construction of the quay.	N/A	1 May 2019 to 30 April 2025	Yes
Port of Mostyn Ltd DML2001	Unknown	4	4	Maintenance dredging of harbour.	N/A	12 October 2020 to 31 March 2026	Yes
Mostyn Breakwater Disposal Site	Open	6	6	Disposal site associated with Port of Mostyn works.	N/A	Unknown	Yes
Tier 1 - Marine Minerals							
Hilbre Swash Marine Aggregate Extraction	Operational	0	3.0	Extraction of up to 12 million tonnes of aggregate (mainly sand) over the course of 15 years at a maximum annual rate of 1.2 million tonnes and an average annual rate of 0.8 million tonnes.	N/A	1 January 2014 to 1 January 2030	Yes
Tier 1 - Offshore Renewables							
Awel y Môr Offshore Wind Farm (RWE	Consented	0	1.70	Offshore wind development application providing for a maximum of 50 turbines, associated transmission assets, and	2024 to 2029	1 January 2030 to 1 January 2055	Yes

Project/Plan	Status	Distance from the Proposed Development (nearest point, km)	Distance from the Area of Project Physical Work (nearest point, km)	Description of Project/Plan	Dates of Construction (if applicable)	Dates of Operation (if applicable)	Overlap with the Proposed Development
Renewables Ltd, 2022)				inter array, interlink and export cables. Generation in excess of 500 MW.			
Tier 1 - Construction and Decommissioning							
Burbo Bank Extension Cable Reburial	Consented/Licensed	0	12.80	Provision for emergency cable reburial where areas have become exposed.	N/A	20 July 2017 to 01 September 2027	Yes
Gwynt y Môr Offshore Wind Farm	Variation Granted	0	0.30	Removal of the Gwynt y Môr Wind Farm meteorological mast which includes topside lattice structure removal, monopile removal, scour protection removal and a seabed survey.	N/A	18 April 2019 to18 April 2029	Yes
Mostyn Energy Park Extension (MEPE)	Submitted	2.3	2.3	Extension of the Mostyn Energy Park at the Port of Mostyn. Requires construction of a 360 m quay, reclamation of 3.5 ha area, capital dredging of new berth pockets and re-dredging of approach channel. Use of dredged material for fill material for reclamation, disposal of dredged material at Mostyn Deep. Maintenance dredging of new and existing berths, approach channel and harbour area.	2023 to 2025	2025 to 2030	Yes
Mona Offshore Wind Farm Suction Bucket Trials	Consented/Licensed	5.60	9.0	The works proposed within this Marine Licence Application consist of trialling suction bucket foundations to assess the install viability within the Mona array area, which is predominantly within Welsh waters.	2023 to 2024	N/A	Yes

Project/Plan	Status	Distance from the Proposed Development (nearest point, km)	Distance from the Area of Project Physical Work (nearest point, km)	Description of Project/Plan	Dates of Construction (if applicable)	Dates of Operation (if applicable)	Overlap with the Proposed Development
Colwyn Bay CRMP	Consented/Licensed	14.30	14.30	Beach recharge of Colwyn Bay as part of the Colwyn Bay Waterfront Project – Phase 2b.	N/A	18 April 2019 to18 April 2029	Yes
Tier 1 - Cables and Pipelines							
Mares Connect	Permitted	0	0	Mares Connect is a proposed 750 MW subsea and underground electricity interconnector system linking the electricity grids in Ireland and Great Britain.	2025 to 2027	2027 onwards	Yes
Tier 2 - Offshore Renewables							
Mona Offshore Wind Project (RPS Group, 2023b)	Pre-application PEIR submitted	5.60	9.0	1.5 GW Offshore wind farm with installation of associated turbine and OSP foundations, along with inter array/ export cables.	2026 to 2029	2030 to 2065	Yes

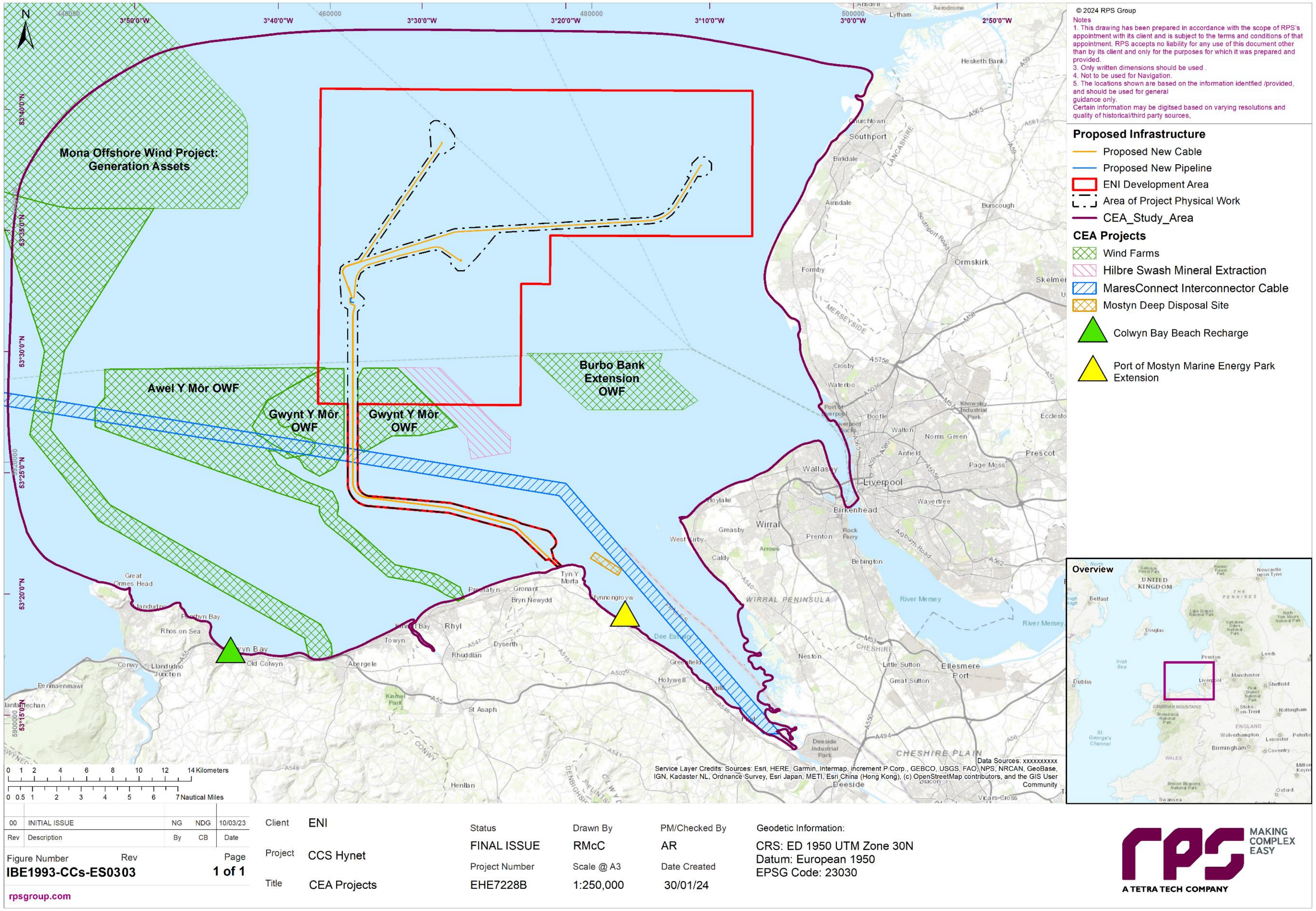

Figure 6.18: Other Projects, Plans and Activities Screened into the Cumulative Effects Assessment

6.12.1 Maximum design scenario – cumulative effects assessment

The maximum design scenarios identified in have been selected as those having the potential to result in the greatest effect on an identified receptor or receptor group. The cumulative effects presented and assessed in this section have been selected from the PDE provided in volume 1, chapter 3 as well as the information available on other projects and plans, in order to inform a ‘maximum design scenario’. Effects of greater adverse significance are not predicted to arise should any other development scenario, based on details within the PDE (e.g. different foundation type or substation layout), to that assessed here, be taken forward in the final design scheme.

Table 6.16: Maximum Design Scenario for the Assessment of Cumulative Effects

<table>
<tr><th rowspan="2">Potential Impact</th><th colspan="3">Phase[a]</th><th rowspan="2">Maximum Design Scenario</th><th rowspan="2">Justification</th></tr>
<tr><th>C</th><th>O</th><th>D</th></tr>
<tr><td>Increased suspended sediment concentrations (SSCs) and sediment deposition</td><td>✓</td><td>✓</td><td>✓</td><td>Maximum design scenario as described for the Proposed Development assessed cumulatively with the following other projects/plans:
No onshore/intertidal activities related to the Proposed Development that may cause a cumulative effect.
Tier 1
Construction phase
• construction of Awel y Môr Offshore Wind Farm;
• operation of Hilbre Swash sand extraction;
• construction and operation of the Mostyn Energy Park Extension (MEPE) and associated maintenance dredging activities and disposal;
• operation of Burbo Bank Extension OWF disposal site;
• reburial of Burbo Bank Extension OWF cabling;
• removal of Gwynt y Môr Offshore Wind Farm meteorological mast including lattice, foundations and scour protection;
• Colwyn Bay beach recharge;
• construction of the MaresConnect UK to Ireland Interconnector Cable; and
• Construction and operation of suction bucket trials for the Mona Offshore Wind Farm.
Operation and maintenance phase
• construction and operation of Awel y Môr Offshore Wind Farm;
• operation of Hilbre Swash sand extraction; and
• removal of Gwynt y Môr Offshore Wind Farm meteorological mast including lattice, foundations and scour protection.
Decommissioning phase
• no tier 2 projects overlap with the Proposed Developments decommissioning phase.</td><td>Outcome of the CEA will be greatest when the greatest number of other schemes are considered in combination. Including schemes and developments within the CEA study area to capture the potential overlap of impacts during the construction, operations and maintenance and decommissioning phases. Activities from schemes that potentially increase suspended sediment concentrations during the temporal overlap with the Proposed Development phases have been included as these may create a cumulative impact on physical features/ receptors.</td></tr>
</table>

Potential Impact	Phase[a] C	O	D	Maximum Design Scenario	Justification
				Tier 2 **Construction phase** • construction of the Mona Offshore Wind Project. **Operation and maintenance phase** • construction and operation of the Mona Offshore Wind Project. **Decommissioning phase** • operation of the Mona Offshore Wind Project.	
Changes to seabed morphology in the subtidal environment due to sand wave clearance and cable protection measures	✓	✓	✓	Maximum design scenario as described for the Proposed Development assessed cumulatively with the following other projects/plans: No onshore/intertidal activities related to the Proposed Development that may cause a cumulative effect. **Tier 1** **Construction phase** • construction of Awel y Môr Offshore Wind Farm; • operation of Hilbre Swash sand extraction; • construction and operation of the Mostyn Energy Park Extension (MEPE) and associated maintenance dredging activities and disposal; • operation of Burbo Bank Extension OWF disposal site; • reburial of Burbo Bank Extension OWF cabling; • Colwyn Bay beach recharge; • construction of the MaresConnect UK to Ireland Interconnector Cable; and • Construction and operation of suction bucket trials for the Mona Offshore Wind Farm **Operation and maintenance phase** • construction and operation of Awel y Môr Offshore Wind Farm; • operation of Hilbre Swash sand extraction; • operation of the Mostyn Energy Park Extension (MEPE) and associated maintenance dredging activities and disposal; • removal of Gwynt y Môr Offshore Wind Farm meteorological mast including lattice, foundations and scour protection; and • operation of the MaresConnect UK to Ireland Interconnector Cable.	Changes to seabed morphology in the subtidal environment due to sand wave clearance and cable protection measures.

Potential Impact	Phase[a] C	O	D	Maximum Design Scenario	Justification
				Decommissioning phase • no tier 1 projects overlap with the Proposed Developments decommissioning phase. **Tier 2** **Construction phase** • construction of the Mona Offshore Wind Project. **Operation and maintenance phase** • construction and operation of the Mona Offshore Wind Project. **Decommissioning phase** • operation of the Mona Offshore Wind Project.	
Activities affecting surrounding water quality	✓	✓	✓	The MDS is as above for increased SSCs and associated deposition for all phases, and consistent with the MDS for changes to seabed morphology in the subtidal environment due to sand wave clearance and cable protection measures additionally for the operation and maintenance phase.	The justification is as above for increased SSCs and associated deposition and changes to seabed morphology in the subtidal environment due to sand wave clearance and cable protection measures.

[a] C=construction, O=operation and maintenance, D=decommissioning

6.13 Cumulative effects assessment

A description of the significance of cumulative effects upon physical processes receptors arising from each identified impact is given below.

6.13.1 Increased suspended sediment concentrations and sediment deposition

6.13.1.1 Construction phase

Sensitivity of receptor

The Dee Estuary SAC, SPA, and SSSI overlap with the proposed project cable route and experiences suspended sediments and deposition as a result of seabed preparation and cable installation activities. The site is designated for its mudflats and sandflats not fully covered by seawater at low tide, saltmarsh habitat, estuaries, and embryonic, shifting, and fixed dunes. These habitats support a wide range of both nationally and internationally important wintering species as well as breeding populations if common tern and little tern, the site regularly supports at least 20,000 waterfowl. The Dee Estuary is considered to be of high ecological value given its numerous international and national designations. The sedimentation identified is localised and composed of native material therefore the structure and function of the designated features are of low vulnerability and recoverable. The sensitivity of the receptor is therefore considered to be low.

West Hoyle Bank is not a designated site but supports sandbanks which are an Annex 1 habitat of the EC Habitats Directive. West Hoyle Bank is an area of shallow water creating rougher areas of wave stress, shifting sand creating sandbanks. The site is of high value given the local importance of the bank to physical processes, acting as a natural breakwater to the Dee Estuary. The sedimentation identified is localised and composed of native material therefore the structure and function of sandbanks is of low vulnerability and recoverable as the active sandbank system is naturally exposed to significant sediment redistribution. The sedimentation identified is localised and composed of native material, furthermore as an active sandbank the site is characterised by sediment redistribution and therefore the structure and function of the features are of low vulnerability and recoverable. The sensitivity of the receptor is therefore considered to be low.

Magnitude of impact

The magnitude of the increase in suspended sediment concentrations arising from seabed preparation involving sand wave clearance, the drilling of monitoring wells, and the installation of cabling have been assessed as negligible for the Proposed Development alone, as described in section 6.11.1. With the cable corridor passing through the Dee Estuary SAC, SPA, and SSSI designations and the West Hoyle Bank Annex 1 habitat, these receptors would be directly affected. The installation of the PoA to Douglas OP cable results in increased SSC and deposition within the Dee estuary designations, with average deposition values reaching in excess of 100 mm. These values reduce greatly with distance however, decreasing to within 100 m with sedimentation levels within the immediate vicinity of the trench circa 3 m and reducing to <10 mm within 100 m. West Hoyle experiences even greater impact during the sand wave clearance preceding cable installation, here sedimentation can be as great as c.3 m along the dredging route, again values decrease with distance from the source, falling to <5 mm within 100 m.

Tier 1

The construction phase of the Proposed Development is expected to coincide with the proposed development of Awel y Môr Offshore Wind Farm. The MDS for potential changes to SSC and deposition at Awel y Môr Offshore Wind Farm provides for pre-lay cable trenching using a Mass Flow Excavator (MFE), sand wave clearance (MFE), cable installation through jetting, dredge spoil disposal at surface, and drill cuttings produced by foundation installation. Construction activities may result in increased SSC and given the close proximity of works it is likely that there will be interaction with sediment plumes from the Proposed Development. Plumes produced during drilling and sand wave clearance activities within the Awel y Môr Array Area may reach the Proposed Development's area of project physical work at up to 50 mg/l on flood tides, with greater interaction at spring tides. Likewise, plumes produced through pre-lay cable trenching within the Awel y Môr Export Cable Corridor may overlap directly with the Proposed Development's area of project physical work though do so at lower values *c*.5 mg/l and are only likely to occur if trenching activities occur simultaneously. The Awel y Môr Offshore Wind Farm, also involves the installation of an interlink cable with the Gywnt y Môr Offshore Wind Farm, with the magnitude of suspended sediments likely being of a similar magnitude to export cable installation. Thus, again it can be expected a cumulative effect that may arise would do so within the natural variability of background levels, and only occur if cable installation operations occurred simultaneously. Cumulative deposition may occur between the PoA to Douglas cable trenching and the foundation drilling with the Awel y Môr Array Area, however, interaction is expected to occur at *c*. <1 mm. There is potential for cumulative impacts between simultaneous cable installation or seabed preparation activities prior to cable installation to cause coalesced plumes within the Dee Estuary designations and/or over West Hoyle Bank. However, the magnitude of the cumulative change would be minimal with suspended sediment concentrations from Awel y Môr construction activities reaching the receptors at background values. These cumulative impacts are expected to remain of limited magnitude due to the rapid decrease in SSC and deposition with distance from the source of sediment disturbance.

The construction phase of the Proposed Development also occurs within the same time frame as a number of smaller construction/decommissioning projects, such as beach recharging at Colwyn Bay and the removal of the Gwynt y Môr met mast situated within the Gwynt y Môr Offshore Wind Farm. In the case of Colwyn Bay, suspended sediments and related deposition caused by beach recharging/nourishment are expected to be of local extent and small magnitude. No cumulative impact is expected to arise here as the extent of plumes (<0.1 mg/l) produced by the trenching of PoA to Douglas cables are located *c*.10 km from Colwyn Bay. Interaction may occur between the trenching of PoA to Douglas cables and the removal of the Gwynt y Môr met mast if activities happen simultaneously, as the Gwynt y Môr Array Areas are completely encompassed by the SSC plume generated by the Proposed Developments cable installation. Though a cumulative impact may occur, the magnitude is expected to be negligible, of local extent and short-term duration. No cumulative effect with the Proposed Development is expected to affect relevant receptors.

The construction phase of the Proposed Development is expected to coincide with the construction and operation and maintenance phases of the Mostyn Energy Park Extension (MEPE) and associated maintenance dredging activities. This development within the Dee Estuary, involves the construction of a 360 m length of new quay wall, the infilling of a 3.5 hectare area behind the new quay wall (requiring *c*.600,000 m^3 of infill material 500,000 m^3 of which will be sourced from dredging activity arisings). Alongside the new quay wall a dredged berth pocket will be required to a depth of - 11 m CD (*c*. 400,000 m^3), whilst re-dredging of the existing berth pocket along the existing quay wall to – 9 m CD will be required (*c*. 400,000 m^3). The largest dredging operation will take the form of the re-dredging of the main navigation channel to a depth of – 4 m CD (*c*. 3 million m^3). The operation and maintenance phase will again involve dredging activities of the new and existing berths, harbour, and approach channel (*c*. 499,995 m^3), and the disposal of resulting dredged material in the existing disposal sites. Both seabed preparation and cable installation activities produce SSC plumes that extend into the Dee Estuary and overlap with the location of construction activities and dredging at the Port of Mostyn MEPE, however, they do so at background levels i.e., < 3 mg/l. It can therefore be judged that although a cumulative impact may arise within the Dee Estuary receptors, the change in SSC would be of negligible significance and recoverable.

The largest overlap in SSC would occur if the disposal of dredged material within the Mostyn Deep disposal site occurred simultaneously with cable installation activities or seabed preparation across West Hoyle Bank, however even in this case overlapping plumes in the vicinity of West Hoyle Bank and within the Dee Estuary would be of limited magnitude due to the decreases in SSC and deposition observed with distance from respective works. Noting also that sediment plumes would be traversing in parallel and not towards one another as they are advected on the same tidal current. Maximum SSC values in the area of overlap can be up to 100 mg/l for both plumes however the more representative average plumes are expected to coincide with values of negligible difference to background levels, likewise sedimentation over the bank can be considered minor and the overall cumulative impact between the disposal of dredged material and the Proposed Development can be considered to be negligible, of local extent and short-term duration. The cumulative impact relating to overlap between operation and maintenance activities from the Mostyn Energy Park Extension and construction activities related to the Proposed Development are expected to be similar of a similar magnitude to the dredging/ disposal activities described above, only of a smaller scale in line with reduced dredge volumes associated with maintenance works instead of construction works and can therefore can be considered to be negligible, of local extent and short-term duration.

The Proposed Development's construction phase coincides with the operation of the Hilbre Swash aggregate extraction site situated *c*.3 km from the PoA to Douglas OP cable installation route. Given the nature of the project as an extraction operation where sediment is being removed from the cell and only mobilised as a side-effect, it is not expected that the resultant SSC plume will be substantial enough to interact with the Proposed Development at significant concentrations, however minimal cumulative deposition <1 mm may occur. No cumulative effect with the Proposed Development is expected to affect relevant receptors.

The Burbo Bank Extension Offshore Wind Farm, a project which has obtained a license for emergency cable reburial, should the need arise, is found in close proximity to the physical processes study area. Depending on the location and scale of the reburial events, there is a possibility for plume overlap with the installation of the PoA to Douglas OP cable, SSCs from construction activities were shown to travel up to 10 km during ebb spring tides. However, SSC plumes associated with the Proposed Developments cable installation would reach Burbo Bank extension at levels of <3 mg/l (this being in line with background turbidity levels). With the resulting cumulative deposition likely to fall below 1 mm. No cumulative effect with the Proposed Development is expected to affect relevant receptors.

During the construction phase of the Proposed Development the Mares Connect cable will be in construction which may result in increased suspended sediment concentrations, the cable directly intersects the PoA to Douglas OP export cable from the Proposed Development. The trenching activities for both projects may run concurrently, and interaction of SSC plumes may occur. However, the concentration of suspended sediment would reduce significantly moving further from the PoA to Douglas trenching route with interacting plumes falling below 10 mg/l within 20 m of the Proposed Developments. Additionally, the suspended sediments mobilised by the Mares Connect cable may interact with those from the Proposed Development's sand wave clearance works across West Hoyle Bank. Cumulative changes would however be expected to fall within background values of <10 mg/l and given the nature of the receptor as an active bedform would be highly recoverable.

As part of the Mona Offshore Wind Farm application, a series of suction bucket foundation trials were consented to, in order to validate the suitability of foundation and optimise design. These works occur within the Mona Array Area at up to 30 locations, using a variety of parameters to best inform final design. At each location the trial may be undertaken up to 3 times and once all activities at the site are complete the full removal of foundation would occur before moving to the next location to repeat. Although the trials of foundation installation and subsequent removal may mobilise sediment within the Mona Array Area, the small scale nature associated with the installation/removal of one foundation at a time would be expected to produce a small plume with much of the sediment suspended settling in the vicinity of the structures. This paired with the fact that the Mona Array Area is largely advected on tidal currents and situated c. 9 km North West of the Proposed Development (at its closest point), indicate that if an overlap in SSC or deposition did occur between the projects, that it would do so at background levels.

Tier 2

The construction phase of the Tier 2 development Mona Offshore Wind Project coincides with that off the Proposed Development. Interaction between suspended sediment plumes may occur should trenching activities be undertaken simultaneously however this is unlikely given the length of construction phase and range of activities. SSC plumes are expected to reach background levels before overlapping with the Proposed Development and additionally plume would not directly interact as they would run in parallel. Cumulative deposition may occur given that the plumes from the Proposed Development may travel up to 15 km west which coincides with the Mona offshore export cable sand wave clearance and cable installation plumes. Cumulative deposition would however be minimal with values <1 mm, and all sediment retained within the sediment cell. No cumulative effect with the Proposed Development is expected to affect relevant receptors.

Cumulative effect

The cumulative effect is predicted to be of local spatial extent, short-term duration, intermittent and high reversibility, with potential impacts to the Dee Estuary SAC/SPA/SSSI and West Hoyle Bank. The magnitude is, therefore, considered to be low adverse.

Significance of effect

Overall, the magnitude of the cumulative impact is low, and the sensitivity of the receptor is low. The cumulative effect will, therefore, be of **minor adverse** significance, which is **not significant**.

6.13.1.2 Operation and maintenance phase

Sensitivity of receptor

The sensitivity of receptors to changes in suspended sediments concentration and sedimentation remains the same as for all construction phases.

The Dee Estuary site would recover from the sedimentation which may occur due to maintenance activities. The material released is native to the sediment cell and the minimal sedimentation would be localised. The sensitivity of the receptor to changes as a result of maintenance activities is therefore considered low and is impacted to a much lesser degree than the construction phase.

West Hoyle Bank is an active bedform feature characterised by sediment redistribution and would recover from the sedimentation which may occur due to maintenance activities. The material released is native to the sediment cell and the minimal sedimentation would be localised. The sensitivity of the receptor to changes as a result of maintenance activities is therefore considered low and is impacted to a much lesser degree than the construction phase.

Magnitude of impact

The magnitude of the increase in suspended sediment concentrations arising from maintenance activities during operations and maintenance phase, has been assessed as low for the Proposed Development alone, as described in section 6.11.1. Maintenance activities may involve the repair, removal, or replacement of the PoA to Douglas OP and Inter-OP cables. it is predicted that the impact may directly affect the Dee Estuary SAC, SPA, SSSI, and West Hoyle Bank if cable maintenance is required in the nearshore area, however, is not expected to affect any other receptors. Impacts due to maintenance works are expected to be of a similar magnitude as those observed in the construction phase associated with cable installation, if not significantly reduced.

Tier 1

The cumulative impact assessment considers the construction, and operation and maintenance phases of Awel y Môr Offshore Wind Farm with the operation and maintenance phase of Proposed Development. The cumulative impacts are expected to be the same as those described for each project in the construction phase only reduced in magnitude. This due to the nature of maintenance activities being both intermittent and a smaller scale than that of the construction phase and therefore any potential cumulative impacts are less likely to occur and be on a smaller scale and be less numerous.

The Proposed Development’s operation and maintenance phase coincides with the operation of the Hilbre Swash aggregate extraction site situated *c*.3 km from the proposed location of the PoA to Douglas OP cable. As described for the construction phase nature of the project as an extraction operation where sediment is being removed from the cell and only mobilised as a side-effect, it is not expected that the resultant SSC plume will be large enough to interact with the Proposed Development at significant concentrations. Additionally given the intermittent nature and smaller scale of work, cumulative impacts during the Proposed Development operation and maintenance phase are likely to be of a smaller magnitude than during the construction phase.

As described in the construction phase, the Proposed Development operations and maintenance phase also overlaps with the decommissioning and removal of the Gwynt y Môr met mast. The magnitude of impact is expected to be similar to that described for the construction phase if cable repair/reburial or replacement was to occur in the PoA to Douglas OP cable sections adjacent to the Gwynt y Môr Array Area. However, impacts are expected to be reduced due to the nature of maintenance activities being both intermittent and a smaller scale than that of the construction phase and therefore any potential cumulative impacts are less likely to occur and be on a smaller scale and be less numerous.

Tier 2

The cumulative impact assessment considers the construction, and operation and maintenance phase of the Mona Offshore Wind Farm coinciding with the operation and maintenance phase of Proposed Development. The magnitude of cumulative impacts are expected to be the same as those described for the project in the construction phase only reduced. This due to the nature of maintenance activities being both intermittent and a smaller scale than that of the construction phase and therefore any potential cumulative impacts are less likely to occur and be on a smaller scale.

Cumulative effect

The cumulative effect is predicted to be of local spatial extent, short-term duration, intermittent and high reversibility, with potential impacts to the Dee Estuary SAC/SPA/SSSI and West Hoyle Bank. The magnitude is, therefore, considered to be low adverse.

Significance of effect

Overall, the magnitude of the cumulative impact is low, and the sensitivity of the receptor is low. The cumulative effect will, therefore, be of **minor adverse** significance, which is **not significant**.

6.13.1.3 Decommissioning phase

Sensitivity of receptor

The Dee Estuary SAC, SPA, and SSSI overlap with the proposed project cable route and experiences suspended sediments and deposition as a result of seabed preparation and cable installation activities. The site is designated for its mudflats and sandflats not fully covered by seawater at low tide, saltmarsh habitat, estuaries, and embryonic, shifting, and fixed dunes. These habitats support a wide range of both nationally and internationally important wintering species as well as breeding populations if common tern and little tern, the site regularly supports at least 20,000 waterfowl. The Dee Estuary is considered to be of high ecological value given its numerous international and national designations. The sedimentation identified is localised and composed of native material therefore the structure and function of the designated features are of low vulnerability and recoverable. The sensitivity of the receptor is therefore considered to be low.

West Hoyle Bank is not a designated site but supports sandbanks which are an Annex 1 habitat of the EC Habitats Directive. West Hoyle Bank is an area of shallow water creating rougher areas of wave stress, shifting sand creating sandbanks. The site is of high value given the local importance of the bank to physical processes, acting as a natural breakwater to the Dee Estuary. The sedimentation identified is localised and composed of native material therefore the structure and function of sandbanks is of low vulnerability and recoverable as the active sandbank system is naturally exposed to significant sediment redistribution. The sedimentation identified is localised and composed of native material, furthermore as an active sandbank the site is characterised by sediment redistribution and therefore the structure and function of the features are of low vulnerability and recoverable. The sensitivity of the receptor is therefore considered to be low.

Magnitude of impact

The magnitude of the increase in suspended sediment concentrations arising from decommissioning activities during the decommissioning phase, has been assessed as low for the Proposed Development alone, as described in section 6.11.1. Decommissioning activities will involve the removal of all project infrastructure and equipment for disposal onshore. It is predicted that the impact may directly affect the Dee Estuary SAC, SPA, SSSI, and West Hoyle Bank when the removal of assets is required in the nearshore area, however, is not expected to affect any other receptors. Impacts due to decommissioning works are expected to be of a similar magnitude as those observed in the construction phase.

Tier 2

The decommissioning phase of the Proposed development overlaps with the operation and maintenance phase of the Mona Offshore Wind Project. The magnitude of cumulative impacts is expected to be the same as those described for the Tier 2 project in the operation and maintenance phase, i.e. similar activities to the construction phase but of reduced scale and magnitude, combined with those of the magnitude of the construction phase for the proposed development. It can therefore be assumed for the same reasons as the construction phase, that no cumulative change will arise with the Mona Offshore Wind Project.

Cumulative effect

No cumulative effect is expected during the decommissioning phase. The magnitude is, therefore, considered to be **low adverse** in line with the Proposed Development alone.

Significance of effect

Overall, the magnitude of the cumulative impact is low in line with the Proposed Development alone**,** and the sensitivity of the receptors are low. The cumulative effect will, therefore, be of **minor adverse** significance, which is **not significant**.

6.13.2 Changes to seabed morphology due to sand wave clearance and cable protection measures

6.13.2.1 Construction phase

Sensitivity of receptor

The zone of influence of the prepared works encompasses a sand wave field to the south of the Douglas OP, along the cable path. The sand waves within Liverpool Bay have a highly mobile and dynamic nature. Sand wave features are predominately aligned perpendicular to the net sediment transport which is to the east and are characterised by gradual east ward migration (ABPmer, 2023b), as supported by a number of sediment transport studies in the region (Kenyon and Cooper, 2005; ABPmer, 2022a; ABPmer, 2022b). The direction of sand wave movement is also evident in Figure 6.3 and Figure 6.4. The loss to the coastal feature identified is localised and sediment displaced is expected to be deposited in the immediate vicinity of the sand wave features, providing material for sand wave regeneration. This deposition would be composed of the native material, furthermore as active seabed features the sand waves are characterised by sediment redistribution, therefore the structure and function of the coastal feature are of low vulnerability and highly recoverable. The sensitivity of the receptor is therefore considered to be low.

West Hoyle Bank is an area of shallow water creating rougher areas of wave stress, shifting sand creating sandbanks. The site is of high value given the local importance of the bank to physical processes as it acts as a natural breakwater. A natural channel currently exists within the sand bank suitable for the laying of cable, intersecting from the north to south, however a worst-case scenario would see a channel dredged through the bank. The changes to seabed morphology are localised and composed of native material, furthermore as an active sand bank the site is characterised by sediment redistribution and therefore the structure and function of the features are of low vulnerability and recoverable. The sensitivity of the receptor is therefore considered to be low.

Magnitude of impact

In order to prepare the seabed for the laying of cable, a number of seabed features require partial clearance. This includes the use of a mass flow excavator to create corridors through two sections of sand waves south of Douglas OP, the material suspended is however expected to settle in the direct vicinity of works, thus providing available sediment for sand wave regeneration and minimising the impact to the sand wave field. A larger scale operation may be required across West Hoyle Bank to facilitate the pre-lay of cable, which poses a greater obstacle to the POA to Douglas OP cable. This operation requires that a dredged channel be cut through the bank, displacing a greater volume of the sand bank. However, the displaced sediment would be deposited in the vicinity of the dredged channel, with a recommendation that it be placed on the western face to allow a natural infilling of the channel with the region’s sediment transport regime, which propagates in a west to east direction. Given the ready supply of sediment in the direct vicinity of works, for both regeneration of sand waves, and the infilling of the dredged sand bank, added with the mobile and dynamic nature of sediment transport in Liverpool Bay, the changes to seabed morphology arising from seabed preparation has been assessed as low for the Proposed Development alone,

Tier 1

The construction phase of the Proposed Development is expected to coincide with the proposed development of Awel y Môr Offshore Wind Farm. The Awel y Môr Offshore Wind Farm will have impacts on seabed morphology and coastal processes within the physical processes study area through the introduction of project infrastructure and seabed preparation activities. As the project infrastructure is introduced the impact to seabed morphology will gradually increase and therefore is best considered within the operation and maintenance phase wherein all infrastructure is in place (see Section 6.13.2.2). The seabed preparation activities associated with Awel y Môr require the sand wave clearance of array cables, export cables, the interlink cable with Gwynt y Môr and turbine/platform foundation installation via dredging techniques. These dredging operations will focus on the levelling of sand waves, therefore the change in water depths associated with the operation, considering the highly mobile migratory nature of the sand waves in the area, will not represent a change greater than the area’s natural variability. Despite the sand wave clearance operations being of a larger scale to the Proposed Development, impacts to seabed morphology are again expected to be temporary and localised, with sediment returning to the areas sediment transport regime and allowing for bedform regeneration. Significant distances separate the works of the Proposed Development and Awel y Môr, with *c*. 5 km between the sand wave clearance activities of the Proposed Development and the clearance activities for the array cable (7,600,000 m^3), foundation installation (500,000 m^3), and *c.* 3 km between the dredged route through West Hoyle Bank and the sand wave clearance associated with export and interlink cabling (7,600,000 m^3). Based on the locality of impacts to seafloor morphology and the distance between changes arising from the operations, it can be expected that no cumulative impact between the two developments during the construction phase will arise.

In the case of Colwyn Bay, beach recharging/nourishment represents a geomorphological change to the coastline and can be expected to have minor impact on seabed morphology. No cumulative impact is expected to arise here as these changes are highly localised and the site is located *c*. 25 km from the nearest change to seabed morphology arising from the Proposed Development.

The construction phase of the Proposed Development is expected to coincide with the construction and operation and maintenance phases of the Mostyn Energy Park Extension (MEPE) and associated maintenance dredging activities. This is a development within the Dee Estuary, involving the construction of a 360 m length of new quay wall, the infilling of a 3.5 ha area behind the new quay wall (requiring *c*. 600,000 m^3 of infill material, 500,000 m^3 of which will be sourced from dredging activity arisings). Alongside the new quay wall a dredged berth pocket will be required to a depth of -11 m CD (*c*. 400,000 m^3), whilst re-dredging of the existing berth pocket along the existing quay wall to – 9 m CD will be required (*c*. 400,000 m^3). The largest dredging operation will take the form of the re-dredging of the main navigation channel to a depth of – 4 m CD (*c*. 3 million m^3). The operation and maintenance phase will again involve dredging activities of the new and existing berths, harbour, and approach channel (*c*. 499,995 m^3), and the disposal of resulting dredged material in the existing disposal sites. Both seabed preparation and infrastructure installation will have an impact upon seabed morphology within the Dee Estuary. As project infrastructure is introduced the impact to seabed morphology will gradually increase and therefore is best considered within the operation and maintenance phase wherein all infrastructure is in place (see Section 6.13.2.2).

Seabed preparation activities predominantly take the form of dredging as described above. The result of these activities on seabed morphology and linked physical processes, was assessed through a modelling study as part of the project application (ABPmer, 2022c), the outcome of which suggested impacts would be highly localised, with changes in flow speed as a result works limited in extent to the dredging location itself and are generally around ±20 to 50 % of baseline flow speeds. As is currently the practice, disposal activity will be targeted to the deeper areas within the site, ensuring that bed level changes are not excessive in any one area, thus minimising the overall change. As a result, associated changes to the local seabed morphology (and sediment transport pathways) will be negligible and no cumulative impact with the Proposed Development will arise. The impact relating to operation and maintenance activities from the Mostyn Energy Park Extension is expected to be of a similar magnitude to the dredging/ disposal activities described above, only of a smaller scale in line with reduced dredge volumes associated with maintenance works as opposed to capital dredging, therefore it can be considered that no cumulative impacts on seabed morphology will arise.

The Proposed Development's construction phase coincides with the operation of the Hilbre Swash aggregate extraction site situated *c*.3 km from the PoA to Douglas OP cable installation route. Given the nature of the project as an extraction operation where sediment is being removed from the cell there will be changes to seabed morphology within the extraction site. However, it is not expected that these changes would result in a cumulative change with the sand wave clearance activities South of Douglas OP or the dredging operation through West Hoyle Bank, as a distance of *c.* 6km separates both sites from Hilbre Swash. This is supported by the extraction operations Coastal Impact Study (NRW, 2013), which found that although changes to seabed morphology may occur, impacts from the operation would be localised to the extraction site.

The Burbo Bank Extension Offshore Wind Farm, a project which has obtained a license for emergency cable repair and reburial, should the need arise. The Burbo Bank Extension is found in close proximity to the physical processes study area. Changes to seabed morphology during the reburial events may arise dependant on the presence of seabed features such as sand waves, however as with the activities for the Proposed Development itself, any change to seabed features would be both limited in magnitude and highly localised, it can therefore be considered that no cumulative impact will arise.

During the construction phase of the Proposed Development the Mares Connect cable will be in construction which may result in changes to seabed morphology. It is likely that sand wave clearance activities will be required along the Mares Connect cable route, however the location and extent of these works is currently not confirmed. It can however be expected that these works will carry a similar magnitude of impact as the Proposed Development with changes to seabed morphology remaining highly localised and of a temporary nature. Given the localised nature of changes to seabed morphology and the distance separating the Mares Connect cable from the clearance activities associated with the Proposed Development (*c*. 3 km from the dredged channel at West Hoyle Bank) no cumulative impact is expected to arise.

The construction phase of the Proposed Development coincides with suction bucket trials aiming to inform the detailed design of foundations for the Mona Offshore Wind Farm. The impact of these foundations on seabed morphology and physical processes would be highly dependent on both the parameters and locations tested. However, given the small scale nature of the trials which involve installing one foundation and removing it before moving to the next trial location to repeat, mean that impacts to seabed morphology will be intermittent and short term, with no long term effect on physical processes. Given the highly localised impact to seabed morphology associated with these trials, it is not expected that a cumulative impact with the Proposed Development will arise.

Tier 2

The construction phase of the Tier 2 development Mona Offshore Wind Project coincides with that off the Proposed Development. Seabed preparation activities defined by the MDS for the Mona Offshore Wind Project, requires sand wave clearance for turbines, offshore platforms, export cables, array cables, and interconnector cables. Despite a significant volume of material being cleared from the seafloor in the array area, wherein the largest clearance operation relates to the inter-array cables (9,542,806 m^3), it is located *c*. 10 km from the sand wave clearance operation South of Douglas OP. Sediment is also expected to be deposited in the direct vicinity of the clearance operations, giving rise to a localised impact to highly recoverable seabed features. Given the impacts from both developments are locally limited and separated by a considerable distance, no cumulative effect is anticipated to arise.

Cumulative effect

The cumulative effect is predicted to be of local spatial extent, short-term duration, intermittent and high reversibility, in line with the Proposed Development alone. The magnitude is, therefore, considered to be low adverse.

Significance of effect

Overall, the magnitude of the cumulative impact is low, and the sensitivity of the receptor is low. The cumulative effect will, therefore, be of **minor adverse** significance, which is **not significant**.

6.13.2.2 Operation and maintenance phase

Sensitivity of receptor

Locations of the cable protection for the proposed development vary in water depths and seabed morphology. Largely these locations fall in depth ranges wherein the bed level change due to the addition of cable crossings with a maximum height of 0.8 m, will lie within the natural variability of water depths in the area, given the dynamic nature of seabed features such as sand waves and mega ripples within Liverpool Bay. The sensitivity of coastal features in these areas are of low vulnerability and recoverable. The sensitivity of the receptor is therefore considered to be low.

Magnitude of impact

The only cable protection measures to be utilised by the Proposed Development occur in the form of cable crossings as the nature of the seabed sediment accommodates cable burial to the required depth. In total up to 32 cable crossings may be required, 10 of which relate to the POA to Douglas OP Cable, eight for the Douglas to Hamilton Inter-OP cable, eight for the Douglas to Hamilton North Inter-OP cable, and six for the Douglas to Lennox Inter-OP cable. Depending on the heights of such cable crossings, and the depth of water they are located in, there can be potential for changes to tide, wave and sediment transport processes due to a changed seabed morphology through altered bed levels. In this case however cable crossings will be up to a maximum height of up to 0.8 m, with widths of 7 m and tapered profiles to reduce the impacts to physical processes and seabed morphology. The cable crossings will be required in a range of depths from c. 5.8 m to c. 30.3 m (CD).

This includes the POA to Douglas OP cable crossing with the Burbo Bank Offshore Wind Farm Extension Export Cable, and further offshore POA to Douglas OP cable crossing with the Western HDVC Link Transmission Cable. As outlined in section 0, the impact due to cable crossings is considered to be of local spatial extent, long term duration, continuous and of high reversibility. Given the small scale of cable crossings to be implemented and further mitigating measures such as tapered profiles and compliance with the MCA navigation guidance, it is not expected that impacts from cable crossings would be sufficient to disrupt offshore bank morphological processes, experience significant secondary scour or destabilise coastal features, the magnitude of impact is therefore considered to be negligible for the Proposed Development alone.

Tier 1

The operation and maintenance phase of the Proposed Development is expected to coincide with the construction and operation and maintenance phases of the Awel y Môr Offshore Wind Farm. The Awel y Môr Offshore Wind Farm will have impacts on seabed morphology and coastal processes within the physical processes study area through the introduction of project infrastructure and prior seabed preparation. It was assessed for the construction phase of the Proposed Development that no cumulative impact due to seabed preparation and sand wave clearance activities during the development of both projects would arise. This due to the scale of works and locality of impacts. Again, given the changes experienced in seabed morphology and physical processes due to presence of cable crossings (which are expected to be limited to the direct vicinity of crossings), no cumulative impact due to construction activities of the Awel y Môr and operation and maintenance of the Proposed Development is expected. Likewise, no cumulative is expected to arise with the overlap in operation and maintenance phases of the two projects. With changes to seabed morphology being highly local, and physical processes such as tidal flows and sediment transport limited to within 1 km of the Awel y Môr Array Area. Therefore, it is not expected that impacts from the presence of Awel y Môr project infrastructure will accumulate with the highly local changes to seabed morphology due to the presence of cable crossings under the scope of the Proposed Development.

The operation and maintenance phase of the Proposed Development is expected to coincide with the operation and maintenance phases of the Mostyn Energy Park Extension (MEPE) and associated maintenance dredging activities. The impact relating to operation and maintenance activities from the Mostyn Energy Park Extension is expected to be of a similar magnitude to the dredging/ disposal activities for the construction phase, only of a smaller scale in line with reduced dredging volumes associated with maintenance works as opposed to capital dredging works. This paired with the even more localised changes expected from the presence of cable crossings associated with the Proposed Development suggests that no cumulative change to seabed morphology will arise.

The Proposed Development’s construction phase coincides with the operation of the Hilbre Swash aggregate extraction site situated *c*.3 km from the PoA to Douglas OP cable installation route. Given the nature of the project as an extraction operation where sediment is being removed from the cell there will be changes to seabed morphology within the extraction site. However, it is not expected that these impacts would result in a cumulative impact with the changes in seabed morphology caused by the Proposed Developments cable crossings, the closest of which is as a distance of *c.* 5 km from Hilbre Swash. This is supported by the extraction operations Coastal Impact Study (NRW, 2013), which found that although changes to seabed morphology may occur, impacts from the operation would be localised to the extraction site.

The Burbo Bank Extension Offshore Wind Farm, a project which has obtained a license for emergency cable repair and reburial, should the need arise, is found in close proximity to the physical processes study area. Changes to seabed morphology during the reburial events may arise dependant on the presence of seabed features such as sand waves, however as with the activities for the Proposed Development itself, any change to seabed features would be both limited in magnitude and highly localised, it can therefore be considered that no cumulative impact will arise.

During the operation and maintenance phase of the Proposed Development the Mares Connect cable will be in operation which may result changes to seabed morphology. It is likely that maintenance activities such as cable repair and reburial will be required along the Mares Connect cable route, however the location and extent of these works is currently not confirmed. It can however be expected that these works may carry a similar magnitude of impact as the sand wave clearance activities discussed for the construction phase of the Proposed Development with changes to seabed morphology remaining highly localised and of a temporary nature. Given the intersection with the Mares Connect cable is one of the anticipated cable crossings for the Proposed Development, a cumulative impact may arise if maintenance works are required in the vicinity of the cable crossing. However, this cumulative effect would be of negligible magnitude and limited spatially.

Tier 2

The cumulative impact assessment considers the construction, and operation and maintenance phases of Mona Offshore Wind Farm coinciding with the operation and maintenance phase of Proposed Development. It was assessed for the construction phase of the Proposed Development that no cumulative impact due to seabed preparation and sand wave clearance activities during the development of both projects would arise. This due to the scale of works and locality of impacts. Again, given the changes experienced in seabed morphology and physical processes due to presence of cable crossings (which are expected to be limited to the direct vicinity of crossings), no cumulative impact due to construction activities of the Mona Offshore Wind Farm and operation and maintenance of the Proposed Development is expected. The operation and maintenance phase of the Mona Offshore Wind Farm also coincides with the operation and maintenance phase of the Proposed Development and will have an impact on seabed morphology and physical processes. However, it can be understood from the Mona Offshore Wind Farm Technical Report (RPS, 2022), that changes caused by the addition of project infrastructure to the water column and seabed will have largely localised impacts to physical processes, with changes to tidal currents and sediment transport being limited to the immediate vicinity of installations. This paired with the fact the Mona Array Area is located *c.* 9 km from the Proposed Development and the highly localised changes expected from the presence of cable crossings associated with the Proposed Development, means it can be expected that no cumulative effect will arise.

Cumulative effect

The cumulative effect is predicted to be of local spatial extent, short-term duration, intermittent and high reversibility, in line with the Proposed Development alone. The magnitude is, therefore, considered to be low adverse.

Significance of effect

Overall, the magnitude of the cumulative impact is low, and the sensitivity of the receptor is low. The cumulative effect will, therefore, be of **minor adverse** significance, which is **not significant**.

6.13.2.3 Decommissioning phase

Sensitivity of receptor

The sand waves within Liverpool Bay have a highly mobile and dynamic nature. Sand wave features are predominately aligned perpendicular to the net sediment transport, which is to the east, and they are characterised by gradual east–ward migration (ABPmer, 2023b), as supported by a number of sediment transport studies in the region (Kenyon and Cooper, 2005; ABPmer, 2022a; ABPmer, 2022b). The direction of sand wave movement is also evident in Figure 6.3. The alteration of coastal features from decommissioning activities much like the construction phase would be localised and sediment displaced expected to be deposited in the immediate vicinity of the sand wave features, providing material for sand wave regeneration. This deposition would be composed of the native material furthermore as active seabed features the sand waves are characterised by sediment redistribution, therefore the structure and function of the coastal feature are of low vulnerability and highly recoverable. The sensitivity of the receptor is therefore considered to be low.

A worst-case scenario would see a channel similar to that created in the construction phase, dredged through the bank. The changes to seabed morphology would again be localised and composed of native material, furthermore as an active sand bank the site is characterised by sediment redistribution and therefore the structure and function of the features are of low vulnerability and recoverable. The sensitivity of the receptor is therefore considered to be low.

Magnitude of impact

The magnitude of the increase in suspended sediment concentrations arising from decommissioning activities during the decommissioning phase, has been assessed as low for the Proposed Development alone, as described in section 6.11.1. Decommissioning activities will involve the removal of all project infrastructure and equipment for disposal onshore. Impacts due to decommissioning works are expected to be of a similar magnitude as those observed in the construction phase.

Tier 2

The decommissioning phase of the Proposed development overlaps with the operation and maintenance phase of the Mona Offshore Wind Project. The magnitude of cumulative impacts is expected to be the same as those described for the Tier 2 project in the operation and maintenance phase, i.e. similar activities to the construction phase but of reduced scale and magnitude, combined with those of the magnitude of the construction phase for the proposed development. It can therefore be assumed for the same reasons as the construction phase, that no cumulative change will arise with the Mona Offshore Wind Project.

Cumulative effect

No cumulative effect is expected during the decommissioning phase. The magnitude is, therefore, considered to be low adverse in line with the Proposed Development alone.

Significance of effect

Overall, the magnitude of the cumulative impact is low in line with the Proposed Development alone**,** and the sensitivity of the receptors are low. The cumulative effect will, therefore, be of **minor adverse** significance, which is **not significant**.

6.13.3 Activities affecting surrounding water quality

6.13.3.1 Construction phase

Sensitivity of receptor

The sensitivity of the receptor is as described above for the assessment of the Proposed Development alone (see section 6.11.3). All receptors are deemed to be of high vulnerability and low recoverability, and the sensitivity is considered to be high.

Magnitude of impact

Tier 1 and Tier 2

There were nine Tier 1 projects and one Tier 2 project identified with the potential to result in cumulative effects surrounding changes in water quality (Table 6.16). As above for the assessment of the Proposed Development alone (section 6.11.3), increased SSCs and associated deposition is the main vector for impacts to water quality. This has been cumulatively assessed already in section 6.13.1.1, and is not repeated here for brevity. The cumulative effect of increased SSCs and associated deposition for Tier 1 and Tier 2 projects is considered to be low.

Water quality could also be cumulatively impacted by accidental pollution from vessels associated with the Tier 2 and Tier 3 projects. However, as per the Proposed Development, the Tier 1 and Tier 2 projects are also expected to comply with MARPOL regulations and have embedded mitigation similar to that of the Proposed Development (e.g. an EMP, which includes a MPCP).

Cumulative effect

Overall, the cumulative effect of impacts to surrounding water quality is predicted to be of local spatial extent, short-term duration, intermittent and high reversibility, with potential impacts to the Dee Estuary SAC/SPA/SSSI and West Hoyle Bank. The magnitude is, therefore, considered to be low adverse.

Significance of effect

Overall, the magnitude of the cumulative impact is low, and the sensitivity of the receptor is high. As per Table 6.13, this yields a minor or moderate significance. The cumulative effect will, be of **minor adverse** significance due to the embedded mitigation measures adopted to minimise the effects of this impact, such as development and adherence to an EMP (including a MPCP), which sets out pollution prevention methods and the requirement for all vessels to comply with the MARPOL regulations.

6.13.3.2 Operation and maintenance phase

Sensitivity of receptor

The sensitivity of the receptor is as described above for the assessment of the Proposed Development alone (see section 6.11.3). All receptors are deemed to be of high vulnerability and low recoverability, and the sensitivity is considered to be high.

Magnitude of impact

Tier 1 and Tier 2

There were five Tier 1 and one Tier 2 projects identified with the potential to result in cumulative effects surrounding changes in water quality (Table 6.16). As above for the assessment of the Proposed Development alone (section 6.11.3), increased SSCs and associated deposition is the main vector for impacts to water quality. This has been cumulatively assessed already in section 6.13.1.2, and is not repeated here for brevity. The cumulative effect of increased SSCs and associated deposition for Tier 1 and Tier 2 projects is considered to be low.

Water quality could also be cumulatively impacted by accidental pollution from vessels associated with the Tier 1 and Tier 2 projects. However, as per the Proposed Development, the Tier 1 and Tier 2 projects are also expected to comply with MARPOL regulations and have embedded mitigation similar to that of the Proposed Development (e.g. an EMP, which includes a MPCP).

Water quality may cumulatively be impacted by changes to seabed morphology in the subtidal environment due to cable protection measures, through secondary scour. This has been cumulatively assessed with regard to the changes in seabed morphology and potential for secondary scour in section 6.13.2.2, and is not repeated here. The cumulative effect of changes to seabed morphology due to sand wave clearance and cable protection measures for Tier 1 and Tier 2 projects is considered to be low.

Cumulative effect

Overall, the cumulative effect of impacts to surrounding water quality due to increased SSCs and associated resuspension of sediment contaminants and accidental pollution is predicted to be of local spatial extent, short-term duration, intermittent and of high reversibility, with potential impacts to the Dee Estuary SAC/SPA/SSSI and West Hoyle Bank. The magnitude is, therefore, considered to be low adverse.

The cumulative effect of impacts to surrounding water quality due to changes to seabed morphology due to cable protection measures is predicted to be of local spatial extent, long term duration, permanent during the operation and maintenance phase and of high reversibility. As described for the project alone, given the small scale of cable crossings to be implemented, it is not expected that impacts from cable crossings would be sufficient to experience significant secondary scour. The magnitude is, therefore, considered to be low adverse.

Significance of effect

Overall, the magnitude of the cumulative impact is low, and the sensitivity of the receptor is high. As per Table 6.13, this yields a minor or moderate significance. The cumulative effect will, be of **minor adverse** significance due to the embedded mitigation measures adopted to minimise the effects of this impact, such as development and adherence to an EMP (including a MPCP), which sets out pollution prevention methods and the requirement for all vessels to comply with the MARPOL regulations.

6.13.3.3 Decommissioning phase

Sensitivity of receptor

The sensitivity of the receptor is as described above for the assessment of the Proposed Development alone (see section 6.11.3). All receptors are deemed to be of high vulnerability and low recoverability, and the sensitivity is considered to be high.

Magnitude of impact

Tier 1

No overlap with the Proposed Developments decommissioning activities and Tier 1 construction, operation and maintenance, or decommissioning phases is anticipated, therefore there is no pathway for a cumulative change in water quality.

Tier 2

The decommissioning phase of the Proposed development overlaps with the operation and maintenance phase of the Mona Offshore Wind Project. The magnitude of cumulative impacts is expected to be the same as those described for the Tier 2 project in the operation and maintenance phase, i.e. similar activities to the construction phase but of reduced scale and magnitude, combined with those of the magnitude of the construction phase for the proposed development. It can therefore be assumed for the same reasons as the construction phase, that no cumulative change will arise with the Mona Offshore Wind Project.

Cumulative effect

No cumulative effect is expected during the decommissioning phase. The magnitude is, therefore, considered to be low adverse in line with the Proposed Development alone.

Significance of effect

Overall, the magnitude of the cumulative impact is low, and the sensitivity of the receptor is high. As per Table 6.13, this yields a minor or moderate significance. The cumulative effect will, be of **minor adverse** significance due to the embedded mitigation measures adopted to minimise the effects of this impact, such as development and adherence to an EMP (including a MPCP), which sets out pollution prevention methods and the requirement for all vessels to comply with the MARPOL regulations.

6.14 Transboundary effects

A screening of transboundary impacts has been carried out and has identified that there was no potential for significant transboundary effects with regard to physical processes from the Proposed Development upon the interests of other states.

6.15 Inter-related effects

Inter-relationships are considered to be the impacts and associated effects of different aspects of the proposal on the same receptor. These are considered to be:

- Project lifetime effects: Assessment of the scope for effects that occur throughout more than one phase of the Proposed Development (construction, operation and maintenance, and decommissioning), to interact to potentially create a more significant effect on a receptor than if just assessed in isolation in these three phases.
- Receptor led effects: Assessment of the scope for all effects to interact, spatially and temporally, to create inter-related effects on a receptor. As an example, all effects on physical processes, such as sediment plumes, may interact to produce a different, or greater effect on this receptor than when the effects are considered in isolation. Receptor-led effects may be short term, temporary or transient effects, or incorporate longer term effects.

A description of the likely interactive effects arising from the Proposed Development on the physical processes receptors is provided in section volume 2, chapter 14.

6.16 Conclusion

Information on physical processes within the physical processes study area was collected through detailed desktop review of existing studies and datasets and supported by numerical modelling.

Table 6.17 presents a summary of the potential impacts, measures adopted as part of the Proposed Development and residual effects in respect physical processes. The impacts assessed include:

- increased SSCs and sediment deposition;
- changes to seabed morphology; and
- activities affecting surrounding water quality.

Overall, it is concluded that there will be no significant effects arising from the Proposed Development during the construction, operational and maintenance or decommissioning phases as all impacts have a significance level of minor or less.

Table 6.18 presents a summary of the potential cumulative impacts, mitigation measures and residual effects. The cumulative impacts assessed include:

- increased SSCs and sediment deposition
- changes to seabed morphology; and
- activities affecting surrounding water quality.

Overall, it is concluded that there will be no significant cumulative effects from the Proposed Development alongside other projects/plans, as all impacts have a significance level of minor or less.

No potential transboundary impacts have been identified regarding effects of the Proposed Development.

Table 6.17: Summary of Potential Environmental Effects, Mitigation and Monitoring.

Description of Impact	Phase[a] C	Phase[a] O	Phase[a] D	Magnitude of Impact	Sensitivity of the Receptor	Significance of Effect	Further Mitigation	Residual Effect	Proposed Monitoring
Increased suspended sediment concentrations (SSCs) and sediment deposition.	✓	✓	✓	C: Low O: Low D: Low	C: Low O: Low D: Low	C: Minor adverse (not significant) O: Minor adverse (not significant) D: Minor adverse (not significant)	N/A	N/A	N/A
Changes to seabed morphology due to sand wave clearance and cable protection measures	✓	✓	✓	C: Low O: Negligible D: Low	C: Low O: Low D: Low	C: Minor adverse (not significant) O: Minor adverse (not significant) O: Minor adverse (not significant)	N/A	N/A	N/A
Activities affecting surrounding water quality	✓	✓	✓	C: Low O: Negligible to low D: Low	C: High O: High D: High	C: Minor adverse (not significant) O: Minor adverse (not significant) D: Minor adverse (not significant)	N/A	N/A	N/A

[a] C=construction, O=operation and maintenance, D=decommissioning

Table 6.18: Summary of Potential Cumulative Environmental Effects, Mitigation and Monitoring.

Description of Impact	Phase[a] C	O	D	Magnitude of Impact	Sensitivity of the Receptor	Significance of Effect	Further Mitigation	Residual Effect	Proposed Monitoring
Increased suspended sediment concentrations (SSCs) and sediment deposition.	✓	✓	✓	C: Low O: Low D: Low	C: Low O: Low D: Low	C: Minor adverse (not significant) O: Minor adverse (not significant) D: Minor adverse (not significant)	N/A	N/A	N/A
Changes to seabed morphology due to sand wave clearance and cable protection measures	✓	✓	✓	C: Low O: Low D: Low	C: Low O: Low D: Low	C: Minor adverse (not significant) O: Minor adverse (not significant) O: Minor adverse (not significant)	N/A	N/A	N/A
Activities affecting surrounding water quality	✓	✓	✓	C: Low O: Low D: Low	C: Low O: Low D: Low	C: Minor adverse (not significant) O: Minor adverse (not significant) D: Minor adverse (not significant)	N/A	N/A	N/A

* C=construction, O=operation and maintenance, D=decommissioning

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Liverpool Bay CCS Ltd

HYNET CARBON DIOXIDE TRANSPORTATION AND STORAGE PROJECT - OFFSHORE

Environmental Statement
Volume 2, Chapter 7: Marine Biodiversity

EHE7228B
Liverpool Bay CCS Ltd
Final
February 2024
Offshore ES
Marine Biodiversity

Glossary

Term	Meaning
Annelida	A large phylum that comprises the segmented worms, which include earthworms, lugworms, ragworms, and leeches.
The Applicant	Liverpool Bay Carbon Capture and Storage (CCS) Limited (Ltd.)
Arthropoda	Phylum with a wide diversity of animals with hard exoskeletons and jointed appendages.
Bathymetry	The measurement of water depth in oceans, seas, and lakes.
Benthic Ecology	Benthic ecology encompasses the study of the organisms living in and on the sea floor, the interactions between them and impacts on the surrounding environment.
Biotope	The combination of physical environment (habitat) and its distinctive assemblage of conspicuous species.
Circalittoral	The region of the sublittoral zone which extends from the lower limit of the infralittoral to the maximum depth at which photosynthesis is still possible.
Cumulative Effects	Changes to the environment caused by a combination of present and future projects, plans or activities.
Demersal	Species that live and feed on or near the seabed (typically used to describe fish).
Demersal Spawners	Species which deposit eggs onto the seabed during spawning.
"Do Nothing" Scenario	The environment as it would be in the future should the Proposed Development not be developed.
Drop Down Video (DDV)	Survey method in which imagery of habitat is collected, used predominantly to survey marine environments.
Echinodermata	Phylum of marine invertebrates, such as a starfish, sea urchin, or sea cucumber.
Elasmobranchs	Cartilaginous fishes which include sharks, rays, and skates.
Ensonified	Filled with sound.
Environmental Impact Assessment	A statutory process by which certain planned projects must be assessed before a formal decision to proceed can be made. It involves the collection and consideration of environmental information, which fulfils the assessment requirements of the Environmental Impact Assessment (EIA) Directive and EIA Regulations, including the publication of an EIA Report.
Epifauna	Organisms living on the surface of the seabed.
Epibenthic	Benthic invertebrates living on the surface of the seabed.
Eulittoral	Applied to the habitat formed on the lower shore of an aquatic ecosystem, below the littoral zone.
Filter Feeder	Suspension feeding animals that feed by straining suspended matter and food particles from water, typically by passing the water over a specialized filtering structure.
Habitat	The environment that a plant or animal lives in.
Important Ecological Features (IEFs)	Habitats, species, ecosystems and their functions/processes that are considered to be important and potentially impacted by the Proposed Development.
Infauna	The animals living in the sediments of the seabed.
Infralittoral	A subzone of the sublittoral in which upward-facing rocks are dominated by erect algae.
Intertidal Area	The area between Mean High Water Springs (MHWS) and Mean Low Water Springs (MLWS).
Invasive Non-Native Species	An introduced organism that becomes overpopulated and adversely alters its new environment.
Littoral	Residing within the littoral zone which extends from the high water mark, which is rarely inundated, to shoreline areas that are permanently submerged.
Magnitude	Size, extent and duration of an impact.
Marine Licence	A Marine Licence is a regulatory instrument awarded to developers that permits development/construction within the marine environment. See chapter 2: Policy and Legislation for further information.
Masking	Masking occurs when noise emissions interfere with a marine animal's ability to hear a sound of interest.

Term	Meaning
Mitigation Measure	Measure which would avoid, reduce, or remediate an impact.
Mollusca	Phylum of invertebrates which have a soft unsegmented body, commonly protected by a calcareous shell.
Non-statutory stakeholder	Organisations with whom the regulatory authorities may choose to engage who are not designated in law but are likely to have an interest in a proposed development.
Nursery	A habitat where juveniles of a species regularly occur as a population.
Particle Motion	The vibration of the water molecules which results in a pressure wave,
Pelagic	Species which live and feed within the water column (typically used to describe fish),
Pelagic Spawners	Species which release eggs into the water column during spawning,
Polychaete	A class of segmented worms often known as bristleworms.
Project	The Project refers to the overall HyNet Carbon Dioxide Transportation and Storage Project.
Project Design Envelope (PDE)	Also known as the Rochdale Envelope, the PDE concept is routinely utilised in both onshore and offshore planning applications to allow for some flexibility in design options, particularly offshore, and more particularly for foundations and turbine type, where the full details of the project are not known at application submission but where sufficient detail is available to enable all environmental impacts to be appropriately considered during the EIA.
Proposed Development	The Proposed Development refers to the offshore components of the Project.
Residual Impact	Residual impacts are the final impacts that occur after the proposed mitigation measures have been put into place, as planned.
Shellfish	For the purposes of this assessment, shellfish is considered a generic term to define molluscs and crustaceans.
Spawning Ground	Spawning grounds are the areas of water or seabed where fish spawn or produce their eggs.
Species	A group of living organisms consisting of similar individuals capable of exchanging genes or interbreeding.
Sublittoral	Area extending seaward of low tide to the edge of the continental shelf.
Subtidal	Area extending from below low tide to the edge of the continental shelf.
Tidal Excursion	The horizontal distance over which a water particle may move during one cycle of flood and ebb.

Acronyms and Initialisations

Acronyms and Initialisations	Description
2D	Two-dimensional
3D	Three-dimensional
ADD	Acoustic Deterrent Devices
Ag	Silver
AL	Action Level
ANSI	American National Standards Institute
As	Arsenic
ASA	Acoustical Society of America
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas
BAC	Background Assessment Concentration
BEIS	Department for Business, Energy, and Industrial Strategy
BERR	Business Enterprise and Regulatory Reform
BOWL	Beatrice Offshore Wind Farm Limited
BP	British Petroleum

Acronyms and Initialisations	Description
CBRA	Cable Burial Risk Assessment
CCS	Carbon Capture and Storage
CCUS	Carbon Capture, Usage, and Storage
CCW	Countryside Council for Wales
Cd	Cadmium
CD	Chart Datum
CEA	Cumulative Effects Assessment
Cefas	Centre for Environment, Fisheries, and Aquaculture Science
CI	Confidence Interval
CIEEM	Chartered Institute of Ecology and Environmental Management
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMACS	Centre for Marine and Coastal Studies
CMS	Construction Method Statement
CO_2	Carbon Dioxide
Co	Cobalt
CPT	Cone Penetration Test
Cr	Chromium
CSIP	Cable Specification and Installation Plan
Cu	Copper
DAERA	Department of Agriculture, Environment and Rural Affairs
DCO	Development Consent Order
DDCs	Drop Down Cameras
DECC	Department of Energy and Climate Change
DEFRA	Department for Environment, Food, and Rural Affairs
DFO	Department of Fisheries and Oceans (Canada)
EcIA	Ecological Impact Assessment
ECoW	Ecological Clerk of Works
EEA	European Economic Area
EIA	Environmental Impact Assessment
EMF	Electromagnetic Fields
EMP	Environmental Management Plan
EN-1	National Policy Statement (NPS) for Energy
EnBW	Energie Baden-Württemberg
EDR	Effective Deterrence Ranges
EPA	Environmental Protection Agency
EPS	European Protected Species
ES	Environmental Statement
EUNIS	European Nature Information Systems
FCC	Flintshire County Council
GIS	Geographical Information System
HDD	Horizontal Directional Drilling
HF	High Frequency
Hg	Mercury
HLCP	The Humber Low Carbon Pipelines

Acronyms and Initialisations	Description
HPI	Habitat of Principal Importance
IAMMWG	Inter-Agency Marine Mammal Working Group
ICES	International Council for the Exploration of the Sea
IEF	Important Ecological Feature
IEMA	Institute of Environmental Management and Assessment
IMO	International Maritime Organisation
INNS	Invasive Non-Native Species
INNSMP	Invasive Non-Native Species Management Plan
IUCN	International Union for the Conservation of Nature
IWC	International Whaling Commission
JNCC	Joint Nature Conservation Committee
LF	Low Frequency
LSE	Likely Significant Effects
Ltd.	Limited
MarESA	Marine Evidence Based Sensitivity Assessment
MarLIN	Marine Life Information Network
MARPOL	International Convention for the Prevention of Pollution from Ships
MBA	Marine Biological Association
MBES	Multi-Beam Echo-Sounder
MCA	Maritime and Coastguard Agency
MCCIP	Marine Climate Change Impacts Partnership
MCZ	Marine Conservation Zone
MDS	Maximum Design Scenario
MF	Mid Frequency
MHWS	Mean High Water Springs
MLWS	Mean Low Water Springs
MMMP	Marine Mammal Mitigation Plan
MMO	Marine Management Organisation
MMOb	Marine Mammal Observer
MPA	Marine Protected Area
MPCP	Marine Pollution Contingency Plan
MSFD	Marine Strategy Framework Directive
MU	Management Unit
MV	Marine Vibroseis
NEQ	Net Explosive Quantity
NERC	Natural Environment Research Council
Ni	Nickel
NIOSH	National Institute for Occupational Safety and Health
NISA	North Irish Sea Array
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPS	National Policy Statement
NPWS	National Park and Wildlife Service
NRW	Natural Resources Wales

Acronyms and Initialisations	Description
NSIP	Nationally Significant Infrastructure Project
OCEMP	Outline Construction Environment Management Plan
OCW	Other Marine Carnivores in Water
OPRED	Offshore Petroleum Regulator for Environment and Decommissioning
OSPAR	Oslo/Paris Convention
OWF	Offshore Wind Farm
PAH	Polycyclic Aromatic Hydrocarbon
PAM	Passive Acoustic Monitoring
Pb	Lead
PCB	Polychlorinated Biphenyl
PCW	Phocid Carnivores in Waters
PEIR	Preliminary Environmental Information Report
PoA	Point of Ayr
p-p	Peak-peak
PPG	Pollution Prevention Guidelines
ppm	Parts per Million
PTS	Permanent Threshold Shift
PSA	Particle Size Analysis
REAC	Register of Environmental Actions and Commitments
RIAA	Report to Inform Appropriate Assessment
RIB	Rigid Inflatable Boat
rms	Root Mean Square
ROV	Remotely Operated Vehicle
SAC	Special Area of Conservation
SBES	Single-Beam Echosounder
SBP	Sub Bottom Profiler
SCOS	Special Committee on Seals
SEAMARCO	Sea Mammal Research Company
SEL	Sound Exposure Level
SEL_{cum}	Cumulative Sound Exposure Level
SEL_{ss}	Single-strike Sound Exposure Levels
SI	Sirenian
SPI	Species of Principal Importance
SPL	Sound Pressure Level
SPL_{pk}	Peak Sound Pressure Level
SPM	Suspended Particulate Matter
SSC	Suspended Sediment Concentration
SSS	Sidescan Sonar
SSSI	Sites of Special Scientific Interest
SWF	Sea Watch Foundation
TBT	Tributyltin
TCPA	Town and Country Planning Act
THC	Total Hydrocarbon Content
TTS	Temporary Threshold Shift

Acronyms and Initialisations	Description
UHRS	Ultra High Resolution Seismic
UK	United Kingdom
UK BAP	United Kingdom Biodiversity Action Plan
US	United States
UXO	Unexploded Ordnance
VHF	Very High Frequency
VSP	Vertical Seismic Profiler
WFD	Water Framework Directive
Zn	Zinc
ZoI	Zone of Influence

Units

Unit	Description
bara	Absolute pressure
cm	Centimetre
cu in	Cubic inch
dB	Decibel
GW	Gigawatt
Hz	Hertz
kHz	Kilohertz
kJ	Kilojoule
km	Kilometre
km^2	Kilometres squared
kV	Kilovolt
kW	Kilowatt
g	Gram
g/l	Grams per litre
h	Hour
Hz	Hertz
m	Metre
mm	Millimetres
m/s	Metres per second
m^2	Metres squared
mg/kg	Milligrams per kilogram
mg/l	Milligrams per litre
MW	Megawatt
nm	Nautical Mile (distance; equal to 1.852 km)
psi	Pound per square inch
s	Second
µg/kg	Micrograms per kilogram
$\mu mol/m^2$	Micromoles per metre squared
µPa	Micro Pascal (10^{-6})

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7 MARINE BIODIVERSITY

7.1 Introduction

This chapter of the offshore Environmental Statement (ES) assesses the potential impacts of the HyNet Carbon Dioxide Transportation and Storage System (hereafter referred to as the 'Project') on Marine Biodiversity. Specifically, this chapter considers the potential impact of the offshore components of the Project that are seaward of Mean High Water Springs (MHWS) (hereafter referred to as the 'Proposed Development') during the construction, operational and maintenance, and decommissioning phases.

Article 3 of Directive 2011/92/EU (as amended) by Directive 2014/52/EU requires that the ES identifies, describes and assesses the direct and indirect significant effects of a project on biodiversity. This Marine Biodiversity chapter encompasses Benthic Subtidal and Intertidal Ecology, Fish and Shellfish Ecology, and Marine Mammals and Marine Turtles.

This chapter specifically addresses three topics:

- Benthic Subtidal and Intertidal Ecology: which includes the organisms with the potential to be present on and/or buried within the subtidal seabed, and intertidal benthic organisms between the low and high water marks within the regional benthic ecology study area.
- Fish and Shellfish Ecology: which includes all fish and shellfish species with the potential to be present within the regional fish and shellfish ecology study area, including demersal, pelagic, bentho-pelagic, diadromous, elasmobranch, and shellfish species.
- Marine Mammals and Marine Turtles: which includes all marine mammal and marine turtle species with the potential to be present within the regional marine mammal study area seaward of MHWS (thus excluding the otter *Lutra lutra,* which will be assessed as a terrestrial species).

The assessment presented is informed by the technical information presented in volume 3, RPS Group (2024a).

A detailed baseline that underpins the impact assessment for each marine biodiversity topic is included in sections 7.8.1, 7.8.2, and these provide characterisations of Benthic Subtidal and Intertidal Ecology, Fish and Shellfish Ecology, and Marine Mammal and Marine Turtles Ecology within their respective study areas. These characterisations are based on an extensive review of desktop literature and data sources and, where applicable, the results of the site-specific benthic surveys undertaken within the benthic ecology study area.

7.2 Purpose of this chapter

The primary purpose of this ES chapter is to assess likely impacts of the Proposed Development on marine biodiversity and to support the consent applications for the Project.

It is intended that this ES chapter will provide prescribed bodies and non-statutory stakeholders with sufficient information to determine the potential impacts of the Proposed Development on marine biodiversity. This ES chapter is intended to inform any consent conditions and any issues of appropriate consents and/or licences.

Overall, this chapter:

- summarises the existing environmental baselines described in volume 3, RPS Group (2024a), and established from desk studies, site-specific surveys, and consultation (sections 7.4 and 7.8).
- identifies embedded mitigation measures which, if required, could prevent, minimise, reduce, or offset the possible environmental effects identified in the impact assessment (section 7.11).
- assesses the potential environmental impacts on benthic subtidal and intertidal ecology, fish and shellfish ecology, and marine mammals, arising from the Proposed Development (section 7.12); and

- assesses the potential cumulative, transboundary, and inter-related effects of the Proposed Development (sections 7.13, 7.14, and 7.15).

Furthermore, to supplement this ES chapter, volume 3, RPS Group (2024a) identifies any assumptions and limitations encountered in compiling the environmental baseline.

7.3 Policy and Legislative Context

Planning policy relevant to the Proposed Development is presented in volume 1, chapter 2. This section presents planning policy which specifically relates to the three Marine Biodiversity topics (Benthic Subtidal and Intertidal Ecology, Fish and Shellfish Ecology, and Marine Mammals and Marine Turtles).

7.3.1 National Policy Statements

Planning policy for CCS technology, specifically in relation to marine biodiversity receptors, is contained in the Overarching National Policy Statement (NPS) for Energy (EN-1) (Department for Business, Energy, and Industrial Strategy (BEIS), 2023). NPS EN-1 includes guidance on what matters are to be considered in the assessment (Table 7.1). NPS EN-1 also highlight a number of factors relating to the determination of an application and in relation to mitigation (Table 7.2).

Table 7.1: Summary Of The NPS EN-1 Provisions Relevant To Marine Biodiversity Receptors

Summary of EN-1 Provision	Where Considered in the EIA
To consider the potential effects, including benefits, of a proposal for a project, the applicant should set out information on the likely significant social and economic effects of the development, and show how any likely significant negative effects would be avoided, reduced, or mitigated. For the purposes of this NPS and the technology specific NPSs the ES should cover the environmental, social and economic effects arising from pre-construction, construction, operation and decommissioning of the project.[1] (BEIS, 2023; paragraph 4.2.4-4.2.5)	Using information set out for each receptor in the Maximum Design Scenario (MDS) (section 7.9.1), the potential impacts on benthic, fish and shellfish, marine mammals and marine turtles receptors during construction, operations and maintenance, and decommissioning phases have been considered in the assessment of impacts in sections 7.12 and 7.13. Embedded mitigation measures have been outlined in section 7.11, and where required, tertiary mitigation has been suggested throughout the assessment.
In cases where the EIA Regulations do not apply and an ES is not therefore required, the applicant should instead provide information proportionate to the scale of the project on the likely significant environmental, social, and economic effects. (BEIS, 2023; paragraph 4.2.13)	The scoping process enables the Proposed Development to deliver environmental information proportionate to the infrastructure. This is demonstrated in this chapter in regard to the justification of the topics scoped out (section 7.9.2) as this demonstrates a proportionate approach.
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. (BEIS, 2023; paragraph 5.4.7)	There are no SSSIs with marine biodiversity features overlapping with the Proposed Development, however further information has been provided on those within the regional study areas, where relevant, in Table 7.9.
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	Relevant policy and legislation for marine biodiversity Important Ecological Features (IEFs) is provided in section 7.7.

[1] In some instances, it may not be possible at the time of the application for development consent for all aspects of the proposal to have been settled in precise detail. Where this is the case, the applicant should explain in its application which elements of the proposal have yet to be finalised, and the reasons why this is the case. (BEIS, 2023; paragraph 4.2.11).

Summary of EN-1 Provision	Where Considered in the EIA
for climate mitigation and adaptation and thereby requiring conservation action. (BEIS, 2023; paragraph 5.4.16)	
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 (including those outside England), on protected species and on habitats and other species identified as being of principal importance for the conservation of biodiversity, including irreplaceable habitats. (BEIS, 2023; paragraph 5.4.17)	Identification of the designated sites is considered in section 7.6 and those which have the potential to be impacted have been considered throughout the assessment in section 7.12. Likely Significant Effects (LSE) on designated sites have been screened and are presented in volume 4, RPS Group (2024b).
The applicant should show how the project has taken advantage of opportunities to conserve and enhance biodiversity and geological conservation interests. (BEIS, 2023; paragraph 5.4.19)	The Proposed Development will aim to conserve habitats through a number of embedded mitigation measures (section 7.11).
Applicants should consult the Marine Management Organisation (MMO) (or Natural Resources Wales (NRW) in Wales) on energy Nationally Significant Infrastructure Projects (NSIPs) which would affect, or would be likely to affect, any relevant marine areas as defined in the Planning Act 2008 (as amended by section 23 of the Marine and Coastal Access Act 2009). Applicants are encouraged to consider the relevant marine plans in advance of consulting the MMO for England or the relevant policy teams at the Welsh government. (BEIS, 2023; paragraph 4.11.5)	Section 7.3.3 covers the consultation process, including any communications with the MMO and NRW. Relevant marine plans are considered in section 7.3.
Marine Conservation Zones (MCZs) (Marine Protected Areas (MPAs) 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 Secretary of State is bound by the duties in relation to MCZs imposed by sections 125 and 126 of the Marine and Coastal Access Act 2009. (BEIS, 2023; paragraph 5.4.9)	All relevant nearby MPAs and designated sites were identified through desktop review and stakeholder consultation (section 7.6). Those which have the potential to be impacted have been considered throughout the assessment in sections 7.12 and 7.13.
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. • During construction and the operations and maintenance phase 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. • mitigation measures should consider existing habitats and should generally seek opportunities to enhance them, rather than replace them. Where practicable, mitigation measures should seek to create new habitats of value within the site landscaping proposals. (BEIS, 2023; paragraph 5.4.35)	The extent of works will be taking place within the Proposed Development and detailed in volume 1, chapter 3. Additionally, MDS has been set out for each receptor (section 7.9.1). Best practice during construction and maintenance will be set out in the Construction Method Statement (CMS) and the Environmental Management Plan (EMP) (see section 7.11). Following the completion of most activities habitats are expected to recover naturally (see section 7.12). The Proposed Development will aim to conserve habitats and species through a number of embedded mitigation measures (section 7.11).

Table 7.2: Summary Of The NPS EN-1 Policy On Decision Making Relevant To Marine Biodiversity Receptors

Summary of EN-1 Provision	Where Considered in the EIA
The government's policy for biodiversity in England is set out in the Environmental Improvement Plan, Biodiversity 2020, the National Pollinator Strategy and the UK Marine Strategy. The aim is to halt overall biodiversity loss, support healthy well-functioning ecosystems and establish coherent ecological networks, with more and better places for nature for the benefit of wildlife and people. This aim needs to be viewed in the context of the challenge presented by climate change. Healthy, naturally functioning ecosystems and coherent ecological networks will be more resilient and adaptable to climate change effects. Failure to address this challenge will result in significant adverse impact on biodiversity and the ecosystem services it provides. (BEIS, 2023; paragraph 5.4.2)	The conservation status of habitats and species is considered throughout this assessment and measures have been adopted to ensure impacts are reduced (section 7.11). The future impact of climate change on the marine ecology in the Irish Sea has been considered in section 7.8.1.9, 7.8.2.10, and 7.8.3.9.
As a general principle, and subject to the specific policies below, development should, in line with the mitigation hierarchy, aim to avoid significant harm to biodiversity and geological conservation interests, including through consideration of reasonable alternatives. Where significant harm cannot be avoided, impacts should be mitigated and as a last resort, appropriate compensation measures should be sought. (BEIS, 2023; paragraph 5.4.42)	Embedded mitigation measures have been outlined in section 7.11, and each impact has been comprehensively assessed in section 7.12 and where required, tertiary mitigation has been suggested.
In taking decisions, the Secretary of State should ensure that appropriate weight is attached to designated sites of international, national, and local importance; protected species; habitats and other species of principal importance for the conservation of biodiversity; and to biodiversity and geological interests within the wider environment. (BEIS, 2023; paragraph 5.4.48)	Identification of the designated sites is considered in section 7.6 and those which have the potential to be impacted have been considered throughout the assessment in sections 7.12 and 7.13. Likely Significant Effects (LSE) on designated sites have been screened and are presented in volume 4, RPS Group (2024b).

7.3.2 Welsh National Marine Plan

The Proposed Development sits within the Welsh waters and therefore Welsh plans such as the relevant 2019 Welsh National Marine Plan (Welsh Government, 2019) have been considered. Key provisions are set out in Table 7.3 along with details as to where these have been addressed within the assessment. Further information on the Welsh National Marine Plan is provided in volume 3, RPS Group (2023a)

Table 7.3: Welsh National Marine Plan 2019 Policies Of Relevance To Marine Biodiversity Receptors

Policy	Key provisions	Where considered in the EIA
Benthic Receptors		
• ENV_01, 02, 03, 04, 05, 06, 07 • SOC_06, 09 • GOV_01	The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions. Commitments to supporting an ecologically coherent network of MPAs.	The extent of each potential impact on the benthic receptors takes into account the abundance and distribution of species and habitats and is considered throughout the assessment and the cumulative assessment (sections 7.12 and 7.13). Identification of the designated sites is considered in section 7.6 and those which have the potential to be impacted have been considered throughout the

Policy	Key provisions	Where considered in the EIA
		assessment in sections 7.12 and 7.13. Likely Significant Effects (LSE) on designated sites have been screened and are presented in volume 4, RPS Group (2024b).
• ENV_01; 03 • GOV_01	Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems.	The potential impact of invasive species in regard to the Proposed Development is considered in sections 7.12 and 7.13.
• ENV_01, 02, 03, 04, 05, 06, 07 • GOV_01	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.	The extent of each potential impact on the benthic receptors take into account the abundance and distribution of species and habitats and is considered throughout the assessment and the cumulative assessment (sections 7.12 and 7.13).
• ENV_01, 02, 03, 07 • GOV_01 • FIS_01	Sea-floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.	Seabed integrity is considered within the temporary habitat disturbance/loss and long-term habitat loss impacts on benthic receptors (sections 7.12 and 7.13). These impacts consider pressures such as changes in substrate or seabed type and the sensitivity of the impacted habitats and species in relation to this pressure.
• ENV_06 • SOC_01 • GOV_01	Contaminants are at a level not giving rise to pollution effects.	The effects of contaminants are considered in the remobilisation of sediment-bound contaminants impacts on benthic ecology receptors (section 7.12.7).
Fish and shellfish		
• ENV_01 • ENV_05 • ENV_07 • GOV_01	Proposals should demonstrate how potential impacts on marine ecosystems have been taken into consideration and should, in order of preference: i. avoid adverse impacts; and/or ii. minimise impacts where they cannot be avoided; and/or iii. 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. Proposals that contribute to the protection, restoration and/or enhancement of marine ecosystems are encouraged.	Potential impacts on fish and shellfish ecology receptors (including underwater noise and effects on important feeding, breeding (including spawning and nursery) and migration areas) from the Proposed Development have been identified in the key parameters for assessment in section 7.9 and further assessed in sections 7.12 and cumulatively with other projects in section 7.13. Embedded mitigation measures have been outlined in section 7.11, and each impact has been comprehensively assessed in section 7.12.
• ENV_02	Proposals should demonstrate how they: • avoid adverse impacts on individual MPAs and the coherence of the network as a whole; • have regard to the measures to manage MPAs; and • avoid adverse impacts on designated sites that are not part of the MPA network.	All relevant nearby MPAs and designated sites were identified through desktop review and stakeholder consultation (section 7.6). Those which have the potential to be impacted have been considered throughout the assessment in sections 7.12 and 7.13. Likely Significant Effects (LSE) on designated sites have been screened and are presented in volume 4, RPS Group (2024b).
Marine mammals		
• ENV_01 • ENV_05 • ENV_07	Proposals should demonstrate how potential impacts on marine ecosystems have been taken into	Potential impacts on marine mammal ecology (including effects associated with underwater noise) from Proposed Development alone and

Policy	Key provisions	Where considered in the EIA
• GOV_01	consideration and should, in order of preference: i. avoid adverse impacts; and/or ii. minimise impacts where they cannot be avoided; and/or iii. 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. Proposals that contribute to the protection, restoration and/or enhancement of marine ecosystems are encouraged.	cumulatively with other projects have been addressed in sections 7.12 and 7.13, respectively. Embedded mitigation measures have been outlined in section 7.11, and each impact has been comprehensively assessed in section 7.12. The potential impacts on fish species and their habitats (including effects on important feeding, breeding (including spawning and nursery) and migration areas) have been assessed in full in sections 7.12. Section 7.12.19 assesses the potential effects on fish species and habitats in the context of how marine mammal prey species may be impacted.
• ENV_02:	Proposals should demonstrate how they: • avoid adverse impacts on individual MPAs and the coherence of the network as a whole; • have regard to the measures to manage MPAs; and • avoid adverse impacts on designated sites that are not part of the MPA network.	All relevant nearby MPAs and designated sites were identified through desktop review and stakeholder consultation (section 7.6). Those which have the potential to be impacted have been considered throughout the assessment in sections 7.12. Likely Significant Effects (LSE) on designated sites have been screened and are presented in volume 4, RPS Group (2024b).

7.3.3 North West Inshore and North West Offshore Marine Plan

The assessment of potential impacts to Marine Biodiversity receptors has also been made with consideration to the specific policies set out in the North West Inshore and North West Offshore Marine Plans (MMO, 2021). Key provisions are set out in Table 7.4 along with details as to how these have been addressed within the assessment. Further information on the Welsh National Marine Plan is provided in volume 3, RPS Group (2023a).

Table 7.4: North West Inshore And North West Offshore Marine Plan Policies Of Relevance To Marine Biodiversity Receptors

Policy	Key provisions	Where considered in the EIA
Benthic Receptors		
• NW-SCP-1 • NW-MPA-1	Proposals within or relatively close to nationally designated areas should have regard to the specific statutory purposes of the designated area. Great weight should be given to conserving and enhancing landscape and scenic beauty in National Parks and Areas of Outstanding Natural Beauty. Proposals that support the objectives of marine protected areas and the ecological coherence of the marine protected area network will be supported	Identification of the designated sites is considered in section 7.6 and those which have the potential to be impacted have been considered throughout the assessment in sections 7.12 and 7.13.

Policy	Key provisions	Where considered in the EIA
• NW-BIO-1	NW-BIO-1 encourages and supports proposals that enhance the distribution of priority habitats and priority species.	The Proposed Development will aim to conserve habitat through a number of embedded mitigation measures adopted to reduce the impacts of the Proposed Development (section 7.11).
• NW-BIO-2	NW-BIO-2 requires proposals to manage negative effects which may significantly adversely impact the functioning of healthy, resilient and adaptable marine ecosystems.	Embedded mitigation measures have been outlined in section 7.11, and tertiary mitigation is considered where the significance of an impact is moderate or major to reduce the significance of the impact to negligible or minor (sections 7.12 and 7.13).
• NW-BIO-3	Proposals that conserve, restore or enhance coastal habitats, where important in their own right and/or for ecosystem functioning and provision of ecosystem services, will be supported.	Section 7.12 considers the magnitude, sensitivity and significance of the impacts associated with the Proposed Development on benthic habitats. Embedded mitigation measures have been outlined in section 7.11, and each impact has been comprehensively assessed in section 7.12 and where required, tertiary mitigation has been suggested. As a result, the Proposed Development seeks to conserve the function and services provided by coastal habitats.
• NW-INNS-1	NW-INNS-1 aims to avoid or minimise damage to the marine area from the introduction or transport of Invasive Non-Native Species (INNS).	The implementation of an EMP as part of the embedded measures adopted by the Proposed Development (section 7.11) will manage and reduce the risk of introduction or spread of INNS. The INNS Management Plan is presented in volume 4, RPS Group (2023b).
Fish and Shellfish		
• NW-FISH-3	Proposals that enhance essential fish habitat, including spawning, nursery and feeding grounds, and migratory routes, should be supported. Proposals that may have significant adverse impacts on essential fish habitat, including spawning, nursery and feeding grounds, and migratory routes, must demonstrate that they will, in order of preference: i. avoid; ii. minimise; and iii. mitigate adverse impacts so they are no longer significant.	The areas of essential fish habitat potentially impacted have been identified in the volume 3, RPS Group (2024a) and summarised in the baseline (section 7.8.2). The impacts as a result of the Proposed Development are assessed in detail in sections 7.12 and 7.13.
• NW-MPA-1	Proposals that support the objectives of marine protected areas and the ecological coherence of the marine protected area network will be supported. Proposals that may have adverse impacts on the objectives of marine protected areas must demonstrate that they will, in order of preference: i. avoid; ii. minimise; and iii. mitigate adverse impacts, with due regard given to statutory advice on an ecologically coherent network.	Designated sites have been identified in section 7.6 and those which have the potential to be impacted have been considered throughout the assessment in sections 7.12 and 7.13.
• NW-BIO-2	Proposals that enhance or facilitate native species or habitat adaptation or connectivity, or native species migration, will be supported. Proposals	The areas of essential fish habitat potentially impacted have been identified in volume 3, RPS Group (2024a) and summarised in the baseline (section 7.8.2). The impacts as a result of

Policy	Key provisions	Where considered in the EIA
	that may cause significant adverse impacts on native species or habitat adaptation or connectivity, or native species migration, must demonstrate that they will, in order of preference: i. avoid; ii. minimise; iii. mitigate adverse impacts so they are no longer significant; and iv. compensate for significant adverse impacts that cannot be mitigated.	Proposed Development are assessed in detail in sections 7.12 and 7.13. Embedded mitigation measures have been outlined in section 7.11, and tertiary mitigation is considered where the significance of an impact is moderate or major to reduce the significance of the impact to negligible or minor (sections 7.12 and 7.13).
• NW-INNS-1	Proposals that reduce the risk of introduction and/or spread of non-native invasive species should be supported. Proposals must put in place appropriate measures to avoid or minimise significant adverse impacts that would arise through the introduction and transport of invasive non-native species, particularly when: 1) moving equipment, boats or livestock (for example fish or shellfish) from one water body to another 2) introducing structures suitable for settlement of invasive non-native species, or the spread of invasive non-native species known to exist in the area.	The prevention of the spread of INNS has been highlighted and considered in section 7.12.6, alongside appropriate embedded measures (section 7.11). Tertiary mitigation is considered where the significance of an impact is moderate or major to reduce the significance of the impact to negligible or minor (sections 7.12 and 7.13). The INNS Management Plan is presented in volume 4, RPS Group (2023b).
• NW-DIST-1 • NW-UWN-2 • NW-CE-1	Proposals that may have significant adverse impacts on highly mobile species through disturbance or displacement and/or result in the generation of impulsive or non-impulsive noise and/or have adverse cumulative effects with other existing, authorised, or reasonably foreseeable proposals must demonstrate that they will, in order of preference: i. avoid; ii. minimise; and iii. mitigate adverse impacts so they are no longer significant.	Potential impacts on fish and shellfish ecology receptors (including underwater noise) from Proposed Development have been identified in the key parameters for assessment in section 7.9 and further assessed in sections 7.12 and cumulatively with other projects in section 7.13. Embedded mitigation measures have been outlined in section 7.11, and each impact has been comprehensively assessed in section 7.12.
• NW-CBC-1	Proposals must consider cross-border impacts throughout the lifetime of the proposed activity. Proposals that impact upon one or more marine plan areas or terrestrial environments must show evidence of the relevant public authorities (including other countries) being consulted and responses considered.	Any potential cross-border impacts have been assessed in the transboundary effects (section 7.13.15) and inter-related effects (section 7.15) sections.
Marine mammals		
• NW-SCP-1 • NW-MPA-1	Proposals within or relatively close to nationally designated areas should have regard to the specific statutory purposes of the designated area.	The process of identifying designated sites has been undertaken for the regional marine mammal study area (section 7.6) and was done to ensure all habitats and features or species of conservation

Policy	Key provisions	Where considered in the EIA
	Proposals that support the objectives of marine protected areas and the ecological coherence of the marine protected area network will be supported. Proposals that may have adverse impacts on the objectives of marine protected areas must demonstrate that they will, in order of preference: i. avoid; ii. minimise; and iii. mitigate adverse impacts, with due regard given to statutory advice on an ecologically coherent network.	importance were considered in this assessment (sections 7.12 and 7.13).
• NW-BIO-2	NW-BIO-2 requires proposals to manage negative effects which may significantly adversely impact the functioning of healthy, resilient and adaptable marine ecosystems.	Embedded mitigation measures have been outlined in section 7.11, and tertiary mitigation is considered where the significance of an impact is moderate or major to reduce the significance of the impact to negligible or minor (sections 7.12 and 7.13).
• NW-CE-1	Proposals which may have adverse cumulative effects with other existing, authorised, or reasonably foreseeable proposals must demonstrate that they will avoid, minimise and mitigate.	Cumulative effects have been considered and their significance assessed in section 7.13. This section includes the consideration of tertiary mitigation where the significance of an impact is moderate or major.
• NW-UWN-2	Proposals that result in the generation of impulsive or non-impulsive noise must demonstrate that they will, in order of preference: i. avoid; ii. minimise; and iii. mitigate adverse impacts on highly mobile species so they are no longer significant.	The potential impacts of underwater noise resulting from the construction, operations and maintenance, and decommissioning phases have been considered in the assessment of impacts in sections 7.12 and 7.13. Embedded mitigation measures have been outlined in section 7.11, and where required, tertiary mitigation has been suggested.

7.4 Consultation

Consultation with relevant stakeholders has been undertaken throughout the consenting process of the Proposed Development. Table 7.5 summarises the issues raised relevant to Benthic Subtidal and Intertidal Ecology, Fish and Shellfish Ecology, and Marine Mammals and Marine Turtles, which have been identified during consultation activities undertaken to date. Table 7.5 also presents how and where these issues have been considered in the production of this Offshore ES.

The installation of the Proposed Development within the intertidal area between MHWS and MLWS, also overlaps with an onshore planning application made to Flintshire County Council (FCC) for works at the Point of Ayr terminal (planning application FUL/000246/23). The onshore planning application and its supporting ES, therefore, duplicates the cable installation works within the intertidal area.

Following submission of the onshore planning application on 14 March 2023, a consultation response from NRW was received on 10 May 2023 and a response from FCC's Ecology Officer was received on 31 May 2023. As a result of these responses, some clarifications on the information presented within the ES, HRA and

Water Framework Directive (WFD) Assessment were provided. Details regarding the issues raised on the onshore application have therefore been included within Table 7.5, and commentary provided on how and where these issues have been considered in the production of this Offshore ES.

Table 7.5: Summary Of Key Consultation Issues Raised During Consultation Activities Undertaken For The Proposed Development Relevant To Marine Biodiversity

Date	Consultee and Type of Response	Issues Raised	Response to Issue Raised and/or where Considered in this Chapter/ES
27 January 2023	Offshore Petroleum Regulator for Environment and Decommissioning (OPRED). Scoping Opinion response	“All relevant environmental data is expected to be sourced, analysed, and presented in relation to the Project. A non-exhaustive list of potential sources of environmental information is provided in Annex 2 but the Developer is expected to consult such other sources as it considers necessary.” “Relevant local environmental data should also be sourced from the appropriate local bodies which may include local environmental records centre, the local wildlife trust, local geo-conservation groups or other recording societies.”	All available relevant environmental data has been identified when characterising the baseline (see volume 3, RPS Group (2024a) and Table 7.8, Table 7.11, and Table 7.14).
		"The ES should assess the environmental effects of the Project upon features of nature conservation interest. It is recommended that the ES thoroughly assesses the potential for the Project to affect national or international sites of nature conservation importance. This should include a full assessment of the direct and indirect effects of the Project on the features of all important nature conservation sites including, but not limited to, Natural England’s Impact Risk Zones, SSSIs, MCZs, and Designated Sites with Fish and Shellfish Qualifying Features. Further website information on these sites and how this may be accessed is provided in Annex 2. In particular, it is noted that the following Welsh sites have been omitted in Table 7-7 (Designated Sites with Fish and Shellfish Qualifying Features) of the ES scoping report: • Dee Estuary SAC, designated for river and sea lamprey; • River Dee and Bala lake SAC, designated for Atlantic salmon, river and sea lamprey; • Afon Gwyrfai a Llyn Cwellyn SAC, designated for Atlantic salmon; • Afon Eden SAC - Cors Goch Trawsfynydd, designated for Atlantic salmon and Freshwater peal mussel; and • River Teifi SAC, designated for Atlantic salmon, river and sea lamprey."	Potential environmental effects upon features of nature conservation interest have been identified following the methodology described in section 7.6 and assessed (where appropriate, see section 7.12) in their respective sections. The recommended Welsh SACs were included in the Fish and Shellfish section (see Table 7.12).

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		"It is advised that records of protected species are sought from the appropriate local biological record centres, nature conservation organisations and National Biodiversity Network (NBN) Atlas (https://nbnatlas.org/.). It is also advised that consideration should be given to the wider context of the location of the Project, in terms of habitat linkages and protected species populations in the wider area to assist the impact assessment."	Records of protected species were sought from the mentioned resources (Table 7.8, Table 7.11, and Table 7.14; see volume 3, RPS Group (2024a) for detailed findings). Wider context has been researched through the use of regional study areas for the three marine biodiversity topics (see Figure 7.1, Figure 7.2, and Figure 7.3) and volume 3, RPS Group (2024a) for the full baseline descriptions of these wider study areas.
		"With respect to the impacts proposed to be scoped into the ES, the introduction of artificial habitat and colonisation of hard structures should not be considered beneficial." "It should also be noted that the introduction of hard substrates may act as a stepping-stone for the introduction of INNS, which is not currently scoped into the assessment. It is advised that the above points are scoped in and assessed."	This has been noted and this impact has been assessed proportionately, taking into consideration changes from the baseline substrate regime (see section 7.12.4). INNS are assessed separately under the impact 'Increased risk of introduction and spread of INNS', which has been assessed for project phases for benthic subtidal and intertidal ecology (see section 7.12.6).
		"Impacts resulting from the release of sediment bound benthic contaminants should be scoped in and assessed for the operational phase."	During the operational phase the potential for release of sediment-bound contaminants is considered lower than during installation and removal of significant infrastructure, with small areas of disturbance anticipated for cable repairs and maintenance. After review of the site-specific contaminants data and the physical processes modelling, it is proposed that this effect remains scoped out during the operational phase.
		"The footprint of area affected by cables and cable protection and potential impacts from scour and secondary scour from the use of cable protection and mattresses on benthic habitats during the operational phase should be scoped into the ES."	This impact is covered within the MDS for Temporary habitat loss and/or disturbance and Long-term subtidal habitat loss (Table 7.21 and Table 7.22) and is included in these assessments of significance, where relevant (see sections 7.12.1, 7.12.3, 7.12.9, and 7.12.10).
		"It is recommended that impacts to benthic ecology [and fish and shellfish] due to Electromagnetic Fields (EMF) is scoped into the ES and that an estimation of EMFs potentially arising from cables (both at exterior and at surface of seabed above buried cables) is scoped in at this stage."	Mitigation of this impact and associated effects through cable burial (at a target depth of between 2 and 3 m depth) and/or rock deposit protection (where burial is not possible) is considered embedded mitigation (see Table 7.32). Therefore, it is proposed that this impact remains scoped out for benthic subtidal and intertidal ecology and fish and shellfish, as with the planned embedded mitigation, it is anticipated that the significance of this effect will be negligible (Table 7.24 and Table 7.25).
		"Details of the footprint area affected by any installation vessels should be included."	This has been noted and is included within the MDS for Temporary habitat loss (Table 7.21 and Table 7.22) and is

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			included in these assessments of significance, where relevant (see sections 7.12.1 and 7.12.9).
		"Long-term subtidal habitat loss – Currently long-term subtidal habitat loss is only predicted to occur directly under the newly installed cable route with rock armour/protection in place. Confirmation that no additional long-term habitat loss is expected from the other activities highlighted is requested."	All relevant project design parameters have been built into the MDS associated with long term subtidal habitat loss, including any structures associated with the new Douglas platform (see Table 7.21 and Table 7.22).
10 May 2023	NRW – comments received in relation to planning application to FCC, application reference FUL/000246/23: Detailed Planning Application For The Retention And Reuse Of The Point Of Ayr Gas Terminal And Associated Gas Pipeline To The Mean Low Water Spring Mark For The Management And Processing Of CO_2; The Construction Of 33kv Electricity And Fibre Optic Connections From Point Of Ayr Gas	**Intertidal mudflats and sandflats** Environmental Statement (ES) Chapter 4: Consideration of Alternatives, paragraph 4.5.10 Foreshore Cables, explains that "The yellow route was discounted, but the dashed yellow option may eventually be selected over the orange option depending on the shifting nature of the sand banks". We advise that you seek clarification on whether the dashed yellow route is still in scope for this application and whether it has been assessed.	The dashed yellow and orange (Vol 2, Chapter 4 Fig 4.2) routes both remain under consideration and were both assessed within this Offshore ES, and the HRA. The dashed yellow and orange routes are in the same location (east side of the existing PoA to Douglas Pipeline between MHWS and MLWS), following the same alignment up to the MLWS covered by the ES and HRA supporting the Planning Application FUL/000246/23. The benefit of the dashed yellow route is that it follows the orange route onshore, so it does not protrude east and provides a more accessible route for construction vessels. However, the issue associated with constructability between the two spits offshore remains (water rushes between the two spits at speed). Therefore, the dashed yellow route and the orange route are both still under consideration. The final choice will be made during detailed design. This is because each route requires bespoke cable installation vessels to implement, and the availability of the vessels cannot be confirmed at this time. Sediment dispersion modelling has been carried out for the reasonable worst-case installation scenario, and both options are being assessed in the Offshore EIA that will support the Marine Licence application to NRW-MLT. **This has been taken into consideration within this Offshore ES.**

Date	Consultee and Type of Response	Issues Raised	Response to Issue Raised and/or where Considered in this Chapter/ES
	Terminal To The Mean Low Water Spring Mark; And Other Associated Development At Land West Of Station Road, Talacre.	**Intertidal mudflats and sandflats** With reference to ES Chapter 9: Biodiversity, para. 9.5.21, Impact assessment methodology, Duration, we advise that habitat loss longer than 5 years should be classed as long-lasting. This is based on the reporting cycle requirements outlined in Article 6a of the Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019.	**Section 9.5.21** of **Chapter 9 Biodiversity of the Town and Country Planning Act (TCPA) Onshore ES** defines the criteria for the duration of time an impact/effect is expected to last. Short-term is up to one year; medium-term is between one and 10 years and long-term is greater than 10 years. The Applicant notes NRW's advice on the length of time against which habitat loss should be considered long-term. Notwithstanding, due to the temporary nature and scale of the cable laying works, as well as the composition of the macrofaunal communities present, rapid recolonisation of disturbed sediment is expected within two years. Therefore, this remains a medium-term impact and would not change the impact assessment or conclusions of the ES. It should also be noted that the area in which the works will be undertaken is classed a depositional area, so any trenches will be quickly infilled over a short period of time. **This has been taken into consideration within this Offshore ES.**
		Intertidal mudflats and sandflats In ES Chapter 9, para. 9.8.7 the applicant proposes the use of a plough to excavate a trench and bury the cable within the intertidal zone. However, in ES Chapter 3: para. 3.4.58, the applicant notes that whilst the use of a plough is the preferred option, if proved to be unsuitable for the cable installation then a cable trencher will be employed. Potential impacts to intertidal habitats from the use of a cable trencher (including the recovery time) are greater than that of the use of a plough. We therefore advise that the worst-case scenario (i.e. the use of the cable trencher) should be assessed, in line with the Rochdale Envelope approach. This equally applies to the consideration of water quality impact in the HRA.	The use of a cable trencher as opposed to a cable plough could result in a greater area of impact due to the potential impacts of sediment compaction from the trencher's tracks. This could potentially result in an estimated impacted area of 18,000 m^2 using the trencher compared to an estimated 1,800 m^2 using the plough. Notwithstanding the above, the impacts from sediment mobilisation on receptors will be the same as that for the plough methodology, as the area of sediment mobilisation will be the same for both methods. As discussed in the response to NRW's comment above relating to Section 9.5.21 of Chapter 9 Biodiversity of the TCPA Onshore ES, due to the temporary nature and scale of cable laying works, combined with the cable laying works being located within a depositional area for sediment, any trenches will be quickly infilled over a short period of time. Furthermore, rapid recolonisation of disturbed sediment is expected within two years. Therefore, in a worst-case scenario, the use of a cable trencher

Date	Consultee and Type of Response	Issues Raised	Response to Issue Raised and/or where Considered in this Chapter/ES
			is still anticipated to have the same medium-term impact presented within the submitted ES and HRA on the intertidal habitat in the absence of any additional mitigation. **This has been taken into consideration within this Offshore ES.**
		Intertidal mudflats and sandflats Potential impacts to the Annex I mudflat and sandflat habitat from siltation and turbidity effects and accidental pollution during construction have been identified in ES Chapter 9: para. 9.9.25 but have not subsequently been assessed. Furthermore, several potential impacts resulting from the cable installation activities that could have an impact on the Annex I mudflat and sandflat habitat have not been assessed. We therefore advise that the following potential impacts should be scoped in and assessed: • Impacts from accidental pollution events • Impacts from increases in suspended sediment concentration and associated deposition (siltation and turbidity effects). This includes impacts from cable installation and repair/maintenance activities and indirect impacts to intertidal habitats (including the Annex I mudflats and sandflats feature) from increased suspended sediment and smothering from suspended sediment plumes generated during construction. This is of particular importance if a cable trencher is used. • Release of sediment bound contaminants – Disturbance of the seabed during construction, operation and decommissioning activities could cause toxicity effects through mobilisation of contaminated sediment during preparation works, cable laying and cable repair activities, which could impact the surrounding benthic communities. • Introduction and spread of invasive non-native species via marine vessels proposed to be used as part of the cable installation works. • Impacts from EMF. With reference to ES Chapter 9: para. 9.9.93, potential EMF impacts from the operation of the cables have been assessed against the fish species that were recorded within the Dee Estuary SAC. As noted by the applicant, many benthic invertebrate species are known to be able to detect EMF. There is some	Temporary disturbance of priority habitat/Annex I mudflat and sandflat habitat will be caused by the cable installation works through the foreshore, by either a cable plough or cable trenching machine. Sediment disturbed during the installation will be backfilled by the machine, so loss would be temporary and localised. If using the cable trenching machine (worst-case scenario) and in the absence of any additional mitigation, an area of approximately 18,000 m^2 (1.8 ha) would be impacted. This includes the area of sediment directly disturbed by the installation of the cable and the area of sediment potentially compacted under the tracks of the machine. Based on this information, the area of habitat within the red line boundary to be temporarily disturbed is expected to be 18.40% of the total intertidal mudflats and sandflats habitat area within the red line boundary of the TCPA Proposed Development, although only 0.017% of the extent of the mudflats and sandflats habitat within the Dee Estuary SAC. Due to the temporary and localised nature of the works and the habitats present, it is considered that effects will be of minor adverse significance (therefore not significant). Potential impacts resulting from the cable installation activities on the Annex I mudflat and sandflat habitat have been considered and are discussed below. There would be no changes to the overall conclusions of the **ES** and **HRA**: • Accidental pollution events during construction activities have the potential to impact the mudflat and sandflat habitats, through release of industrial chemicals such as fuel and lubricants. As the intertidal works will be undertaken at low tide where possible, it will allow any potential pollution events to be contained and localised to the works area. This would therefore reduce the potential for spread and scale of impacts.

Date	Consultee and Type of Response	Issues Raised	Response to Issue Raised and/or where Considered in this Chapter/ES
		evidence that EMFs affect crustacea behavioural patterns which would potentially include certain species under Section 7 (Environment Wales Act 2016) e.g. crawfish/spiny lobster *Palinurus elephas*. We advise that these should be reviewed and assessed (where appropriate) as part of the application.	If a spill occurs during high tide works, the release will be dispersed through tidal flow, thus reducing the severity of the spill. In addition to these factors, the species present within the works area are of medium sensitivity to pollution and have a medium resistance (to hydrocarbons and synthetic compounds) and have the ability to recolonise areas relatively quickly. Accidental pollution events and control measures will be detailed within the detailed CEMP and standard procedures will be followed in order to reduce potential impacts. Pollution controls are currently detailed within measures T-GN-002, T-BD-017 and T-BD-019 the Register of Environmental Actions and Commitments (REAC) (Document Reference: T.5.3) and Section 4.2 of the Outline Construction Environment Management Plan (OCEMP) (Document Reference: T.5.1). • The release of sediment-bound contaminants during cable laying and cable maintenance activities has the potential to impact benthic communities through toxicity effects. However, where possible the works will be undertaken at low tide and the trenches would be backfilled through natural deposition. As such, this reduces the potential impacts, which will be localised in nature. In addition, the species present within the works area are of medium sensitivity and resilience to chemical pressures and are able to recolonise rapidly. Therefore, the effects from sediment-bound contaminant release are likely to be negligible (not significant). • As described Section 1.7.3.1 of Vol 3, RPS Group (2024c), suspended sediment plumes for seabed preparation activities were quantified. In all cases, the material released was native to the bed sediments and, although there are periods of increased turbidity, the material was retained in the sediment cell and would be subsequently assimilated into the existing sediment transport regime. Suspended sediments may reach into the estuary during cable trenching from PoA to Douglas, but generally do so at background levels, i.e. 30 mg/l. As such, significant effects are not predicted. • Mobilisation of specialised vessels in order to undertake the cable laying work has the potential to introduce INNS, through release of ballast water and from larval release from the hulls of vessels. As the vessels will be moored below MLWS and

Date	Consultee and Type of Response	Issues Raised	Response to Issue Raised and/or where Considered in this Chapter/ES
			will offload the cable into the intertidal zone, the spread of INNS will be controlled by the implementation of a Biosecurity Risk Assessment as described in Section 2.8 Biosecurity Risk Assessment. Biosecurity mitigation measure detailed within T-BD-032 of the REAC (Document Reference: T.5.3) and OCEMP (Document Reference: T.5.1) • EMF generated by the cables is likely to be ~0.1 µT at the seabed for a cable buried at 1m deep, which is below the levels which have impacts upon marine life, including fish and marine invertebrates. In addition, the cables will be buried 3 m below the surface through the intertidal zone, which will mean that the EMF at the surface will be even less than the ~0.1 µT. Furthermore, the habitats present along the intertidal section of the cable route – intertidal sand and mudflats – are not optimal for species such as the crawfish/spiny lobster, which has a habitat preference of rocky exposed coasts with depths of 5-400 m. In addition to this, the desk study and field surveys did not identify any other benthic invertebrates that are sensitive to EMF. Therefore, the potential effects are likely to be negligible (not significant). Cable repair activities would be no worse in terms of potential impacts than installation activities already assessed. **This has been taken into consideration within this Offshore ES, and the REAC and OCEMP commitments made within the Onshore ES, will be implemented by the Contractor for the Offshore works.**
		Intertidal mudflats and sandflats With reference to ES Chapter 9: para. 9.9.21, we advise that clarification is sought on what activity is expected to result in the "*loss of sections of intertidal mudflat S7 Priority habitat/mudflat and sandflat Annex I habitat"* and what area of habitat loss this equates to. We would not expect any long-lasting habitat loss as a result of the cable trenching as the trench would be backfilled.	Temporary disturbance (rather than loss) to priority habitat will be caused by the installation of the cable installation works through the foreshore, by either a cable plough or cable trenching machine. The term disturbance has been used in this response as the Applicant agrees that there would be no long-term habitat loss given the backfilling of the trench. If using the cable trenching machine (worst-case scenario) and in the absence of any additional mitigation, an area of approximately 18,000 m^2 (1.8 ha) would be impacted. This includes the area of sediment directly disturbed by the installation of the cable and the area of sediment potentially crushed under the tracks of the machine.

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			Based on this information, the area of habitat within the red line boundary of the TCPA Proposed Development to be temporarily disturbed is expected to be 18.40% of the total intertidal mudflats and sandflats habitat area, although only 0.017% of the extent of the mudflats and sandflats habitat within the Dee Estuary SAC. Sediment disturbed during the installation will be backfilled by the machine, subsequent infilling from deposited suspended sediments, as well as natural deposition, so disturbance would be temporary and localised. **This has been taken into consideration within this Offshore ES.**
		Intertidal mudflats and sandflats Based on the sensitivity of the biotopes to the impact and the expected recovery rate we do not expect the impact from temporary habitat loss, and/or disturbance from the cable installation on the biotopes that were encountered during the Phase I Habitat Survey, to be of major and/or moderate significance. This impact is expected to be temporary, and the habitat should return to pre-impact conditions within the short-term following return of the sediment. However, we are unable to confirm this without clarification of the extent of the area that will be impacted. Mitigation measures such as the use of matting to reduce compaction of the sediment could be used, but further information is needed to understand these impacts. Therefore, until the following information is provided, we are unable to agree with the assessment conclusions regarding biotopes.	Due to the temporary and localised nature of the works and the habitats present, the Applicant agrees that effects would not be of moderate or major significance. It is considered that effects of habitat disturbance during construction will be of minor adverse significance (therefore, not significant). The use of track matting to reduce the impacts from compaction could reduce the area of impact to that within the trenched area. However, this may not be required due to the short-term nature of the works and the high resilience of the habitat types and species present. **This has been taken into consideration within this Offshore ES.**
		Intertidal mudflats and sandflats An assessment of the impact of temporary habitat loss and/or disturbance from cable installation against the biotopes (ES Habitat Survey Report, Annex E, Figure 3.1 Biotope Map of the Survey Area) recorded during the Phase I habitat survey using the information provided in Marine Evidence based Sensitivity Assessment (MarESA) (e.g. sensitivity, resilience and expected recovery rate). This should	The predominant habitat type identified within the survey area was *Macoma balthica* and *Arenicola marina* in littoral muddy sand. This habitat and its associated species are resilient to change and able to recolonise following disturbance relatively quickly, with studies showing that recolonisation of dug/disturbed areas taking place with two to three months[2]. Recolonisation time will depend upon factors such as recruitment and migration of

[2] https://www.marlin.ac.uk/habitats/detail/1087#sensitivity_review

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		assess the impact from disturbing the sediment as a result of the cable laying activities and potentially from the use of vehicles on the beach to install the cable (e.g. use of a mobile tracked machine). The assessment should also include the total extent of the impact i.e. the area in m^2 and or km^2 of impact and furthermore, what this equates to (percentage) of the Annex I mudflat and sandflat feature of the Dee Estuary SAC and to the whole Dee Estuary SAC. Clarification is also sought on any mitigation measures in relation to the impact of tracked vehicles that might be required.	adults into the disturbed area, however it is expected that disturbed areas will be fully recolonised within two years. The Dee Estuary SAC covers a total of 10,573.73 ha of intertidal mudflats and sandflats not covered by water at low tide. The intertidal cable works have the potential to impact 1.8 ha (worst-case scenario when considering the use of a cable trenching machine), equating to 0.017% of this habitat type within the SAC. Therefore, effects to the intertidal mudflats and sandflats of the SAC are considered to be of negligible significance due to the scale of the impacts and the resilience of the habitats present. The use of track matting to reduce the impacts from compaction could reduce the area of impact to that within the trenched area. However, this may not be required due to the short-term nature of the works and the high resilience of the habitat types and species present. **This has been taken into consideration within this Offshore ES, and the REAC and OCEMP commitments made within the Onshore ES, will be implemented by the Contractor for the Offshore works.**
		Intertidal mudflats and sandflats Regarding ES Chapter 9: para. 9.9.85 we note that the operation of the repurposed pipeline is expected to increase the temperature of the soil and associated habitats around the pipeline. We advise that clarification is sought on whether an increase in temperature is expected in the intertidal zone; if so, potential impacts on the Annex I mudflats and sandflat feature should be assessed.	Soil temperature analysis of three locations, including the intertidal mudflats and sandflats habitat, was carried out by Wood in 2023. The results of this analysis concluded that there was no significant impact on soil/sand temperature near the surface as a result of the Foreshore Pipeline. The report concluded that during summer months, the temperature at 0.1 m below the surface would be 1.8°C above ambient temperature (18.6°C compared to 17°C), whereas during winter it would be 2.3°C above ambient (5.3°C compared to 3°C). A more detailed analysis method (CFD modelling) was undertaken, which indicated that the temperature of soil/sand 10m either side of the pipe was affected by the presence of the pipeline. However, the greatest impacts to temperature change were within 1m of the pipe. These temperature changes are within the tolerance levels of the habitats and species present within the pipeline area. Therefore, significant effects are not predicted.

Date	Consultee and Type of Response	Issues Raised	Response to Issue Raised and/or where Considered in this Chapter/ES
			This has been taken into consideration within this Offshore ES.
		Intertidal mudflats and sandflats With reference to ES Chapter 19: Combined and Cumulative Effects, until the potential impacts to intertidal habitats from the cabling activities have been scoped in and assessed appropriately, we are unable to agree that the effects to ecological receptors are non-negligible and can therefore be scoped out of the cumulative effects assessment. Please note these comments are also applicable to appendix 19.1 Inter-Project effects assessment.	See **ES Chapter 3 – Proposed Development Description** for details on the methods and activities involved for the cable installation. Approximately 1.8 ha of the intertidal mudflats and sandflats habitat within the red line boundary of the Proposed Development is expected to be temporarily disturbed by the cable trenching activities. However, this equates to only 0.017% of the extent of the mudflats and sandflats habitat within the Dee Estuary SAC. The habitats and species present within the works area are resilient to disturbance and have the potential to recolonise within months of the works being completed. The MarESA assessment for this habitat type indicates that the habitat and populations should be fully recovered within two years of cessation of works. The species present are also moderately tolerant to increases in sediment temperature, with the modelled temperature changes falling within these tolerances. This ES concludes that no significant effects (moderate significance or above, in line with the EIA methodology used throughout the assessment) will be incurred because of the proposed cable trenching works. **This has been taken into consideration within this Offshore ES, and the REAC and OCEMP commitments made within the Onshore ES, will be implemented by the Contractor for the Offshore works.**
		Intertidal mudflats and sandflats With reference to ES Chapter 19: Table 6-2. Potential effects upon the Dee Estuary/Aber Dyfrydwy SAC, Annex I mudflat and sandflat feature the potential for the cable installation and repair/maintenance activities to result in increases in sediment-bound contaminants and suspended sediment concentration (SSC) leading to siltation and turbidity effects and thus impacts to the Annex I features of the Dee Estuary SAC has not been screened in and assessed. This is of particular importance if	Results from the sediment dispersion numerical modelling presented in this ES (see volume 3, RPS Group (2024c)) show that suspended sediment plumes from all cable installation activities showed that while there are periods of increased turbidity, the suspended material is retained in the same sediment cell and would be subsequently assimilated into the existing sediment transport regime. Suspended sediments may reach into the Dee Estuary during cable installation, but generally do so at background levels, i.e. 30 mg/l.

Date	Consultee and Type of Response	Issues Raised	Response to Issue Raised and/or where Considered in this Chapter/ES
		a cable trencher is to be used so we advise that it should be appropriately assessed.	The sediment plume modelling also concluded that most of the sediment deposition would take place within 30 m of the cable laying activities. Therefore, impacts and effects will be localised and temporary. Overall, LSE are not predicted in relation to siltation and turbidity. **This has been taken into consideration within this Offshore ES.**
		Intertidal mudflats and sandflats With reference to ES Chapter 19: Table 6-2. Potential effects upon the Dee Estuary/Aber Dyfrydwy SAC, subsection (a), we advise that further assessment should be undertaken to support the conclusions of the HRA. LSE from habitat loss and/or disturbance to the Annex I mudflat and sandflat feature resulting from cable installation activities have been identified and some evidence relating to the resilience and recovery of the habitat has been presented. We advise that given an LSE has been identified, the impact should be assessed at Stage 2 Appropriate Assessment against the conservation objectives for the feature, with the appropriate evidence to rule out an adverse effect on site integrity presented.	Table 6.2 referenced by NRW is found within the **Onshore TCPA HRA report (Document Reference T.5.4)** and not ES Chapter 19. As such, the Applicant assumes that this comment relates to the HRA. Table 6.2 of the **Onshore TCPA HRA report (Document Reference T.5.4)** assesses LSE upon the Dee Estuary SAC. This includes an assessment of direct habitat loss of the mudflats and sandflats Annex I habitat. In summary, no LSE in relation to habitat loss of the mudflats and sandflats SAC qualifying feature were identified. The only LSE identified for the mudflats and sandflats qualifying feature was in relation to hydrological effects. This was carried through to the Appropriate Assessment, mitigation measures were detailed, and no adverse effects on the integrity of this feature were predicted. Since the HRA for the Onshore TCPA was undertaken, further details on the cable installation methodology, presented in this Offshore ES at **Chapter 3 – Proposed Development Description**, have been reaffirmed the conclusions made in the HRA report of no LSE in relation to mudflats and sandflats associated with habitat loss. The Dee Estuary SAC covers a total of 10,573.73 ha of intertidal mudflats and sandflats not covered by seawater at low tide. The intertidal cable works have the potential to temporarily disturb 1.8 ha, equating to 0.017% of this habitat type within the Dee Estuary SAC. There would be no long-term habitat loss given the backfilling of the trench (temporary disturbance of habitat only). Due to the nature of the foreshore within the project area, the topography will return to its pre-works state after several tidal cycles due to the physical processes in this location and as described in this Offshore ES in volume 3, RPS Group (2024c).

Date	Consultee and Type of Response	Issues Raised	Response to Issue Raised and/or where Considered in this Chapter/ES
			The predominant habitat type identified within the survey area (and cable route) was *Macoma balthica* and *Arenicola marina* in littoral muddy sand. This habitat and its associated species are resilient to change and able to recolonise following disturbance relatively quickly, with studies showing that recolonisation of dug/disturbed areas taking place with two to three months. Recolonisation time will depend upon factors such as recruitment and migration of adults into the disturbed area. However, it is expected that disturbed areas will be fully recolonised within two years. As such, it is expected that the abundance of typical species of the mudflat and sandflat feature within the SAC will be maintained. **This has been taken into consideration within this Offshore ES.**
		Intertidal mudflats and sandflats With regards to appendix A – Section 6.4.2 (a) of the shadow HRA, we welcome plans to work at low water to avoid the potential impacts of SSC plumes on Annex I protected features (Chapter 9, Table 9-21). However, we advise further assessment regarding the practicality of working only at low water if trenching is employed as the cable installation method. For example, whether it would be possible to undertake the cable laying work within one low water period as outlined in appendix 18.3 Water Framework Directive Assessment, Table 4-14. If any cable laying works take place outside low water, we advise that the potential for SSC plumes should be assessed, in particular, the possibility for smothering of protected features, by the deposition of sands and fine material, mobilised by trenching activities.	The Applicant confirms that it cannot be guaranteed that the cable installation across the intertidal area would only be carried out at low tide. There are many factors that would influence the timing that cannot be guaranteed at this time. Please refer to this Offshore ES at **Chapter 3 – Proposed Development Description** for proposed schedules of cable laying activities, suggesting that it would not be possible to undertake the cable laying within one low tide water period. The potential for suspended sediment concentrations and potential for smothering of protected features has been considered above, with no LSE to qualifying mudflat and sandflat habitat of the Dee Estuary SAC predicted. **This has been taken into consideration within this Offshore ES.**
		Intertidal mudflats and sandflats We also advise further assessment regarding the transition of cable laying methods beyond MLWS. We acknowledge that this application covers activities to MLWS, however, in order to assess the impacts of cable laying activities within the intertidal zone the methods for continuing these works past MLWS need to be understood. For	The Applicant confirms that intertidal cable laying would commence only once a Marine Licence for cabling below MHWS has been granted. Cable laying would commence offshore from the Douglas platform towards the shore, and to do this would require a Marine Licence.

Date	Consultee and Type of Response	Issues Raised	Response to Issue Raised and/or where Considered in this Chapter/ES
		example, whether intertidal cable laying would commence only once a Marine License for cabling below MHWS has been granted.	**The impacts of the cable laying beyond MLWS have been assessed in this Offshore ES for the Marine Licence.**
		Estuaries We note that, providing the exit pit and cables can be situated 2-3m below the ground, rock armour and cable protection would not be required. However, we advise that you seek clarification that backfilling associated with the exit pit would restore the original profile of the beach, to ensure the alongshore sediment transport pathways will not be interrupted.	The Applicant confirms that backfilling associated with the exit pit would restore the original profile of the beach, to ensure the alongshore sediment transport pathways will not be interrupted. It should also be noted that the HDD exit pit would be located above the MHWS mark, which is illustrated in the cross-section extract in this Offshore ES at **Chapter 3 – Proposed Development Description**.
		Estuaries We also advise that you seek clarification that cable laying methods would not change the overall profile of the intertidal area. For example, if trenching methods are employed, backfilling methods should ensure the original gradient of the Intertidal area is restored, to minimise the potential for secondary impacts to physical processes and thus sediment transport pathways.	The Applicant confirms that cable laying methods would not change the overall profile of the intertidal area.
		Fish Features We note that ES Chapter 15: Noise and Vibration, para. 15.9.14 details the potential for piling to be required as part of the modifications to the Point of Ayr (PoA) terminal. However, it is not clear where within the PoA application site the piling may be required. We therefore advise that your Authority confirms whether piling would be required within the intertidal zone. If piling would occur in the intertidal zone, then further information/mitigation would be required. We advise that project-specific noise modelling may be required if other mitigation cannot be implemented, depending on the size of piles and duration of piling.	The Applicant confirms that no piling activities will be required within the intertidal zone during the cable laying and burial, therefore further mitigation is not proposed.
		General We note reference to conservation status but no specific reference to Current Conservation Status (CCS) or Favourable Conservation Status (FCS). There is also no reference to EC EPS Guidance regarding this e.g. Commission notice Guidance document on the strict protection of animal species of Community interest under the Habitats Directive C/2021/7301 final. However, we would not be concerned about this being considered as part of the EPS licensing application for the	Consideration of CCS and FCS will be included within any subsequent EPS licence application. The Applicant has considered impacts to species at the appropriate geographical scale and the context of likely impact from construction and operation.

Date	Consultee and Type of Response	Issues Raised	Response to Issue Raised and/or where Considered in this Chapter/ES
		proposals. The Applicant should note that a hierarchical geographical scaled approach may not be applicable when demonstrating no detriment to maintenance of FCS; the above EC guidance indicates assessments at various spatial scales.	
		Schedule 1 birds We advise that as currently proposed, the works could cause disturbance to little tern. For example, paragraph 7.5.7 of appendix A: Habitats Regulations Assessment Information to Inform an Appropriate Assessment, states that 'a watching brief would be undertaken by the Ecological Clerk of Works (ECoW) in relation to the established Little Tern colony if any construction works are to be undertaken around the PoA Terminal between April and July, inclusive para. 7.5.8 states that 'If any birds are showing disturbance behaviour within the 300m buffer zone during any stage of the works, the ECoW would stop work until it can be determined that disturbance has subside''. We advise that disturbing the birds, then stopping works after the disturbance has occurred, would still be classed as a disturbance of a Schedule 1 species, as the disturbance event will have already occurred. We therefore advise that the detailed CEMP should include a commitment that, if construction works are due to be undertaken between April and July inclusive, and if there is any habitat with the potential to be used for little tern nesting within 300m of the development, the ECoW should check for little tern breeding activity before any works are undertaken. If nesting little tern are present within 300m of the proposed development, no works should be undertaken.	The Applicant has noted this comment, which would be covered under the scope of the ECoW.
31 May 2023	Flintshire County Council comments received in relation to planning application to FCC, application reference FUL/000246/23	**Dee Estuary SAC – Intertidal Works** An intertidal plough will be used to lay cable on completion of creation of the cable route through the dunes. The zone of disturbance for the cable installation is expected to be around 15 metres total width for each cable. The two cables from PoA Terminal to Douglas Offshore Platform are expected to be laid at a minimum separation distance of 30 metres, within two separate trenches. The minimum cables burial depth (top of cables) is expected to be between two and three metres. The spatial extent of the effect will be very small and of short duration. Works will be undertaken at low tide to reduce the risk of sediment contamination.	See this **Offshore ES at Chapter 3 – Proposed Development Description** for further details on the cable trencher installation methodology. See response to NRW comments in relation to TCPA Onshore ES Chapter 3: para. 3.4.58, ES Chapter 9, para. 9.8.7 and ES Chapter 9: para. 9.9.21 for clarification on potential impacts to the priority habitat/Annex I habitat caused by the cable installation works using a cable plough or cable trenching machine through the Foreshore area. Please see responses to NRW comments in relation to TCPA Onshore ES Chapter 9: para. 9.9.85 and ES Chapter 9: para.

Date	Consultee and Type of Response	Issues Raised	Response to Issue Raised and/or where Considered in this Chapter/ES
		NRW have raised issues regarding their installation; clarification is required regarding their concerns the key one being confirmation that an intertidal plough will be used rather than trenching as suggested elsewhere in the ES. Operational impacts: Compression at the Terminal will increase the temperature of the CO_2 and although cooled by the air coolers as far as practicable, the CO_2 will remain above ambient temperature. Heat modelling (ref 9.56) indicates that ground soil 10m either side of the pipeline will be affected by the presence of hot fluid inside the pipe but there will be a minimal impact on change in temperatures of soil or sand beyond a distance of approx. 1m from the top of the pipe due to the low thermal conductivity of soil and sand. EMFs are generated by the current that passes through the cables. However, they are only likely to be detectable within the immediate vicinity of the cables with negligible impact at 0.5m above them. The depth of the cables means there is not likely to be a significant impact on fish or benthic invertebrates, however NRW require clarification.	9.9.93 for details relating to heat modelling and EMF, respectively. Please see responses to NRW comments in relation to TCPA Onshore ES Chapter 9: para. 9.9.21 for clarification on potential impacts to the Dee Estuary from sediment dispersion numerical modelling
		Dee Estuary SAC – Foredunes The HDD exit hole location and relevant equipment yard will fall within the intertidal habitat adjacent to the sensitive embryonic/foredune habitat. A temporary access route for the foreshore works is proposed along the boundary of the dune habitat which comprises bare sand. The route will be matted to minimize damage. REAC: T- BD- 005 REAC: T BD 047 references the specific pollution prevention measures to be put in place.	**This has been taken into consideration within this Offshore ES, and the REAC and OCEMP commitments made within the Onshore ES, will be implemented by the Contractor for the Offshore works.**
		Dee Estuary SAC – Compound (temporary parking area) Compound (temporary Parking Area) will be located in the Talacre Beach car park, on bare ground within the existing fenced parking area and will avoid sensitive saltmarsh habitat. Protective measures/fencing and monitoring will be provided to avoid damage REAC T-BD-006	**This has been taken into consideration within this Offshore ES, and the REAC and OCEMP commitments made within the Onshore ES, will be implemented by the Contractor for the Offshore works.**
		Dee Estuary SAC – Impacts to aquatic environment construction pollution / operational discharge Pollution prevention and surface water management is included within the OCEMP and REAC.	The Applicant confirms that pollution prevention measures and surface water management are secured within measures **T-WR-004 to T-WR-029** of the **REAC.**

Date	Consultee and Type of Response	Issues Raised	Response to Issue Raised and/or where Considered in this Chapter/ES
		A Biosecurity Risk Assessment and a non native invasive species management plan will be produced to address potential spread of invasive non-native species from intertidal ploughing activities. REAC T-BD-032-033	The Applicant also confirms that mitigation in relation to INNS (Biosecurity Method Statement) is secured within measures **T-BD-032 and 033** of the **REAC.** **This has been taken into consideration within this Offshore ES, and the REAC and OCEMP commitments made within the Onshore ES, will be implemented by the Contractor for the Offshore works.**
		Dee Estuary SAC – Changes in air quality Dust management plan to be provided as part of the agreed CEMP to include use of screens/barriers, covering of stockpile soils, dust suppression techniques etc as necessary to prevent dust deposition on the saltmarsh habitat.	A Dust Management Plan was submitted with the planning application within **Annex A of the OCEMP.** It will be implemented by the Construction Contractor and includes measures to control emissions, in addition to dust and PM10 mitigation measures. **This has been taken into consideration within this Offshore ES, and the REAC and OCEMP commitments made within the Onshore ES, will be implemented by the Contractor for the Offshore works.**
		Dee Estuary SAC – Heat generation and EMFs Compression at the PoA Terminal will increase the temperature of the CO_2 and although cooled by the air coolers as far as practicable, the CO_2 will remain above ambient temperature. Although the Foreshore Pipeline will be buried and insulated by its concrete coating, there is the potential for this to increase the temperature of the surrounding environment of the Foreshore Pipeline which has the potential to impact natterjack toad and sand lizard breeding opportunities and hibernation behaviour. Currently there are no natterjack toad or sand lizards found within the red line boundary but the long term proposals are to enable the populations to expand. Heat modelling (ES Ch 9 Ref 9.56) indicates that ground soil 10m either side of the pipeline will be affected by the presence of hot fluid inside the pipe but there will be a minimal impact on change in temperatures of soil or sand beyond a distance of approx. 1m from the top of the pipe. What is the estimated depth of cables under the dunes? Presumably this will be as a depth that will not impact burrowing natterjacks (or sand lizards)?	See the response to NRW comments above in relation to TCPA Onshore ES Chapter 9: para. 9.9.85, which provides further details regarding temperature modelling. In relation to the estimated depth of the cables, cables would be buried to the desired depth of 2-3 m. Soil temperature analysis showed that the pipeline had minimal impact on the change in soil/sand temperature over a distance of approximately 1m from the top of the pipe. Natterjack toads typically burrow to depths of less than 50 cm (although can be deeper in winter) and sand lizard burrow to up to 1 m deep. Therefore, when considering the depth of the pipe (3 m) and the minimal impact on change in temperature beyond 1m from the top of the pipe, impacts to burrowing natterjack toad and sand lizard are not predicted because of heat changes. The Applicant acknowledges the potential for screening in relation to working areas close to saltmarsh/mudflat/reedbed habitat, notably in relation to reducing disturbance to qualifying bird species of The Dee Estuary SPA and Ramsar. Measure **T-BD-037** of the **REAC** refers to this provision, if needed.

Date	Consultee and Type of Response	Issues Raised	Response to Issue Raised and/or where Considered in this Chapter/ES
		iii) PoA Construction compound within colliery site in close proximity to the Dee estuary and associated saltmarsh/mudflats/reedbeds to the south and east. There is already tree and shrub planting *in situ* but temporary screening can be provided to prevent noise and visual impacts on the estuarine habitats.	**This has been taken into consideration within this Offshore ES, and the REAC and OCEMP commitments made within the Onshore ES, will be implemented by the Contractor for the Offshore works.**

7.5 Methodology to Inform the Baseline

A site-specific benthic characterisation survey and Phase 1 intertidal walkover survey were undertaken in 2022, which provided detailed information on the following:

- species assemblage and community structure;
- habitat classification;
- sediment contamination; and
- presence of species and habitats of conservation importance.

This survey was undertaken based on published guidance and best industry practice. A summary of this survey is presented in Table 7.6.

Table 7.6: Summary Of Site-Specific Survey Data

Title	Extent of survey	Overview of survey	Survey contractor	Date	Reference to further information
HyNet Carbon Capture and Storage (CCS) and Decommissioning Benthic Characterisation Survey	The survey covered two areas: (1) the CCS area and all associated infrastructures, and (2) existing Eni oil and gas infrastructure that is proposed to be either partly or fully decommissioned and repurposed.	Data was collected at 85 sampling stations using Drop Down Cameras (DDCs) and grab sampling (0.1 m^2 Day grab, 0.2 m^2 dual Van Veen grab, and a 0.1 m^2 mini-Hamon grab).	Ocean Ecology	2022	Summarised in volume 3, RPS Group (2024a) and presented in full in volume 3, Ocean Ecology and RPS Group (2023).
Phase 1 Intertidal Walkover Survey	A 500 m buffer either side of the existing 20" natural gas pipeline connecting the Point of Ayr Terminal to the Douglas platform was surveyed from MHWS to approximately Mean Low Water Springs (MLWS). This was undertaken on Talacre Beach at the Point of Ayr, near Prestatyn, North Wales.	A walkover survey was conducted over two days. Detailed notes on shore type, wave exposure, and sediments and species/biotopes present were collected. Exploratory digging for sub-surface fauna was undertaken on an ad hoc basis. Sieving was undertaken at seven sampling stations using a 0.5 mm mesh.	RPS	2022	Summarised in volume 3, RPS Group (2024a) and presented in full in volume 3, RPS Group (2023c).

There were no site-specific surveys undertaken to inform the fish and shellfish or marine mammal and marine turtle baseline characterisations. These topics were characterised in full through a detailed desktop review of key datasets, reports, and scientific publications. These included the results of site-specific monitoring undertaken at Consented Offshore Wind Farms (OWFs) which either overlap or are situated in proximity to the Proposed Development (e.g. Gwynt y Môr). These key desktop data sources are presented in Table 7.8, Table 7.11, and Table 7.14 for each marine biodiversity topic.

7.6 Identification of Designated Sites

All designated sites within the various marine biodiversity study areas defined for the three topic (refer to section 7) and relevant qualifying features that could be affected by the construction, operational and maintenance, and decommissioning phases of the Proposed Development were identified using the three-step process described below:

- Step 1: All designated sites of international, national and local importance within the marine biodiversity study areas were identified using various sources. These included interactive maps showing designated sites in the United Kingdom (UK) and Ireland from the National Park and Wildlife Service (NPWS) and the Joint Nature Conservation Committee (JNCC).
- Step 2: Information was compiled on the relevant Marine Biodiversity interest features for each designated site identified.
- Step 3: Using the above information and expert judgement, sites were considered further if:
  - A designated site with relevant Marine Biodiversity features directly overlapped with the Proposed Development, therefore having the potential to be directly affected by the Proposed Development; or
  - A designated site and associated features are located within the potential Zone of Influence (ZoI) for impacts associated with the Proposed Development, and therefore have the potential to be indirectly affected by the Proposed Development.

7.7 Important Ecological Features

IEFs are species or habitats considered to be important and potentially affected by the Proposed Development. They are considered to be important due to the quality or extent of the habitat, rarity of the species or habitat, or the extent to which the species or habitat is threatened (Chartered Institute of Ecology and Environmental Management (CIEEM), 2022). They are considered IEFs if they are designated under international, national, regional, or local legislation or conservation plans (e.g. Annex I habitats or Annex II species designated under the Habitats Directive, Oslo Paris Convention (OSPAR) List of Threatened and/or Declining habitats or species, or the UK Post-2010 Biodiversity Framework). In 2012, the UK Post-2010 Biodiversity Framework succeeded the UK Biodiversity Action Plan (UK BAP), and Species of Principal Importance (SPI) and Habitats of Principal importance (HPI) were drafted for England, Scotland, Wales, and Northern Ireland under the following legislation:

- Section 41 of the Natural Environment and Rural Communities Act 2006 (England);
- Section 2(4) of the Nature Conservation (Scotland) Act 2004;
- Section 7 of the Environmental Act (Wales); and
- Section 3(1) of the Wildlife and Natural Environment Act (Northern Ireland) 2011.

The criteria used to inform the valuation of IEFs are presented in Table 7.7, while the IEFs identified and their conservation status and valuation of importance are presented in their respective marine biodiversity sections below (Table 7.10, Table 7.13, and Table 7.20).

Table 7.7: Criteria Used To Evaluate The IEFs In The Marine Biodiversity Sections

Value of IEF	Criteria to Define Value
International	• Internationally designated sites (e.g. Special Areas of Conservation (SACs)). • Habitats and species protected under international law that are listed as a qualifying feature of an internationally designated site (e.g. Annex I habitats, Annex II species, or European Protected Species (EPS) within a SAC boundary). • Listed under Appendix I and II of the Bonn Convention on the Conservancy of Migratory Species of Wild Animals (hereafter: 'The Bonn Convention'). • Listed under Annex II (strictly protected fauna) or Annex III (protected fauna) of the Bern Convention on the Conservation of European Wildlife and Natural Habitats (hereafter: 'The Bern Convention'). • Listed under the Convention on the International Trade in Endangered Species of Flora and Fauna (CITES).
National	• Nationally designated sites (e.g. MCZs). • Species or habitats protected under national law (e.g. UK Post-2010 Biodiversity Framework).

Value of IEF	Criteria to Define Value
	• OSPAR List of Threatened and/or Declining Species and Habitats within OSPAR Region III (Celtic Seas). • Annex I habitats not within a SAC boundary. • Internationally protected species (including EPS) that are not qualifying interest features of a designated site but are regularly recorded within the various marine biodiversity study areas in relatively low densities. Therefore, this area is not considered to be important for these species at an international context. • Internationally protected species or habitats that are not qualifying interest features of a designated site but are listed as SPIs or HPIs on a local action plan within the various marine biodiversity study areas.
Regional	• Habitats or species that provide important prey items for other species of conservation value. • Fish and shellfish species that have spawning and/or nursery grounds within the regional fish and shellfish ecology study area that are important regionally (i.e. they may spawn in other parts of UK and Irish waters but this is a key spawning/nursery area). • Internationally protected species or habitats that are not qualifying interest features of any designated sites and are infrequently recorded within the local marine biodiversity study areas in very low numbers compared to other regions of the UK and Ireland.
Local*	• Habitats and species which are not protected under conservation legislation, and may be common in UK and Irish waters, but form a key component of the marine biodiversity within the various marine biodiversity study areas. • Fish and shellfish with spawning and/or nursery grounds out with the Proposed Development but within the regional fish and shellfish ecology study area.

* The Local criteria are not applicable to marine mammals due to the high level of protection under international law for all marine mammal species.

7.8 Existing Baseline Description

7.8.1 Benthic Subtidal and Intertidal ecology

7.8.1.1 Study Area

To support the development of the benthic subtidal and intertidal ecology section, two study areas are defined:

- The Proposed Development benthic ecology study area: this is defined as the area encompassing the Proposed Development, offshore pipelines (including intertidal habitats up to the MHWS), and associated cables in Liverpool Bay (Figure 7.1). This is the area within which site-specific benthic surveys have been undertaken, the results of which will inform the baseline characterisation within this Technical Report.
- The regional benthic ecology study area: this is defined as the area encompassing the wider Irish Sea habitats and includes the neighbouring consented OWFs and designated sites (Figure 7.1). This area will be characterised by desktop data and will provide a wider context to the site-specific data collected within the benthic ecology study area.

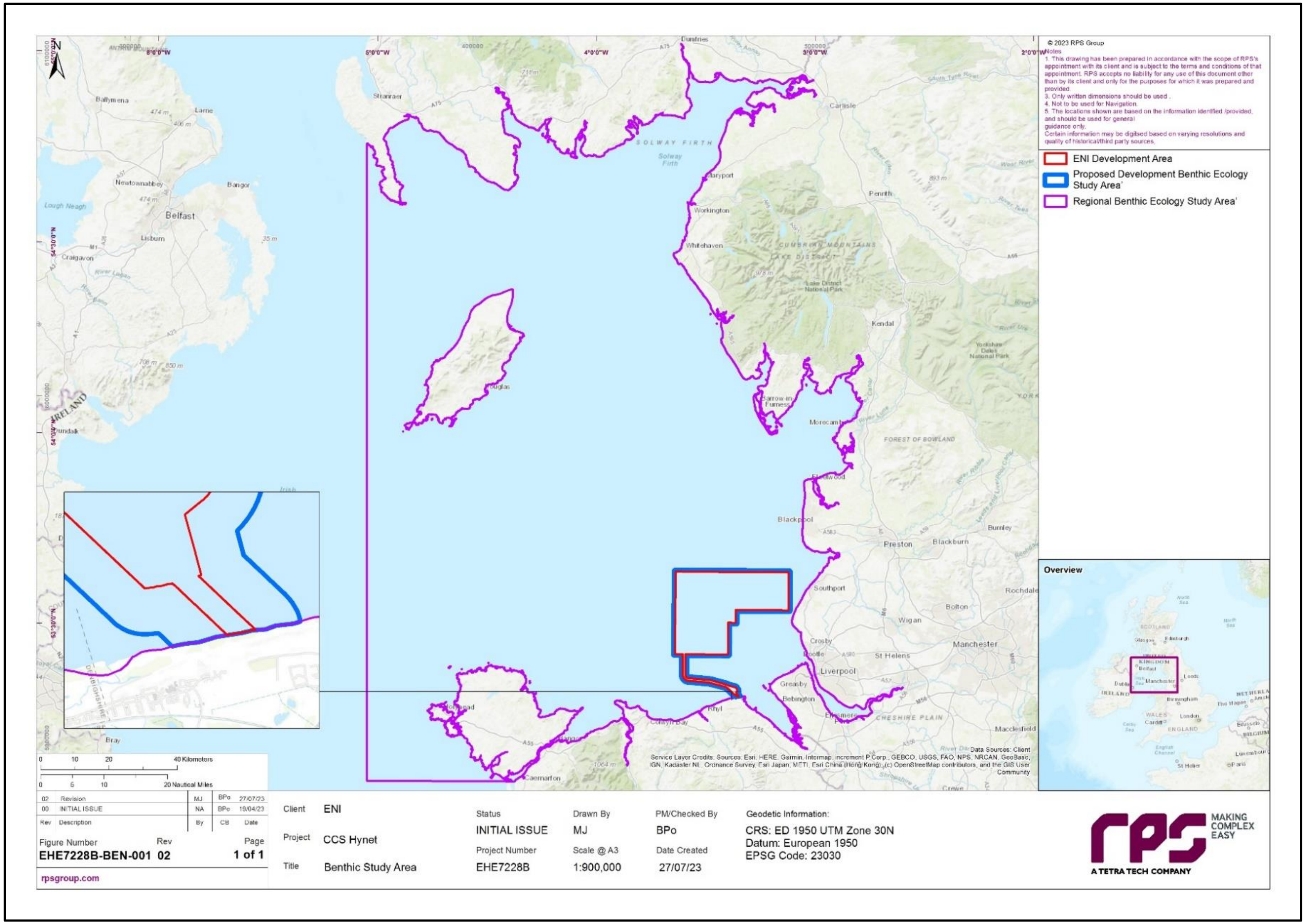

Figure 7.1: Benthic Ecology Study Area

7.8.1.2 Desktop Datasets

Information on benthic ecology was collected through a detailed desktop review of existing studies and datasets. These are summarised at Table 7.8 below. Further, two site-specific benthic surveys were undertaken in 2022, the results of which were used to characterise the benthic ecology baseline. Brief details on this survey are provided in Table 7.6, with a thorough summary presented in volume 3, RPS Group (2024a) and presented in full in volume 3, Ocean Ecology and RPS Group (2023) and RPS Group (2023c).

Table 7.8: Summary Of Key Desktop Reports For The Characterisation Of The Benthic Subtidal And Interdial Ecology Baseline

Title	Source	Year	Author
UK Offshore Energy Strategic Environmental Assessment Future Leasing/Licensing for Offshore Renewable Energy, Offshore Oil & Gas and Gas Storage and Associated Infrastructure OESEA4 2022 Environmental Report	BEIS	2022	BEIS
NBN Atlas	NBN Atlas	2021	NBN Atlas
Awel y Môr Preliminary Environmental Information Report: volume 2, Chapter 5: Benthic Subtidal and Intertidal Ecology	RWE Renewables UK	2021	RWE Renewables UK, 2021a
Awel y Môr Preliminary Environmental Information Report: volume 4: Annex 5.3: Benthic Ecology Intertidal Characterisation	RWE Renewables UK	2021	RWE Renewables UK, 2021b
JNCC MPA Mapper	JNCC	2020	JNCC
European Union (EU) SeaMap	European Marine Observations and Data Network (EMODNet)	2019	EMODnet
Subtidal Ecology: In: Manx Marine Environmental Assessment (2nd Edition)	The Government of the Isle of Man	2018	Howe, 2018a
A big data approach to macrofaunal baseline assessment, monitoring and sustainable exploration of the seabed	Centre for Environment, Fisheries, and Aquaculture Science (Cefas)	2017	Cooper and Barry
Dredged material disposal site monitoring around the coast of England: results of sampling (2015-2016).	Cefas	2016	Bolam *et al.*
Burbo Bank OWF Benthic and Annex I Habitat Pre-construction Survey Field Report	Burbo Bank OWF (UK) Ltd and DONG Energy	2015	Centre for Marine and Coastal Studies (CMACS)
Rhiannon OWF Preliminary Environmental Information Chapter 9 Benthic Ecology	Celtic Array Ltd.	2014	Celtic Array Ltd. 2014a
Walney OWF Year 3 postconstruction benthic monitoring technical survey report (2014 survey).	Walney OWF (UK) Ltd and DONG Energy	2014	CMACS

Title	Source	Year	Author
Burbo Bank Extension OWF Environmental Statement volume 2 – Chapter 12: Subtidal and Intertidal Benthic Ecology	DONG Energy	2013	DONG Energy, 2013a
Volume 1 Environmental Statement Walney Extension, Chapter 10: Benthic Ecology	DONG Energy	2013	DONG Energy, 2013b
Ormonde OWF Year 1 post-construction benthic monitoring technical survey report (2012 survey)	RPS Energy	2012	CMACS, 2012a
Walney OWF Year 1 post construction benthic monitoring technical survey report (2012 survey)	Walney OWF (UK) Ltd and DONG Energy	2012	CMACS, 2012b
Burbo Bank Extension OWF EIA Scoping Report	DONG Energy	2010	Sørensen *et al*.
Burbo Bank OWF Pre-construction Contaminants Investigation	Burbo Bank OWF (UK) Ltd and DONG Energy	2005	CMACS, 2005a
Gwynt y Môr OWF Marine Ecology Technical Report	Centre for Marine and Coastal Studies (CMACS)	2005	CMACS, 2005b
Gwynt y Môr OWF Environmental Statement volume 1	npower renewables Ltd. and Gwynt y Môr OWF	2005	npower renewables Ltd.
Post-construction Results from The North Hoyle OWF	North Hoyle OWF	2005	May
Broadscale seabed survey to the east of the Isle of Man	The University of Liverpool for British Petroleum	1997	Holt *et al.*
Offshore benthic communities of the Irish Sea	Mackie	1990	Mackie

7.8.1.3 Subtidal Sediments

Overall, the regional benthic ecology study area was predominantly comprised of deep circalittoral coarse sediment, circalittoral sandy mud, circalittoral fine sand, circalittoral muddy sand, and deep circalittoral sand (EMODnet, 2019). Tide-swept circalittoral mixed sediments are present in deeper sections, such as in the south of the regional benthic ecology study area (BEIS, 2022). In the nearshore, along the North Wales coast and west coast of England, the sediment is largely sandy mud or muddy sand (BEIS, 2022). Liverpool Bay, and more specifically the regional benthic ecology study area, is therefore largely comprised of sandy, gravelly and muddy sediments.

Overall, the Proposed Development benthic ecology study area was predominantly comprised of deep circalittoral coarse sediment, circalittoral coarse sediment, circalittoral find sand or circalittoral muddy sand, and deep circalittoral sand (EMODnet, 2019). The results of the site-specific survey demonstrated varying amounts of mud, gravel, and sand across the sampling stations, with sand being the main component. Finer sediments were also recorded in the decommissioning sampling stations, which could be associated with drill cuttings. No known Annex I Sandbanks, or OSPAR threatened and declining habitats found to be located within the Proposed Development benthic ecology study area. However, there was a small area of Annex I Reef located within the Proposed Development along the northern border. Furthermore, Subtidal Mixed Muddy

Sediment, which is listed as a HPI under the UK Post-2010 Biodiversity Framework, was identified across the south-west of the Proposed Development.

7.8.1.4 Sediment Contamination

Arsenic (As) and Cadmium (Cd) exceeded Cefas Action Level (AL) 1 at one sampling station each (GS23 and GS34, respectively), and Mercury (Hg) was above the OSPAR Background Assessment Concentration (BAC) levels in seven sampling stations (GS10, GS31, GS32, GS33, GS34, GS66, GS68). Zinc (Zn) was the most abundant metal across all samples; however, concentrations never exceeded any reference levels. All metals occurred in concentrations comparable to existing background data or in line with the range of concentrations known for areas located in proximity of active platforms. None of the polycyclic aromatic hydrocarbons (PAHs) exceeded Cefas AL1 at any of the CCS and full decommissioning stations, while chrysene and benzo[a]pyrene were above Cefas AL1 at one partial decommissioning station (GS36). A positive correlation was observed between chrysene, benzo[a]pyrene and mud content with higher PAHs concentrations in muddier sediments apart from station GS36 which had the highest chrysene and benzo[a]pyrene concentrations but an average mud content. No relationship was observed between the concentration of PAHs and proximity to platforms that could have indicated dispersal of drill cuttings. Total hydrocarbon content (THC) was the highest (30,600 µg/kg) at partial decommissioning station GS36, where chrysene and benzo[a]pyrene were found to exceed Cefas AL1. In the North Sea, THC concentrations at locations between 1 and 2 km from an active platform range between 32,710 µg/kg and 33,810 µg/kg, in line with the findings at station GS36 which was located in proximity of a platform. All polychlorinated biphenyls (PCBs) were measured below detection limits at all CCS stations and did not exceed Cefas AL1 at any of the decommissioning stations. All organotins measured (dibutyltin and tributyltin) were below the detection limit at all sampling stations.

7.8.1.5 Seabed Communities

A diverse macrobenthic assemblage was identified across the site-specific survey area, including both CCS and decommissioning areas. A total of 2,001 individuals and 215 taxa recorded across CCS stations, with the brittlestar *Amphiura filiformis* being the most abundantly recorded taxon accounting for 15.3% of all individuals identified. Key epifaunal taxa identified in CCS samples were the tube worm *Spirobranchus triqueter*, which accounted for 20% of all individuals, and Actinaria which was identified in 30% of all samples. A total of 13,332 individuals and 322 taxa were recorded within decommissioning samples. Most decommissioning stations were characterised by the presence of Nemertea and *Kurtiella bidentata*, which occurred in 98% of samples. The epifaunal community was characterised by relatively high numbers of the common brittlestar *Ophiothrix fragilis* and Actiniaria, with the latter being also the most frequently occurring taxon.

The Particle Size Analysis (PSA) and the macrobenthic data clearly indicated the presence of a heterogeneous substrate and a diverse macrobenthic community across the site-specific survey area. Despite sand being the dominant size fraction at all sampling stations, the relative contributions of mud and gravel greatly varied among stations, resulting in the presence of an intricate mosaic of substrates across the survey area. Sediment heterogeneity and the diverse macrobenthic community observed meant that no clear biotopes could be defined. As such, EUNIS classifications were limited to a EUNIS level 4 at most stations. However, several biotopes illustrative of the HPIs ‘Subtidal sands and gravels’ and ‘Mud habitats in deep water’ were identified (Table 7.10).

7.8.1.6 Intertidal Communities

The Phase 1 Intertidal Walkover survey recorded a range of species and biotopes typical for the area, and commonly occurring around the UK. The survey area was within the Dee Estuary/Aber Dyfrdwy SAC. A primary reason for the selection of this SAC was the Annex I Habitat (1140) Mudflats and sandflats not covered by seawater at low tide. This habitat includes the following biotopes which were recorded in the survey area:

- Talitrids on the upper shore and strand-line (LS.Lsa.St.Tal);
- Polychaete/bivalve-dominated muddy sand shores (LS.LSa.MuSa);
- Barren or amphipod-dominated mobile sand shores (LS.LSa.MoSa); and

- *Macoma balthica* and *Arenicola marina* in littoral muddy sand (LS.LSa.MuSa.MacAre).

Species recorded during this intertidal survey included polychaetes (A. *marina, L. koreni, A. defodiens, O. fusiformis, L. conchilega*, and *Glycera* sp.), bivalves (*M. Balthica, M. Tenius,* and *S. plana*), gastropods (*L. littorea* and *P. catenus*), and various fish and shellfish species (such as green shore crab *Carcinus maenus*, common cockle *Cerastoderma edule*, brown shrimp *Crangon crangon*, and juvenile flatfish).

7.8.1.7 Designated Sites

There are a number of designated sites that occur within the regional benthic ecology study area. These sites are further detailed in Table 7.9. Several of these sites are included in the Natural England and JNCC advice document on key sensitivities of habitats and MPAs to offshore cabling (Natural England and JNCC, 2019). These include: the Solway Firth SAC, West of Copeland MCZ, West of Walney MCZ, Morecambe Bay SAC, Shell Flat and Lune Deep SAC, and the Dee Estuary SAC/Aber Dyfrdwy SAC.

Table 7.9: Sites Designated For Relevant Benthic Subtidal And Intertidal Qualifying Features Located Within The Regional Benthic Ecology Study Area

Designated Site	Minimum Distance to Proposed Development (km)	Site Description and Qualifying Features Related to Benthic Subtidal and Intertidal Ecology
Fylde MCZ	0.00	The Fylde MCZ was designated in 2013 in order to maintain the broadscale habitat “subtidal sand” and the habitat of conservation importance “subtidal sands and gravels”, which are situated within the MCZ boundary. **Relevant Qualifying Features:** subtidal sand (EUNIS Habitat A5.3) and subtidal mud (EUNIS Habitat A5.3). These habitats are highly productive and have been shown to support diverse bivalve mollusc populations, including species the nut shell *Nucula nitidosa*, razor shell *Pharus legumen* and white furrow shell *Abra alba* (Natural England, 2019).
Dee Estuary SAC/Aber Dyfrdwy SAC	0.00	The Dee Estuary is one of the largest estuaries within the UK, comprising an area of over 140 km^2, with an intertidal area made up of predominantly mudflats, sandflats and saltmarsh. The estuary lies on the boundary between England and Wales. **Relevant Qualifying Features:** the following Annex I habitats are primary reasons for the designation of this SAC: Mudflats and sandflats that are not covered by seawater at low tide (1140), Salicornia and other annuals colonizing mud and sand (1310), and Atlantic salt meadows *Glauco-Puccinellietalia maritimae* (1330). Annex 1 Estuaries (1130) are also present, but not a primary reason for designation (JNCC, 2023a).
Ribble Estuary SSSI	2.70	The Ribble Estuary SSSI is located on the coast of Lancashire and Merseyside and covers an area of 92.26 km^2. The SSSI also contains the Ribble Marshes National Nature Reserve. **Relevant Qualifying Features:** A survey in the north of the site (Natural England, 2015), near Lytham-St-Annes, found the upper shore to be characterised by sandy habitat with a range of polychaete species and amphipods. The fauna in sediments on the lower shore area identifying high numbers of juvenile brittlestars and fragments of hydroids and bryozoans. A large number of empty razor shells *Ensis* spp. were also present scattered over the sediment surface.

Designated Site	Minimum Distance to Proposed Development (km)	Site Description and Qualifying Features Related to Benthic Subtidal and Intertidal Ecology
Menai Strait and Conwy Bay SAC/Y Fenai a Bae Conwy SAC	13.54	The Menai Strait and Conwy Bay SAC is located in north-west Wales and characterised as having unique physiographic conditions that are critical for marine wildlife (NRW, 2018). The variations in sediment composition, water clarity, and tidal regime result in a diverse collection of marine communities (NRW, 2018). **Relevant Qualifying Features:** the following Annex I habitats are primary reasons for the designation of this SAC: Mudflats and sandflats that are not covered by seawater at low tide (1140), Sandbanks which are slightly covered by sea water all the time (1110), and Reefs (1170). Annex 1 Large shallow inlets and bays (1160) and Submerged or partially submerged sea caves (8330) are also present, but not a primary reason for designation (JNCC, Ocean Ecology and RPS Group (2023)).
Shell Flat and Lune Deep SAC	15.18	The Shell Flat and Lune Deep SAC is located approximately 3 and 20 km from the east of the Lancashire Coast, at the mouth of Morecambe Bay, and is named after the deep water channel at Lune Deep and large sandbank features (Shell Flat) in the north and south of the SAC (JNCC, 2023b). **Relevant Qualifying Features:** Annex I Sandbanks which are slightly covered by sea water all the time (1110) and Reefs (1170) are the primary reasons for the designation of the SAC (JNCC, 2023b).
Creigiau Rhiwledyn/Little Ormes Head SSSI	15.45	Creigiau Rhiwledyn/Little Ormes Head SSSI is located on the north Wales coastline and overlaps the Y Fenai a Bae Conwy/Menai Strait and Conwy Bay SAC. This SSSI covers an area of 0.36 km^2 (Countryside Council for Wales (CCW), 2002). **Relevant Qualifying Features:** This site is notable for various marine biological features including specialised and nationally scarce cave, rockpool, overhang and rock-boring bivalve biotopes (physical habitats and their associated community of species including animals and plants) within the intertidal zone (CCW, 2002).
Pen Y Gogarth/Great Ormes Head SSSI	18.29	Pen Y Gogarth/Great Ormes Head SSSI is located on the north Wales coastline and overlaps the Y Fenai a Bae Conwy/Menai Strait and Conwy Bay SAC, and covers an area of 3.03 km^2 (CCW, 2013). **Relevant Qualifying Features:** This site is notable for having a large area of moderately exposed rock, supporting a complete zonation of marine biotopes. It also has specialised and nationally scarce flora and fauna, most typically associated with rock pool, cave and limestone rock habitats found between the Great Orme and the Solway Firth (CCW, 2013).
Aber Afon/Conwy SSSI	21.43	Aber Afon/Conwy SSSI is located on the north Wales coastline, at the mouth of the river Conwy and overlapping with the Y Fenai a Bae Conwy/Menai Strait and Conwy Bay SAC, and covers an area of 12.95 km^2 (CCW, 2003). **Relevant Qualifying Features:** This site is notable as a high-quality example of an intertidal estuarine community (CCW, 2003). The site supports nationally important 'piddock' communities on eulittoral peat, eulittoral firm clay with blue mussel, lower eulittoral soft

Designated Site	Minimum Distance to Proposed Development (km)	Site Description and Qualifying Features Related to Benthic Subtidal and Intertidal Ecology
		rock with toothed wrack *Fucus serratus* and sublittoral fringe soft rock with oarweed *Laminaria digitata* (CCW, 2003). In addition, the site supports specialised communities of shallow pools on mixed substrata with hydroids, ephemeral algae and common periwinkle *Littorina littorea* (CCW, 2003).
Morecambe Bay SAC	26.50	The Morecambe Bay SAC is a predominantly sandy bay at the confluence of the Leven, Kent, Lune and Wyre estuaries. It is one of the largest areas of intertidal flats in Britain and includes various habitat and sediment types (JNCC, 2023d). **Relevant Qualifying Features**: the following Annex I habitats are primary reasons for the designation of this SAC: Estuaries (1130), Mudflats and sandflats that are not covered by seawater at low tide (1140), Large shallow inlets and bays (1160), Salicornia and other annuals colonizing mud and sand (1310), and Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) (1330). Annex 1 Sandbanks which are slightly covered by seawater all the time (1110), Coastal lagoons (1150), and Reefs (1170) are also present, but not a primary reason for designation (JNCC, 2023d).
West of Walney MCZ	28.73	The West of Walney MCZ is located offshore of Walney Island, Cumbria, and covers a total area of 388 km^2. The seabed habitat within the West of Walney MCZ is predominantly comprised of subtidal mud. This broad-scale habitat feature is considered part of an area known as the eastern Irish Sea mud belt. Sea-pen and burrowing megafauna communities (which is considered Threatened and/or Declining habitat in the north-east Atlantic, and specifically in the Irish Sea, by the OSPAR commission) makes up a component part of the subtidal mud habitat occurring within the site's boundary. This habitat is characterised by the presence of sea-pens (feather-like soft corals) and burrowing animals such as mud shrimp *Corophium valuator* and the Norway lobster *Nephrops norvegicus*, which is a commercially important species (JNCC, 2021a) **Relevant Qualifying Features:** Subtidal sand (EUNIS Habitat A5.3), Subtidal mud (EUNIS Habitat A5.3), and Sea-pen and burrowing megafauna communities (OSPAR list of threatened or declining habitats).
West of Copeland MCZ	47.13	The West of Copeland MCZ covers an area of 158 km^2, with seabed comprising of predominatly subtidal sand and subtidal coarse sediments. These habitats support a range of benthic species, such as worms, sea urchins, anemones, crustaceans, molluscs, and sea mats (JNCC, 2021b). **Relevant Qualifying Features:** subtidal coarse sediments (A5.1), subtidal sand (A5.2), and subtidal mixed sediments (A5.4) (JNCC, 2021b).
Drigg Coast SAC	70.06	The Drigg Coast SAC encompasses around 11 km, and is composed of extensive sand dunes, saltmarsh, intertidal mudflats and sandflats, and estuaries (MMO, 2019). **Relevant Qualifying Features:** The Annex I habitat, Estuaries (1130), present as a primary feature for site selection. Furthermore, the following Annex I habitats

Designated Site	Minimum Distance to Proposed Development (km)	Site Description and Qualifying Features Related to Benthic Subtidal and Intertidal Ecology
		are also present as qualifying features but not primary reasons for site selection: Mudflats and sandflats not covered by seawater at low tide (1140), Atlantic salt meadows (Glauco-Puccinellietalia maritimae) (1330), and Salicornia and other annuals colonizing mud and sand (1310) (JNCC, 2023g).
Isle of Man Marine Nature Reserves (MNRs)	70.06 to 91.05	There are ten MNRs around the Isle of Man, encompassing 10.8% of Manx waters: Baie Ny Carrickey, Calf and Wart Bank, Douglas Bay, Langness, Laxey Bay, Little Ness, Niarbyl Bay, Port Erin Bay, Ramsay Bay, and West Coast (Manx Wildlife Trust, 2023). **Relevant Qualifying Features:** although it varies between site, these MNRs are collectively designated for maerl, rocky reefs, kelp forests, eelgrass beds, brittlestar beds, sea caves, subtidal sandbanks, sea anemones, ocean quahog *Arctica islandica*, and the nudibranch *Cumanotus beaumonti* (Designation of MNR Guidance Notes, undated). Under Section 33 of the Wildlife Act (1990), the following benthic subtidal and intertidal features cannot be removed or damaged in any of the Isle of Man MNRs: maerl, rocky reefs, sea anemones, ocean quahog, and sea caves (Manx Marine Nature Reserves Byelaw, 2018).
Cumbria Coast MCZ	73.09	The Cumbria Coast MCZ is located on the west coast of England and stretches for approximately 27 km along the coast, covering a total area of 22 km^2 (Department for Environment, Food, and Rural Affairs (DEFRA), 2019d). This site is notable as it is an extensive and important example of intertidal rocky shore habitats and associated communities on the sedimentary coast of north-west England (DEFRA, 2019d). **Relevant Qualifying Features:** high energy intertidal rock, honeycomb worm *Sabellaria alveolata* reefs, intertidal biogenic reefs, intertidal sand and muddy sand, intertidal underboulder communities, moderate energy infralittoral rock, and peat and clay exposures (DEFRA, 2019d).
Allonby Bay MCZ	116.32	The Allonby Bay MCZ is an inshore site on the English side of the Solway Firth, covering approximately 40 km^2. **Relevant Qualifying Features:** intertidal biogenic reefs, intertidal coarse sediment, intertidal sand and muddy sand, moderate energy infralittoral rock, subtidal biogenic reefs, subtidal coarse sediments, subtidal sand, subtidal mixed sediments, and *S. alveolate* beds (DEFRA), 2016).
Luce Bay and Sands SAC	122.06	The Luce Bay and Sands SAC is located on the south-west coast of Scotland. The variation in physical and environmental conditions throughout the site, including rock and soft sediment types, water clarity and exposure to tidal currents and wave action result in a wide range of habitats and associated marine communities (JNCC, 2023t). **Relevant Qualifying Features:** The Annex I habitats Large shallow intlets and bays (1160) and Shifting dunes along the shoreline with *Ammophila arenaria* (2120) are present as primary features for site

Designated Site	Minimum Distance to Proposed Development (km)	Site Description and Qualifying Features Related to Benthic Subtidal and Intertidal Ecology
		selection. Furthermore, the Annex I habitats Reefs (1170), Sandbanks which are slightly covered by seawater at all time (1110), and Mudflats and sandflats not covered by seawater at low tide (1140) are present as qualifying features, but not a primary reason for site selection (JNCC, 2023t).
Solway Firth SAC	123.85	Solway Firth SAC is a large, shallow, and complex estuary with a diverse mix of intertidal habitats (tidal rivers, estuaries, mud flats, sand flats, lagoons, salt marshes and salt steppes) (JNCC, 2023f). **Relevant Qualifying Features:** The Annex I habitats Estuaries (1130), Sandbanks which are slightly covered by sea water at all times (1110), Mudflats and sandflats not covered by seawater at low tide (1140), Salicornia and other annuals colonizing mud and sand (1310), and Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) are present as primary features for site selection. Furthermore, the Annex I habitat: Reefs (1170) is present as a qualifying feature, but not a primary reason for site selection (JNCC, 2023f).

7.8.1.8 IEFS

As detailed in section 7.7, the valuation of benthic subtidal and intertidal IEFs is defined at four levels: international, national, regional, and local. IEFs identified within the regional benthic ecology study area are presented in Table 7.10.

Table 7.10: Benthic Subtidal And Intertidal IEFs Within The Proposed Development Benthic Ecology Study Area

IEF	Description and Illustrative Biotopes	Importance within the Proposed Development Benthic Ecology Study Area	Justification
Subtidal Habitats and Species			
Subtidal Sands and Gravels	Subtidal sands and gravel sediments are the most common habitats found below the level of the lowest low tide around the coast of the United Kingdom and Ireland. Illustrative biotopes identified within the Proposed Development were: • Circalittoral coarse sediment (SS.SCS.CCS; A5.14) – *Mediomastus fragilis, Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel (SS.SCS.CCS.MedLumVen) • Infralittoral fine sand (SS.SSa.IfiSav; A5.23) – *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand (SS.SSa.IFiSa.NcirBat) • Circalittoral fine sand (SS.SSa.CfiSa; A5.25) • Circalittoral muddy sand (SS.SSa.CmuSa; A5.26)	National	HPI under the UK Post-2010 Biodiversity Framework.
Mud Habitats in Deep Water	Mud habitats in deep water (circalittoral muds) that occur below 20 to 30 m in many areas of the UK and Ireland's marine environment. Illustrative biotopes identified within the Proposed Development were: • Circalittoral sandy mud (SS.SMu.CsaMu; A5.35) – *Amphiura filiformis, Kurtiella bidentata* and *Abra nitida* in circalittoral sandy mud (SS.SMu.CSaMu.AfilKurAnit)	National	HPI under the UK Post-2010 Biodiversity Framework.
Subtidal Mixed Muddy Sediment	Subtidal Mixed Muddy Sediment was identified across the southern Proposed Development. This habitat may support a wide range of infauna and epibiota, including polychaetes, bivalves, echinoderms, anemones, hydroids and Bryozoa. Illustrative biotopes identified within the Proposed Development were: • *O. fragilis* and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment (SS.SMx.CMx.OphMx).	National	OSPAR list of threatened and/or declining habitats and a HPI under the UK Post-2010 Biodiversity Framework.

IEF	Description and Illustrative Biotopes	Importance within the Proposed Development Benthic Ecology Study Area	Justification
Annex I Reef	An area of Annex I Reef was identified within the north of the Proposed Development (Figure 7.4). Representative biotopes are not available for this reef, however, based on existing habitat mapping derived from the JNCC, bedrock or stony reefs are thought to be present. In the assessment, it will be assessed alongside the other subtidal habitats and species IEFs.	National	Annex I Habitat out with an SAC boundary that overlaps with the Proposed Development.
Ross Worm (*Sabellaria spinulosa*)	A filter-feeding polychaete worm which can form biogenic reefs on the seabed and intertidal zone.	Local	*S. spinulosa* reefs are listed on the OSPAR list of threatened and/or declining habitats and a HPI under the UK Post-2010 Biodiversity Framework. However, no reefs were identified, only individual animals.
Intertidal Habitats and Species			
Mudflats and sandflats not covered by seawater at low tide	The following habitats were recorded during the Phase 1 Intertidal Walkover Survey, and are included in the Annex I Habitat Mudflats and sandflats not covered by seawater at low tide (1140): • Talitrids on the upper shore and strand-line (LS.Lsa.St.Tal) • Polychaete/bivalve-dominated muddy sand shores (LS.LSa.MuSa) • Barren or amphipod-dominated mobile sand shores (LS.LSa.MoSa) • *M. balthica* and *A. marina* in littoral muddy sand (LS.LSa.MuSa.MacAre).	International	Annex I Habitat that overlaps with the Proposed Development. This habitat is a qualifying feature of the Dee Estuary/Aber Dyfrdwy SAC (see row below).
Designated Sites			
Dee Estuary/Aber Dyfrdwy SAC	The Dee Estuary is one of the largest estuaries within the UK, comprising an area of over 140 km^2, with an intertidal area made up of predominantly mudflats, sandflats and saltmarsh. The estuary lies on the boundary between England and Wales. The SAC is designated for the following Annex I Habitats: Mudflats and sandflats not covered by seawater at low tide (1140) and 1130 Estuaries (1130) (JNCC, 2023a). Mudflats and sandflats not covered by seawater at low tide are extensive	International	The Dee Estuary/Aber Dyfrdwy SAC is an internationally designated site which overlaps with the Proposed Development. The SAC overlaps with 0.21 km^2, which accounts for 0.13% of the total SAC area. Several Annex I Habitats are listed as qualifying features of this SAC.

IEF	Description and Illustrative Biotopes	Importance within the Proposed Development Benthic Ecology Study Area	Justification
	throughout the site and are present in the intertidal sections which overlap with the Proposed Development. For example, the sandy areas between Prestatyn and the Point of Ayr (PoA) mainly consist of mobile sands dominated by amphipods and polychaetes (Natural England and CCW, 2010). Although no defined biotopes are available, those presented for the Mudflats and sandflats not covered by seawater at low tide IEF above will also be applicable to the Dee Estuary/Aber Dyfrdwy SAC and used in the assessment.		
Fylde MCZ	Highly productive sediments of subtidal sand and subtidal mud that support a range of crustaceans, starfish, and shellfish, such as small nut-shell, razor shell, and white furrow shell. The area of the Fylde MCZ which overlaps with the Proposed Development has been assigned the biotope: Sublittoral sands and muddy sands (SS.SSa) (Envision Mapping, 2015), however has not been assigned more specific biotopes. As this area overlaps with the Subtidal sands and gravels IEF identified during the site-specific survey within the Proposed Development, the representative biotopes will also be used to characterise the Fylde MCZ in the assessment.	National	The Fylde MCZ is a nationally designated site which overlaps with the Proposed Development at parts. It overlaps with 41.40 km^2, which accounts for 15.87% of the total MCZ area.

7.8.1.9 Future Baseline Scenario

As per Offshore Oil & Gas Exploration, Production, Unloading and storage (Environmental Impact Assessment) Regulations 2020 and the Marine Works (Environmental Impact Assessment) Regulations 2007, an assessment of the future baseline conditions has been carried out in the event that the Proposed Development does not come forward. This is presented for each marine biodiversity topic, presented here for benthic subtidal and intertidal ecology, in section 7.8.2.10 for fish and shellfish, and in section 7.8.3.9 for marine mammals and marine turtles.

The baseline environment presented in this section and in volume 3, RPS Group (2024a) is extensive, and accurately representative, accounting for seasonality and interannual variability. However, this baseline is not static, and will exhibit larger degrees of natural change over longer time periods, due to naturally occurring cycles and processes and any potential changes resulting from climate change. This long-term change will occur even if the Proposed Development does not come forward. Thus, it will be necessary to contextualise any potential impacts that might occur over the expected 25-year operational lifetime of the Proposed Development when undertaking impact assessments.

In addition to the effects of climate change on the marine environment, variability and long-term changes on physical processes may cause direct and indirect effects to benthic habitats and communities in the mid to long term future (Department of Energy and Climate Change (DECC), 2016). The best evidence indicates that long term changes to benthic ecology may be related to long term changes in the climate or in nutrients (DECC, 2016), with shifts in abundances and species composition being driven by climatic processes. Currently, benthic communities are also influenced by anthropogenic activities. These include pollution and contamination, and seabed disturbing activities such as dredging, trawling, and development. A scientific review by the Marine Climate Change Impacts Partnership (MCCIP) concluded that climatic processes both directly (e.g. winter mortality), and indirectly (e.g. via hydrographic conditions), influence the abundance and species composition of seabed communities (MCCIP, 2008). In turn, alteration to the seabed communities could alter rates and timing of processes such as nutrient cycling, planktonic larval supply, and organic waste assimilation. Recently, DEFRA's focus on the risk of climate change to ecosystem services has centred on the following topics:

- INNS and their likely detriment to native communities and ecosystems;
- the increased risk to species as their distributions shift of disease from new pathogens; and
- the impacts on areas of high biodiversity value in the coastal zone from increased storms and erosion (HM Government, 2022).

DEFRA also highlight the risks associated with ocean acidification and higher water temperatures which are linked to climatic changes (HM Government, 2022).

7.8.2 Fish and Shellfish ecology

7.8.2.1 Study Area

Fish and shellfish are known to be highly variable, both spatially and temporally. Therefore, to effectively characterise the fish and shellfish ecology baseline, two study areas have been defined:

- The regional fish and shellfish ecology study area includes waters within England, Ireland, Wales, Scotland and the Isle of Man. The regional fish and shellfish ecology study area will allow for the characterisation of fish and shellfish receptors within the eastern Irish Sea, accounting for migration and additional spatial and temporal variability. The regional fish and shellfish ecology study area is therefore defined as the area encompassing the ICES Statistical Area VIIa, Proposed Development, offshore pipelines (including intertidal habitats up to the MHWS), and associated cables in Liverpool Bay (Figure 7.2).
- Where information is available, fish and shellfish ecology has been assessed on a local scale, within the Proposed Development fish and shellfish ecology study area. This area is the same as the Proposed Development, which includes the offshore pipelines (including intertidal habitats up to the MHWS) and associated cables in Liverpool Bay (Figure 7.2).

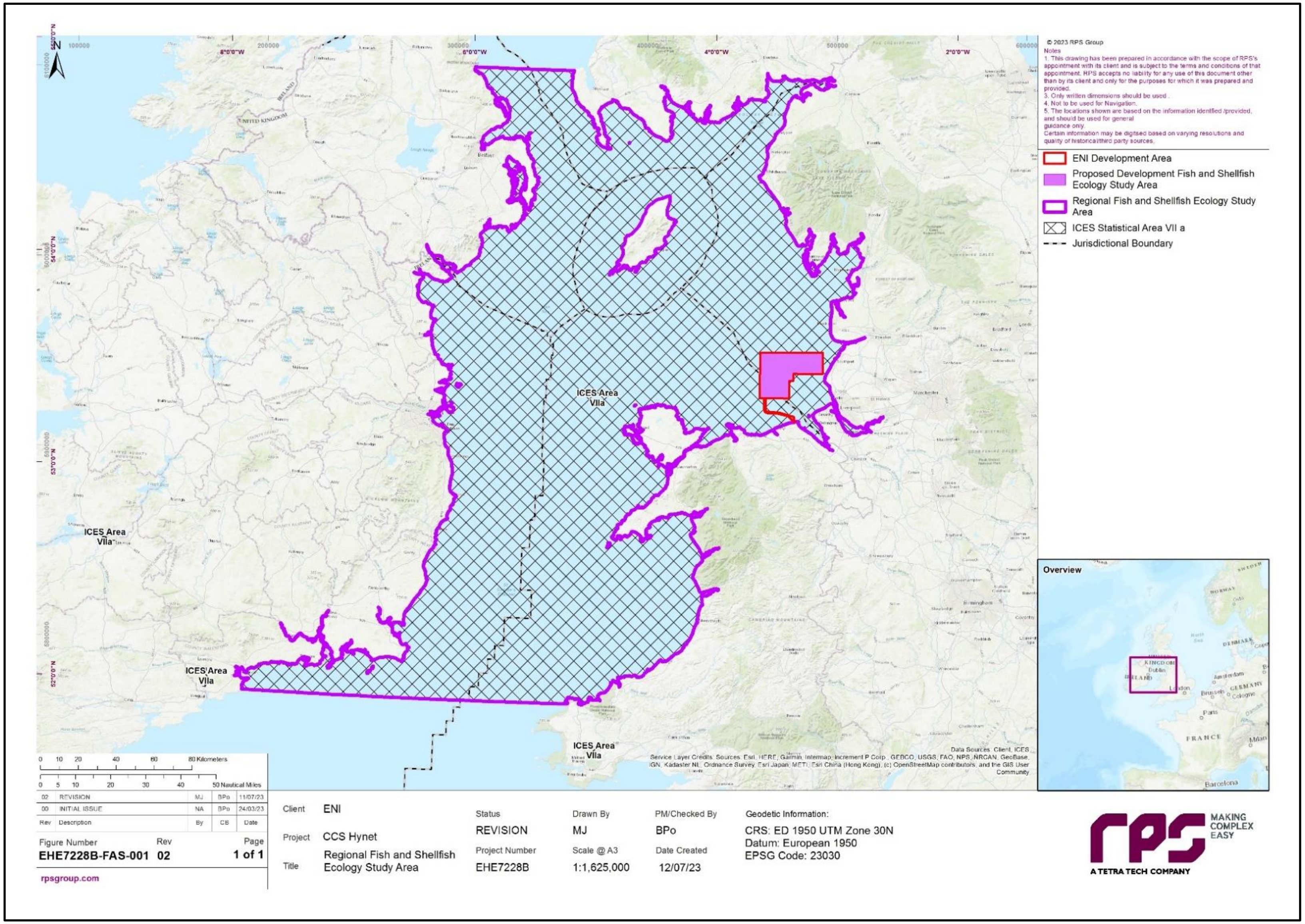

Figure 7.2: Regional Fish And Shellfish Ecology Study Area

7.8.2.2 Desktop Datasets

The fish and shellfish ecology baseline within the regional fish and shellfish ecology study area was characterised by a thorough review of key desktop datasets. Information on these and full details are presented in volume 3, RPS Group (2024a), and a summary of the key desktop sources utilised is presented in Table 7.11.

Table 7.11: Summary Of Key Desktop Reports For The Characterisation Of The Fish And Shellfish Ecology Baseline

Title	Source	Year	Author
Fishbase Species Records	Fishbase	2023	Fishbase
National Parks and Wildlife Service (NPWS) Designations Viewer	NPWS	2023	NPWS
Celtic Seas ecoregion – Fisheries overview, including mixed-fisheries considerations	International Council for the Exploration of the Seas (ICES)	2022	ICES
Review of the Irish Sea	Irish Sea Network	2022	Irish Sea Network
CMACS Rhly Flats OWF Benthic Grab Survey, 2006 Survey	Ryhl Flats OWF	2021	Marine Data Exchange
NBN Atlas	NBN Atlas	2021	NBN Atlas
Spawning and nursery grounds of forage fish in Welsh and surrounding waters	Cefas	2021	Campanella and van der Kooij
Pressures on forage fish in Welsh Waters	Cefas	2021	van der Kooij *et al.*
JNCC MPA Mapper	JNCC	2020	JNCC
Bass and Ray Ecology in Liverpool Bay	Bangor University	2020	Moore *et al.*
Marine Life Information Network (MarLIN): Biology and Sensitivity Key Information Reviews	MarLin and Plymouth Marine Biological Association of the United Kingdom	2007 – 2020	MarLIN (assorted authors)
Application for Offshore Carbon Storage Licence Environmental Appendix Liverpool Bay Area Environmental Sensitivity Assessment	Eni	2019	Eni UK
Sectoral Marine Plan for Offshore Wind Energy. Strategic Habitat Regulations Appraisal (HRA): Screening and Appropriate Assessment Information Report – Final. Appendix I: Fish Literature Review	ABPMer	2019	ABPMer
Welsh Waters Scallop Surveys and Stock Assessment	Bangor University	2019	Delargy *et al.*

Title	Source	Year	Author
Updating fisheries sensitivity maps in British Waters	Marine Scotland	2014	Aires *et al.*
Ormonde OWF Adult and Juvenile Fish and Epi-benthic Post-construction Survey	Ormonde OWF	2013a	Brown and May Marine Ltd.
Walney Offshore Wind Farm, Year 2 Post-construction Monitoring Fish and Epibenthic Survey.	Walney OWF	2013b	Brown and May Marine Ltd.
Burbo Bank Extension Adult and Juvenile Fish Characterisation Surveys	Burbo Bank OWF	2013a	DONG Energy, 2013
Screening Spatial Interactions between Marine Aggregate Application Areas and Sandeel Habitat	MarineSpace	2013	Latto *et al.*
Screening Spatial Interactions between Marine Aggregate Application Areas and Atlantic Herring Potential Spawning Areas	MarineSpace	2013	Reach *et al.*
Spawning and nursery grounds of selected fish species in UK waters	Cefas	2012	Ellis *et al.*
Ormonde OWF Adult and Juvenile Fish and Epi-benthic Post-construction Survey	Ormonde OWF	2012a	Brown and May Marine Ltd.
West of Duddon Sands Offshore Wind Farm, Adult and Juvenile Fish and Epibenthic Pre-Construction Surveys	West of Duddon Sands OWF	2012b	Brown and May Marine Ltd.
EIA Scoping Report	Rhiannon Wind Farm Limited	2012	Centrica Energy and DONG Energy
Pre-construction monitoring 2010 survey	Gwynt y Mor OWF	2011	CMACS
Burbo Bank OWF, Year 3 Post-construction 2m beam trawl report (2009 survey)	Burbo Bank OWF	2011	SeaScape
Autumn fish trawl survey	Celtic Array (Zone 9)	2010	CMACS
Burbo Bank OWF, First Post-Construction 2m beam trawl report (2007 survey)	Burbo Bank OWF	2008	SeaScape

Title	Source	Year	Author
Burbo Bank OWF Post-construction Marine Fish 4m Beam Trawl Survey	Burbo Bank OWF	2006	CMACS
Post-construction Results from The North Hoyle OWF	North Hoyle OWF	2005	May
Gwynt y Mor Offshore Wind Farm Marine Ecology Technical Report	Gwynt y Mor OWF	2005b	CMACS
Fisheries Sensitivity Maps in British Waters	Cefas	1998	Coull *et al.*

7.8.2.3 Marine fish

There are a range of marine fish with the potential to be present within the regional fish and shellfish ecology study area, comprised of demersal, pelagic, and benthopelagic species. Demersal species include sandeels Ammodytidae, blennies Blenniiformes, gobies Gobiidae, wrasses Labridae, and a wide range of flatfish, such as flounder *Platichthys flesus*, halibut *Hippoglossus hippoglossus*, lemon sole *Microstromus kitt*, plaice *Pleuronectes platessa*, sole *Solea solea*, solenette *Buglossidium leteum*, thickback sole *Microchirus variegatus*, and turbot *Scophthalmus maximus*. Benthopelagic species include anglerfish *Lophius piscatorius*, cod *Gadus morhua*, European hake *Merluccius merluccius*, haddock *Melanogrammus aeglefinus*, ling *Molva molva*, pollock *Pollachius pollachius*, poor cod *Trisopterus minutus*, and saithe *Pollachius virens*. Finally, pelagic species include herring *Clupea harengus*, mackerel *Scomber scombrus*, sprat *Sprattus sprattus*, and potentially European anchovy *Engraulis encasicolus*, European sardine *Sardina pilchardus*, and garfish *Belone belone.*

7.8.2.4 Diadromous fish

Diadromous fish species with the potential to be present within the regional fish and shellfish ecology study area during at least one portion of their migratory life cycle include Atlantic salmon *Salmo salar,* allis shad *Alosa alosa*, European eel *Anguilla anguialla*, river lamprey *Lampetra fluviatilis*, sea lamprey *Petromyzon marinus*, sea trout *S. trutta*, smelt *Osmerus eperlanus*, and twaite shad *A. fallax*.

7.8.2.5 Elasmobranchs

Elasmobranchs (e.g. sharks, rays, and skates) with the potential to be present within the regional fish and shellfish ecology study area include basking shark *Cetorhinus maximus*, blonde ray *Raja brachyura*, common smoothhound *Mustelus mustelus*, cuckoo ray *R. naevus,* lesser spotted dogfish *Scyliorhinus canicula,* nursehound *S. stellaris*, spotted ray *R. montagui*, spurdog *Squalus acanthias*, thornback ray *R. clavata,* and tope *Galeorhinus galeus*.

7.8.2.6 Shellfish

Shellfish species with the potential to be present within the regional fish and shellfish ecology study area include molluscs such as blue mussel *Mytilus edulis*, common cockle, common whelk *Buccinum undatum*, king scallop *Pecten maximus*, queen scallop *Aequipecten opercularis*, and squid *Loligo* spp and ommastrephidae. Crustaceans include brown crab *Cancer pagurus*, brown shrimp, green shore crab, European lobster *Hommarus gammarus*, Norway lobster *Nephrops norvegicus*, spiny lobster, swimming crabs *Liocarcinus spp.*, and velvet swimming crab *Necora puber*.

In addition, freshwater pearl mussel *Margaritifera margaritifera* in rivers and streams flowing into the regional fish and shellfish ecology study area has the potential to be indirectly affected due to its obligate parasitic life cycle stage with Atlantic salmon and sea trout.

7.8.2.7 Spawning and nursing grounds

The regional fish and shellfish ecology study area provides spawning and nursery grounds for a number of ecologically and commercially important fish and shellfish species. These are briefly summarised here, with a detailed account (including figures) provided in volume 3, RPS Group (2024a).

Data from Cefas (Ellis *et al.*, 2012) and fisheries sensitivity maps (Coull *et al.*, 1998) provide spatially explicit diagrams of the nursery and/or spawning areas for key species. These data illustrate that spawning grounds for species such as cod, ling, mackerel, plaice, sandeel, sole, sprat, and whiting overlap with the Proposed Development. In addition, there are spawning grounds in the vicinity of the Proposed Development in the wider Liverpool Bay area for horse mackerel, lemon sole, and Norway lobster. Nursery grounds for anglerfish, cod, herring, mackerel, plaice, sandeel, sole, spotted ray, spurdog, thornback ray, tope shark, and whiting also overlap with the Proposed Development. In addition, there are nursery grounds in the vicinity of the Proposed Development in the wider Liverpool Bay area for haddock, lemon sole, and Norway lobster.

More recently, Aires *et al.* (2014) and Campanella and van der Kooij (2021) published reports which enhanced the spawning and nursery ground data presented in Coull *et al.* (1998) and Ellis *et al.* (2012) for certain species. Further detail on these can be found in on a species-by-species basis volume 3, RPS Group (2024a).

In addition, the results of the PSA conducted during the site-specific benthic characterisation survey (section 7.8.1) were used to assess herring and sandeel spawning habitat suitability within the Proposed Development. This was undertaken following the methodology presented in Latto *et al.* (2013) and Reach *et al.* (2013). These species spawn on the seabed and are, therefore, particularly sensitive to seabed disturbance. They have specific spawning habitat preferences, based on the composition of sands, gravels, and muds. For herring, 1.31% of all sampling stations were classified as ‘suitable’ spawning habitat, 5.26% as ‘sub-prime’, and 93.42% were ‘unsuitable’. For sandeel, a total of 14.47% of sampling stations were classified as ‘prime’ spawning habitat, 19.74% as ‘suitable’, 22.37% as ‘sub-prime’, and 43.42% as ‘unsuitable’.

7.8.2.8 Designated sites

There are a number of designated sites that occur within the Proposed Development and the regional fish and shellfish ecology study area. These sites are further detailed in Table 7.12.

Table 7.12: Sites Designated For Relevant Fish And Shellfish Qualifying Features Located Within The Regional Fish And Shellfish Ecology Study Area

Designated Site	Minimum Distance to Proposed Development (km)	Site Description and Qualifying Features Relevant to Fish and Shellfish
Dee Estuary/Aber Dyfrdwy SAC	0.00	The Dee Estuary is one of the largest estuaries within the UK, comprising an area of over 140 km^2, with an intertidal area made up of predominantly mudflats, sandflats, and saltmarsh (ENI, 2021). The estuary lies on the boundary between England and Wales. **Relevant Qualifying Features:** Annex II sea lamprey and river lamprey are present as a qualifying feature but not a primary reason for site selection (JNCC, 2023a).

Designated Site	Minimum Distance to Proposed Development (km)	Site Description and Qualifying Features Relevant to Fish and Shellfish
Ribble Estuary MCZ	9.58	The Ribble Estuary MCZ I is located on the north-west coast of England, near Preston, and covers an area of approximately 15 km^2. **Relevant Qualifying Features:** Smelt is a protected feature within the MCZ and is known to congregate in large shoals, migrating to freshwater areas to spawn. This MCZ provides crucial habitat that is necessary for smelt to complete their lifecycle (DEFRA), 2019a).
Wyre-Lune MCZ	21.45	The Wyre-Lune MCZ is located in the southern part of Morecambe Bay and covers an area of approximately 92 km^2. **Relevant Qualifying Features:** Smelt is a protected feature within the MCZ and is known to congregate in large shoals, migrating to freshwater to spawn. This MCZ provides crucial habitat that is necessary for smelt to complete their lifecycle (DEFRA, 2019b).
River Dee and Bala Lake/Afon Dyfrdwy a Llyn Tegid SAC	22.53	The River Dee is one of North Wales' premier rivers for Atlantic salmon populations, and also supports important populations of migratory lampreys and non-migratory fish, such as the brook lamprey *Lampetra planeri* and bullhead *Cottus gobio.* **Relevant Qualifying Features:** Annex II Atlantic salmon is present as a primary reason for site selection, while Annex II sea lamprey and river lamprey are present as qualifying features but not the primary reason for site designation (JNCC, 2023j).
Afon Gwyrfai a Llyn Cwellyn SAC	50.95	Afon Gwyrfai a Llyn Cwellyn is representative of small montane rivers in north-west Wales. **Relevant Qualifying Features**: Annex II Atlantic salmon are a primary reason for site designation (JNCC, 2023p)
Afon Eden - Cors Goch Trawsfynydd SAC	60.81	The tributary of the Afon Mawddach supports the only known viable freshwater pearl mussel population in Wales. **Relevant Qualifying Features**: Annex II freshwater pearl mussel are a primary reason for site designation, and Annex II Atlantic salmon are present as a qualifying feature but not a primary reason for site selection (JNCC, 2023q)
Isle of Man MNRs	70.06 – 91.05	As detailed in Table 7.9, there are ten MNRs around the Isle of Man, encompassing 10.8% of Manx waters (Manx Wildlife Trust, 2023). **Relevant Qualifying Features:** although it varies between site, these MNRs are collectively designated for basking shark, common skate *Dipturus batis*, European eel, flame shell *Limaria hians,* horse mussel, sandeel, and spiny lobster (Designation of MNR Guidance Notes, undated). Under Section 33 of the Wildlife Act (1990), the following fish and shellfish features cannot be removed or damaged in any of the Isle of Man MNRs: European eel (except by catch and release), flame shell, horse mussel, spiny lobster, king scallop, and queen scallop (Manx Marine Nature Reserves Byelaws, 2018).
River Derwent and Bassenthwaite Lake SAC	87.43	The River Derwent and Bassenthwaite Lake SAC is an inland body of water and river of approximately 18 km^2. **Relevant Qualifying Features:** Annex II sea lamprey, river lamprey, and Atlantic salmon are present as primary reasons for site selection (JNCC, 2023i).
River Ehen SAC	91.14	The River Ehen SAC supports England's largest population of Freshwater pearl mussel, which is listed on the IUCN Red List as 'critically endangered' in Europe. Atlantic salmon are also present and are involved in the complicated life histories of freshwater pearl mussel (Natural England, 2022). **Relevant Qualifying Features:** Annex II Freshwater pearl mussel are a primary reason for site selection, and Annex II Atlantic salmon are present but not a primary reason (JNCC, 2023h).
Allonby Bay MCZ	116.32	The Allonby Bay MCZ is an inshore site on the English side of the Solway Firth, covering approximately 40 km^2. **Relevant Qualifying Features:** blue mussel beds (DEFRA, 2016).

Designated Site	Minimum Distance to Proposed Development (km)	Site Description and Qualifying Features Relevant to Fish and Shellfish
River Teifi /Afon Teifi SAC	119.81	The Teifi is a predominantly mesotrophic river in mid Wales. **Relevant Qualifying Features**: Annex II Atlantic salmon and river lamprey are a primary reason for site designation, and Annex II sea lamprey are present as a qualifying feature but not a primary reason for site selection (JNCC, 2023r)
Cardigan Bay SAC/Bae Ceredigion SAC	122.76	Cardigan Bay SAC is located between Pembrokeshire and Ceredigion, extending 20 km from the coast, and protecting an area of the sea greater than 1,000 km^2. **Relevant Qualifying Features:** Annex II sea lamprey and river lamprey are present as a qualifying feature but not a primary reason for site selection (JNCC, 2023e).
Solway Firth SAC	123.85	Solway Firth SAC is a large, shallow, and complex estuary with a diverse mix of intertidal habitats (tidal rivers, estuaries, mud flats, sand flats, lagoons, salt marshes and salt steppes) (JNCC, 2023f). **Relevant Qualifying Features:** Annex II sea lamprey and river lamprey are a primary reason for site selection (JNCC, 2023f).
Solway Firth MCZ	131.87	The Solway Firth MCZ is an inshore site of approximately 45 km^2. **Relevant Qualifying Features:** Smelt is a protected feature within the MCZ, which provides critical habitat for feeding and post-larval development (DEFRA, 2019c).
Slaney River Valley SAC	198.26	The Slaney River Valley SAC overlaps Raven Point Nature Reserve SAC, The Raven SPA and Wexford Harbour and Slobs SPA (NPWS, 2011). **Relevant Qualifying Features**: The Slaney River Valley SAC is designated in part for Annex II freshwater pearl mussel, sea lamprey, river lamprey, Atlantic salmon, and twaite shad (NPWS, 2011a).

7.8.2.9 IEFs

As detailed in section 7.7, the valuation of fish and shellfish IEFs is defined at four levels: international, national, regional, and local. Fish and shellfish IEFs identified within the regional fish and shellfish ecology study area are presented in Table 7.13.

Table 7.13: Fish And Shellfish IEFs Within The Proposed Development

IEF	Scientific Name	Importance within the Proposed Development	Justification
Demersal Fish (Flatfish)			
Lemon sole	*Microstomus kitt*	Local	Undetermined and unspecified spawning and nursery grounds that do not overlap with the Proposed Development but are within the regional fish and shellfish ecology study area.
Plaice	*Pleuronectes platessa*	National	Listed as a SPI under the UK Post-2010 Biodiversity Framework. Low and high intensity spawning, and low intensity nursery grounds overlapping with the Proposed Development.
Sole	*Solea solea*	National	Listed as a SPI. Low and high intensity spawning, and nursery grounds overlapping with the Proposed Development.
Other flatfish species	-	Local	Other flatfish species, including dab (*Limanda limanda*), flounder *(Platichthys flesus*), halibut (*Hippoglossus hippoglossus*), solenette (*Buglossidium leteum*), and thickback sole (*Microchirus variegatus*), are likely to occur within the regional fish and shellfish ecology study area. These species, however, have no documented spawning or nursery grounds within the regional fish and shellfish ecology study area.
Demersal Fish (Gadoids)			
Cod	*Gadus morhua*	National	Listed as a SPI, as 'vulnerable' on the IUCN Red List, and on the OSPAR list of threatened and declining species within OSPAR Region III (Celtic Seas). High intensity spawning and nursery grounds overlap with the Proposed Development. Juvenile cod are an important forage fish species, as they provide prey for a range of larger fish, birds, and marine mammals.
Ling	*Molva molva*	National	Listed as a SPI. Low intensity spawning grounds overlap with the Proposed Development.
Whiting	*Merlangius merlangius*	National	Listed as a SPI. Low intensity spawning and high intensity nursery grounds overlap with the Proposed Development. Juvenile whiting are an important forage fish species, as they provide prey for a range of larger fish, birds, and marine mammals
Demersal Fish (Others)			
Anglerfish	*Lophius piscatorius*	National	Listed as a SPI.

IEF	Scientific Name	Importance within the Proposed Development	Justification
			Low intensity nursery grounds overlap with the Proposed Development.
Sandeel species	Ammodytidae spp.	National	Listed as a SPI. There are five sandeel species present in UK and Irish waters, with lesser sandeel *Ammodytes tobianus* and greater sandeel *Hyperoplus lanceolatus* being the most common. All sandeel species are important forage fish, as they are prey species for a wide range of larger fish, birds and marine mammals, and constitute an important component of marine food webs. High intensity spawning grounds and low intensity nursery grounds overlap with the Proposed Development. Similarly, over 50% of the sediment samples collected within the Proposed Development during the site-specific surveys indicated prime, suitable, and sub-prime spawning habitat preference.
Pelagic Fish			
Herring	*Clupea harengus*	National	Listed as a SPI. There are high intensity nursery grounds overlapping with the Proposed Development. However, the majority of sediment samples collected within the Proposed Development site-specific surveys indicated unsuitable spawning habitat preference.
Mackerel	*Scomber scombrus*	National	Listed as a SPI. Like sandeel, mackerel are an important forage fish for a range of larger fish, birds, and marine mammals and are thus, an important element of marine food webs. Low intensity spawning and nursery grounds overlap with the Proposed Development.
Sprat	*Sprattus sprattus*	Regional	Important forage fish species for a range of larger fish, birds, and marine mammals and are thus, an important element of marine food webs. Undetermined spawning grounds overlap with the Proposed Development.
Elasmobranchs			
Basking shark	*Cetorhinus maximus*	International	Listed as a SPI, under Appendix II of CITES, and under Appendix I and II of the Bonn Convention. Basking shark are also listed on the OSPAR list of threatened and declining species within OSPAR Region III (Celtic Seas). Further, the north-east Atlantic population are classed as 'Endangered' on the IUCN Red List and are protected in the UK under the Wildlife and Countryside Act 1981.
Spotted ray	*Raja montagui*	National	Listed as 'of least concern' by the IUCN Red List and on the OSPAR list of threatened and declining species within OSPAR Region III (Celtic Seas). Low intensity nursery grounds identified within the Proposed Development.
Spurdog	*Squalus acanthias*	Regional	Listed as a SPI, as 'vulnerable' on the IUCN Red List, and on the OSPAR list of threatened and declining species within OSPAR Region III (Celtic Seas).

IEF	Scientific Name	Importance within the Proposed Development	Justification
			High intensity nursery grounds identified within the Proposed Development.
Thornback ray	*Raja clavata*	Regional	Low intensity nursery grounds identified within the Proposed Development.
Tope	*Galeorhinus galeus*	Regional	Listed as a SPI, and as 'vulnerable' on the IUCN Red List. Low intensity nursery grounds identified within the Proposed Development.
Diadromous Fish			
Atlantic salmon	*Salmo salar*	International	Listed as a SPI, as 'vulnerable' by the IUCN Red List, and on the OSPAR list of threatened and declining species within OSPAR Region III (Celtic Seas). Atlantic salmon are also listed as Annex II species under the Habitats Directive and are qualifying features of numerous SACs within the regional fish and shellfish ecology study area. Atlantic salmon are likely to migrate through the regional fish and shellfish ecology study area during their life cycle.
Allis shad	*Alosa alosa*	National	Listed as a SPI, as 'of least concern' by the IUCN Red List, and on the OSPAR list of threatened and declining species within OSPAR Region III (Celtic Seas). Allis shad are an Annex II species under the Habitats Directive but are not a qualifying feature of any designated sites within the regional fish and shellfish ecology study area. Allis shad may potentially migrate through the regional fish and shellfish ecology study area during their life cycle.
European eel	*Anguilla anguilla*	National	Listed as a SPI, as 'critically endangered' by the IUCN Red List, and on the OSPAR list of threatened and declining species on within OSPAR Region III (Celtic Seas). Listed as a qualifying feature of multiple MNRs within the regional fish and shellfish ecology study area. European eel are likely to migrate through the regional fish and shellfish ecology study area during their life cycle.
River lamprey	*Lampetra fluviatilis*	International	Listed as a SPI and as of 'least concern' by the IUCN Red List. River lamprey are also listed as Annex II species under the Habitats Directive and are qualifying features of numerous SACs within the regional fish and shellfish ecology study area. River lamprey are likely to migrate within the regional fish and shellfish ecology study area during their life cycle, although only within coastal and estuarine areas.
Sea lamprey	*Petromyzon marinus*	International	Listed as a SPI, as of 'least concern' by the IUCN Red List, and on the OSPAR list of threatened and declining species within OSPAR Region III (Celtic Seas). Sea lamprey are also listed as Annex II species under the Habitats Directive and are qualifying features of numerous SACs within the regional fish and shellfish ecology study area.

IEF	Scientific Name	Importance within the Proposed Development	Justification
			Sea lamprey are likely to migrate through the regional fish and shellfish ecology study area during their life cycle
Sea trout	*Salmo trutta*	National	Listed as a SPI, as 'of least concern' by the IUCN Red List, and on the OSPAR list of threatened and declining species. Sea trout are likely to migrate through the regional fish and shellfish ecology study area during their life cycle
Smelt	*Osmerus eperlanus*	National	Listed as a SPI, as 'of least concern' by the IUCN Red List. Smelt is not an Annex II species but is listed as a qualifying feature of multiple MCZs within the regional fish and shellfish ecology study area. Smelt are likely to migrate within the regional fish and shellfish ecology study area during their life cycle, although only within coastal and estuarine areas.
Twaite shad	*Alosa fallax*	National	Listed as a SPI and as 'of least concern' by the IUCN Red List. Twaite shad are an Annex II species under the Habitats Directive but are not a qualifying feature of any designated sites within the regional fish and shellfish ecology study area. Twaite shad may potentially migrate through the regional fish and shellfish ecology study area during their life cycle
Shellfish			
Freshwater pearl mussel	*Margaritifera margaritifera*	International	Listed as a SPI and as 'endangered' by the IUCN Red List. Listed as an Annex II species under the habitats directive and is a qualifying feature of numerous designated sites within the regional fish and shellfish ecology study area.
Spiny lobster	*Palinurus elephas*	National	Listed as a SPI and as a qualifying feature of multiple MNRs within the regional fish and shellfish ecology study area.
Blue mussel	*Mytilus edulis*	Local	Species which are not protected under conservation legislation, and are common in UK and Irish waters, but form a key component of the marine biodiversity within Proposed Development.
Brown crab	*Cancer pagurus*		
Common whelk	*Buccinum undatum*		
European lobster	*Homarus gammarus*		
King scallop	*Pecten maximus*		

IEF	Scientific Name	Importance within the Proposed Development	Justification
Queen scallop	*Aequipecten opercularis*		
Velvet swimming crab	*Necora puber*		
Norway lobster	*Nephrops norvegicus*	Local	Species which is not protected under conservation legislation, and is common in UK and Irish waters, but forms a key component of the marine biodiversity within Proposed Development. Spawning grounds of undetermined intensity and nursery grounds of unspecified intensity identified within the regional fish and shellfish ecology study, but not overlapping with the Proposed Development.
Other shellfish	-	Local	Other shellfish, such as common cockle (*Cerastoderma edule*), swimming crabs (*Liocarcinus spp.*), and squid (*Loligo spp.*) have been identified as being likely to occur within the regional fish and shellfish ecology study area. These are species which are not protected under conservation legislation, and may be common in UK and Irish waters, but form a key component of the marine biodiversity within Proposed Development.

7.8.2.10 Future Baseline Scenario

As stated in section 7.8.1.9, an assessment of the future baseline conditions has been carried out in the event that the Proposed Development does not come forward, in line with the Offshore Oil & Gas Exploration, Production, Unloading and storage (Environmental Impact Assessment) Regulations 2020 and the Marine Works (Environmental Impact Assessment) Regulations 2007.

The baseline environment presented in this section and in volume 3, RPS Group (2024a) is extensive, and accurately representative, accounting for seasonality and interannual variability. However, this baseline is not static, and will exhibit larger degrees of natural change over longer time periods, due to naturally occurring cycles and processes and any potential changes resulting from climate change. This long-term change will occur even if the Proposed Development does not come forward. Thus, it will be necessary to contextualise any potential impacts that might occur over the expected 25-year operational lifetime of the Proposed Development when undertaking impact assessments.

Direct and indirect changes to fish and shellfish populations and communities may occur as a result of variability and long-term changes within the Irish Sea. These changes include projected increases in average sea surface temperature of up to 1.9°C and changes in the timing of maximum and minimum temperatures (Olbert *et al.,* 2012). As a result of rising sea temperatures, species adapted to colder water (such as cod and herring) will begin to seek cooler waters, while warm water adapted species will become more established in the previous locations (Drinkwater, 2005). This potential future change will occur in tandem with the known overall reduction in production and stock recovery in Irish Sea fish populations (Bentley *et al.,* 2020). Future changes are expected to be exacerbated by these increasing temperatures and extreme weather events, which can increase stratification of phytoplankton food sources in the Irish Sea, which leads to decoupling of predator and prey interactions and impacts fish population survival rates (Morrison *et al*., 2020).

The geographical range and virulence of diseases affecting economically important shellfish populations may also be exacerbated by rising sea temperatures (Rowley *et al.,* 2014). This could cause potential threats to long-term survivability, and adversely impact overall shellfish population levels. Combined with increasing temperatures, ocean acidification could also adversely impact shell strength (Mackenzie *et al.,* 2014), resulting in reduced protection against predators, and significant reductions in the economic value (Narita *et al*., 2012).

There are many uncertainties around how climate change will affect the marine environment, which makes the future baseline scenario difficult to accurately predict. Any changes that may occur during the lifespan of the Proposed Development should be considered in the context of both greater variability and sustained trends occurring on national and international scales in the marine environment.

7.8.3 Marine Mammals and Marine Turtles

7.8.3.1 Study Area

Marine mammals and marine turtles are known for being highly mobile and covering vast distances within their range of distribution. Therefore, two study areas have been defined:

- the Proposed Development marine mammal and marine turtle study area: this is defined as the area encompassing the Proposed Development, (including the offshore pipelines, and associated cables in Liverpool Bay) plus a buffer of 10 km (Figure 7.3).
- the regional marine mammal and marine turtle study area: this is defined as the area encompassing the wider Irish Sea (Figure 7.3). This area has been informed by marine mammal Management Units (MUs) and will provide wider context for characterising the baseline. The regional marine mammal study area will also aid in informing the assessment where the ZoI for given impacts, such as underwater noise, which may potentially extend beyond the Proposed Development marine mammal study area.

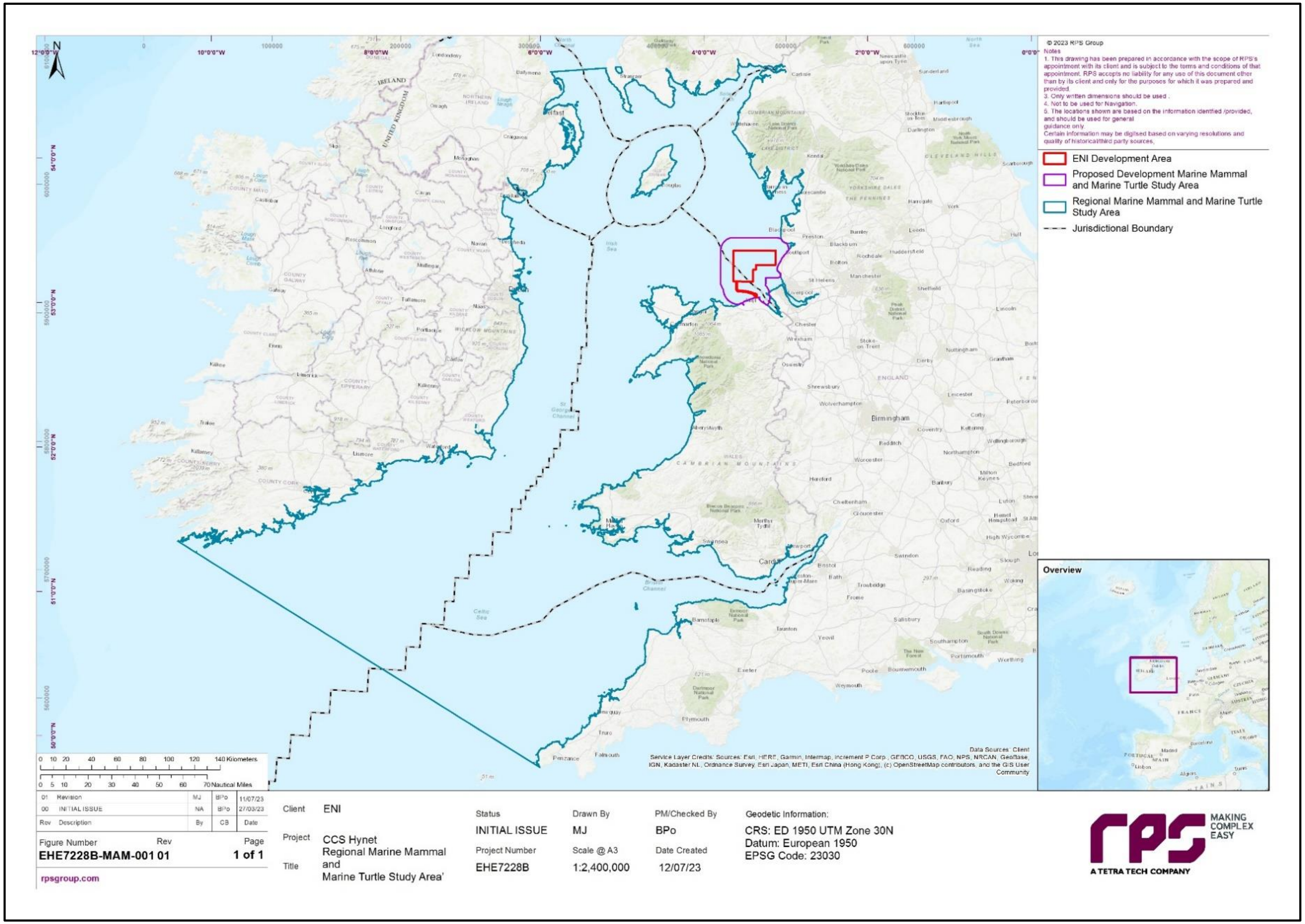

Figure 7.3: Marine Mammal And Marine Turtle Study Areas

7.8.3.2 Desktop Datasets

The marine mammal baseline within the Proposed Development marine mammal study area and the regional marine mammal study area was characterised by a thorough review of key desktop datasets and reports. Information on these and full details are presented in volume 3, RPS Group (2024a) and a summary of the key desktop sources utilised is presented in Table 7.14. There were no site-specific marine mammal surveys conducted for the Proposed Development, so the results of site-specific surveys undertaken for OWFs in close proximity to the Proposed Development have been utilised. This included Gwynt y Môr OWF and Awel y Môr OWF.

Table 7.14: Summary Of Key Desktop Reports For The Characterisation Of The Marine Mammal Baseline

Title	Source	Year	Author
NPWS Designations Viewer	NPWS	2023	NPWS
Sympatric seals, satellite tracking and protected areas: habitat-based distribution estimates for conservation and management	Frontiers in Marine Science.	2022	Carter et al.
Updated abundance estimates for cetacean management units in UK waters (Revised 2022)	JNCC	2022	Inter-Agency Marine Mammal Working Group (IAMMWG)
Review of the Irish Sea	Irish Sea Network	2022	Irish Sea Network
British and Irish Marine Turtle Strandings and Sightings. Annual Report 2021	Marine Environmental Monitoring	2022	Penrose et al.
Estimates of cetacean abundance in European Atlantic waters from the SCANS-III (Small Cetaceans in the European Atlantic and North Sea) aerial and shipboard surveys	Sea Mammal Research Unit (SMRU), University of St. Andrews	1994 - 2021	Hammond et al. 2002, 2017, 2021
NBN Atlas	NBN Atlas	2021	NBN Atlas
Awel Y Môr OWF Marine Mammal Baseline Characterisation	SMRU	2021	Sinclair, et al.
Scientific Advice of Matters Related to the Management of Seal Populations	Special Committee on Seals (SCOS) and Natural Environment Research Council (NERC)	2020, 2021	SCOS
JNCC MPA Mapper	JNCC	2020	JNCC
Habitat-based predictions of at-sea distribution for grey and harbour seals in the British Isles	SMRU, University of St Andrews	2020	Carter et al.
Distribution maps of cetacean and seabird populations in the North-East Atlantic	Journal of Applied Ecology	2020	Waggitt et al.

Title	Source	Year	Author
Long-term insights into marine turtle sightings, strandings and captures around the UK and Ireland (1910–2018)	Journal of the Marine Biological Association of the United Kingdom	2020	Botterell et al.
Gwynt y Môr OWF Post-construction Aerial Surveys 2016 to 2019	APEM Ltd.	2017 - 2019	Goddard et al., 2017, 2018, Goulding et al., 2019
Marine Mammals-Cetaceans. In; Manx Marine Environmental Assessment (1.1 Edition - partial update)	The Government of the Isle of Man	2018	Howe, 2018b
Bottlenose Dolphin Monitoring in Cardigan Bay, 2014 – 2016. NRW Evidence Report 191	NRW	2018	Lohrengel et al.,
Aerial thermal-imaging surveys of Harbour and Grey Seals in Northern Ireland	Department of Agriculture, Environment, and Rural Affairs, Northern Ireland	2019	Duck and Morris
Aerial surveys of cetaceans and seabirds in Irish waters: Occurrence, distribution and abundance in 2015-2017	Department of Communications, Climate Action, and Environment	2018	Rogan et al.
Revised Phase III Data Analysis of Joint Cetacean Protocol (JCP) Data Resource	JNCC	2016	Paxton *et al.*
The identification of discrete and persistent areas of relatively high harbour porpoise density in the wider UK marine area	JNCC	2015	Heinänen and Skov
Atlas of the distrіcution and relative abundance of marine mammals in Irish offshore waters 2005 - 2011	Irish Whale and Dolphin Group	2013	Wall *et al.*
Phase II Data Analysis of Joint Cetacean Protocol (JCP) Data Resource	JNCC	2011	Paxton *et al.*
Burbo Bank Extension Offshore Wind Farm: Environmental Impact Assessment Scoping Report	DONG Energy	2010	Sørensen *et al.*
Cetaceans in Irish waters: A review of recent research	Royal Irish Academy.	2009	O'Brien *et al.*
Atlas of Marine Mammals of Wales	Countryside Council for Wales	2009	Baines and Evans
Gwynt y Mor Offshore Wind Farm Marine Ecology Technical Report	Gwynt y Mor OWF	2005	CMACS, 2005b
Background information on marine mammals for Strategic Environmental Assessment	SMRU	2005	Hammond *et al.*
Cetacean Distribution Atlas	JNCC	2003	Reid *et al.*

Title	Source	Year	Author
Cetacean distributions in the waters around the British Isles	Natural Environment Research Council	1998	Evans

7.8.3.3 Cetaceans

There are five cetacean species likely to be present and/or occur regularly within the regional marine mammal study area:

- bottlenose dolphin *Tursiops truncatus;*
- harbour porpoise *Phocoena phocoena;*
- minke whale *Balaenoptera acutorostrata;*
- risso's dolphin *Grampus griseus*); and
- short-beaked common dolphin *Delphinus delphus* (hereafter: 'common dolphin').

As detailed in section 7.8.3.1, the regional marine mammal study area was informed by species MUs. The most recent abundance estimates for each species respective MU are provided by the Inter-Agency Marine Mammal Working Group (IAMMWG, 2022) and are presented in Table 7.15. Further detail on the ecology, abundance, and densities of these five cetacean species is provided in volume 3, RPS Group (2024a).

Table 7.15: Cetacean Abundance Estimates Within Their Respective MUs (Rogan *et al.,* 2018; Hammond *et al.,* 2021; IAMMWG, 2022)

Species	Management Unit (MU)	Abundance of animals in MU	95% Confidence Interval (CI)
Harbour porpoise	Celtic and Irish Sea	62,517 (CV = 0.13)	48,324 - 80,877
Bottlenose dolphin	Irish Sea	293 (CV = 0.54)	108 – 793
	Offshore Channel, Celtic Sea & South West England	10,947 (0.25)	6,727 – 17,814
Common dolphin	Celtic and Greater North Seas	102,656 (CV = 0.29)	58,932 – 178,822
Risso's dolphin		12,262 (CV = 0.46)	5,227 – 28,764
Minke whale		20,118 (CV = 0.18)	14,061 – 28,786

7.8.3.4 Pinnipeds

There are two pinniped species likely to be present and/or occur regularly within the regional marine mammal study area: grey seal *Halichoerus grypus*, and harbour seal *Phoca vitulina*. As detailed in section 7.8.3.1, the regional marine mammal study area was informed by species MUs. There are five MUs that are encompassed or overlap with the regional marine mammal study area: the Northern Ireland MU, Wales MU, Southwest (SW) Scotland MU, SW England MU, and Northwest (NW) England MU. The most recent abundance estimates for each species respective MU are provided by the Special Committee on Seals (SCOS) and are presented in Table 7.16. There are limited data available on the SW England MU, Wales MU, and NW England MU, with grey seal population estimates unavailable for these MUs and the harbour seal population estimates should be regarded as rough estimates only. Further detail on the ecology, abundance, and densities of grey seal and harbour seal is provided in volume 3, RPS Group (2024a).

Table 7.16: Most Recent August Haul-Out Counts And Population Estimates Of Grey And Harbour Seal In Their Respective MUs (SCOS, 2020, 2021)

Management Unit (MU)	Grey Seal		Harbour Seal	
	August Haul-Out Count	**Population Estimate**	**August Haul-Out Count**	**Population Estimate**
Northern Ireland	505	2,113	1,012	1,405
SW Scotland	517	2,163	1,709	2,373
NW England	250	Estimate not available	5	6
Wales	900		10	13
SW England	500		0	0

7.8.3.5 Marine Mammal Population Densities

The marine mammal population densities and populations estimates that will be taken forward to the assessment is presented in Table 7.17. Further information on these data sources is provided in volume 3, RPS Group (2024a). As this information is not available for marine turtles, population-based assessment will only be included for the marine mammal IEFs.

Table 7.17: Summary Of Marine Mammal Densities That Will Be Taken Forward To The Assessment

Species	Density (animals per km^2)	Management Unit (MU)[5]	Population Estimate in MU
Harbour porpoise	0.086[1]	Celtic and Irish Sea	62,517
Bottlenose dolphin	0.0082 to 0.035[2]	Irish Sea	293
Short-beaked common dolphin	0.018[3]	Celtic and Greater North Seas	102,656
Risso's dolphin	0.0313[2]	Celtic and Greater North Seas	12,262
Minke whale	0.0173[2]	Celtic and Greater North Seas	20,118
Grey seal	0.467 to 4.06[4]	Wales	3,766
		NW England	1,046
		Northern Ireland	2,113
		SW Scotland	2,163
		Isle of Man estimate	400
		East of Ireland Southeast of Ireland	1,749[6] 2,326[6]
		OSPAR Region III	60,780
Harbour seal	0.0049 to 0.593[4]	Wales	14
		NW England	7
		Northern Ireland	1,406
		Isle of Man	No estimate available

[1] SCANS-III (Hammond *et al*., 2021) Block F

[2] SCANS-III (Hammond *et al.,* 2021) for adjacent Block E, as none observed for Block F and high-density coastal area density in outer Cardigan Bay from Lohrengel *et al*. (2018)

[3] SCANS-II (Hammond *et al*., 2013) Block O, as no values for SCANS-III for this species

Species	Density (animals per km^2)	Management Unit (MU)[5]	Population Estimate in MU

[4] Carter *et al.* (2022) – average and maximum densities calculated to per km^2 using absolute mean values for cells overlapping with the Proposed Development marine mammal and marine turtle study area.

[5] All population estimates include the Isle of Man unless population estimate is given separately.

[6] Population estimates based upon counts from Duck and Morris (2019), using scalars from Lonergan *et al.* (2013) for harbour seal and Russell *et al.* (2016) for grey seal

7.8.3.6 Marine Turtles

Six species of marine turtle have been documented within UK and Irish waters:

- green turtle *Chelonia mydas*;
- hawksbill turtle *Eretmochelys imbricata*;
- kemp's ridley turtle *Lepidochelys kempii*;
- leatherback turtle *Dermochelys coriacea*;
- loggerhead turtle *Caretta caretta*; and
- olive ridley turtle *Lepidochelys olivacea* (Botterell *et al.,* 2020).

Due to the relative paucity of information surrounding the ecology, distribution, and abundance of these six species within UK and Irish waters in comparison to that available for marine mammals, they have been grouped together as 'marine turtles' for the purposes of this assessment.

There are no MUs available for marine turtles in UK and Irish waters, with the majority of information surrounding their abundance, seasonality, and distribution coming from records of sightings and strandings. These data have been recorded since 1748, and are reported annually by Marine Environmental Monitoring, most recently for 2021 (Penrose *et al.,* 2022). Overall, a total of 2,882 marine turtles have been recorded throughout this 273-year dataset, with the majority attributed to leatherback turtle (n = 2,172), followed by unidentified species (n = 394), loggerhead turtle (n = 268), Kemp's ridley turtle (n = 76), green turtle (n = 15), hawksbill turtle (n = 1), and olive ridley turtle (n = 1) (Penrose *et al.,* 2022). Of these 2,882 records, the majority have been recorded in Ireland (Table 7.18).

Table 7.18: Number Of Sightings And Strandings Of All Marine Turtles Between 1748 And 2021 (Penrose *et al.,* 2022)

Region	Number of Sightings and Strandings of all Marine Turtle Species	
	2021	**1748 - 2021**
Ireland	6	1,358
England	7	699
Scotland	11	425
Wales	5	292
Northern Ireland	0	41
Isle of Man	1	37
Channel Islands	0	17
Offshore waters	0	13
Total	**30**	**2,882**

7.8.3.7 Designated sites

There are a number of designated sites with marine mammal qualifying features within the regional marine mammal study area, as detailed in Table 7.19. There are no designated sites with marine turtle qualifying features.

Table 7.19: Sites Designated For Relevant Marine Mammal Qualifying Features Located Within The Regional Marine Mammal Study Area

Designated Site	Minimum Distance to Proposed Development (km)	Qualifying Features Related to Marine Mammals and Site Description
North Anglesey Marine /Gogledd Môn Forol SAC	39.68	The North Anglesey Marine SAC stretches from the northern coast of the Isle of Anglesey into the Irish Sea. Relevant Qualifying Features: Annex II harbour propose are a primary reason for site selection (JNNC, 2021c).
Isle of Man MNRs	70.06 – 91.05	As detailed in Table 7.9, there are ten MNRs around the Isle of Man, encompassing 10.8% of Manx waters (Manx Wildlife Trust, 2023). Relevant Qualifying Features: although it varies between individual MNRs, these sites are collectively designated for harbour seal, grey seal, harbour porpoise, minke whale, and Risso's dolphin (Designation of MNR Guidance Notes, undated).
Lleyn Peninsula and the Sarnau/Pen Llŷn a'r Sarnau SAC	85.70	The Lleyn Peninsula and Sarnau SAC encompasses area of sea, coast, and estuary that is known to support a wide array of marine habitat, flora and fauna. Relevant Qualifying Features: Annex II marine mammals (bottlenose dolphin and grey seal) are present as qualifying features but not primary reasons for site selection (JNCC, 2023k).
West Wales Marine /Gorllewin Cymru Forol SAC	82.99	The West Wales Marine SAC covers an area of 7,377 km^2, extending into the Irish Sea from North Wales to West Wales. The average water depth in the area ranges from 40-50 m and up to 100 m. Relevant Qualifying Features: Annex II harbour propose are a primary reason for site selection (JNCC, 2023l).
North Channel SAC	111.78	The North Channel SAC comprises an area of 1,604 km^2, located along the east coast of Northern Ireland and extending into the northern portion of the Irish Sea (JNCC, 2021d). Relevant Qualifying Features: Annex II harbour propose are a primary reason for site selection (JNCC, 2021d).
Cardigan Bay/Bae Ceredigion SAC	122.76	Cardigan Bay SAC is located between Pembrokeshire and Ceredigion, extending 20 km from the coast, and protecting an area of the sea greater than 1,000 km^2. Relevant Qualifying Features: Annex II bottlenose dolphin are a primary reason for site selection, while Annex II grey seal are present as a qualifying feature but not a primary reason for site selection (JNCC, 2023e).
Strangford Lough SAC	142.70	The main feature of the Strangford Lough SAC is the sea inlet itself, which is known to have emerged from melting ice sheets and is less than 10 m in depth, however the SAC supports a range of species and habitats (Department of the Environment, 2007). Relevant Qualifying Features: Annex II harbour seal are present as a qualifying feature but not a primary reason for site selection (JNCC, 2023m).

Designated Site	Minimum Distance to Proposed Development (km)	Qualifying Features Related to Marine Mammals and Site Description
Murlough SAC	146.97	This SAC is relatively shallow (depth up to 33 m) and supports a range of coastal species and habitats. Relevant Qualifying Features: Annex II harbour seal are present as a qualifying feature but not a primary reason for site selection (JNCC, 2023n).
Rockabill to Dalkey Island SAC	155.10	This site includes a range of dynamic inshore and coastal waters win the Western Irish Sea and is roughly 7 km wide and 40 km long (National Parks and Wildlife Service (NPWS), 2013a). Relevant Qualifying Features: Rockabill to Dalkey Island SAC is designated for Annex II harbour porpoise (NPWS, 2013a).
Lambay Island SAC	157.45	Lambay is the largest Irish east coast island, situated approximately 4 km off the Dublin coast dominated by igneous rock, ash, shale and limestone (NPWS, 2013b). Relevant Qualifying Features: Lambay Island SAC is designated in part for Annex II grey seal and harbour seal (NPWS, 2013b).
The Maidens SAC	190.72	The Maidens SAC is formed by a group of rocky reefs off the coast of Larne, Northern Ireland. Relevant Qualifying Features: Annex II grey seal are a primary marine feature responsible for the designation of the SAC (Department of Agriculture, Environment and Rural Affairs (DAERA), 2023).
Bristol Channel Approaches/Dynesfeydd Môr Hafren SAC	194.73	The Bristol Channel Approaches SAC spans the Bristol Channel between the northern coast of Cornwall and Wales. Relevant Qualifying Features: Annex II harbour porpoise are a primary reason for site selection (JNCC, 2021e).
Pembrokeshire Marine/Sir Benfro Forol SAC	195.44	The Pembrokeshire Marine SAC is located on the south-west coast of Wales. Relevant Qualifying Features: Annex II grey seal are a primary reason for site selection (JNCC, 2023o).
Slaney River Valley SAC	198.26	The Slaney River Valley SAC overlaps Raven Point Nature Reserve SAC, The Raven SPA and Wexford Harbour and Slobs SPA (NPWS, 2011). Relevant Qualifying Features: The Slaney River Valley SAC is designated in part for Annex II harbour seal (NPWS, 2011a).
Saltee Islands SAC	239.28	The Saltee Islands SAC is located off the coast of Wexford, Ireland, which feature sea caves and cliffs. Relevant Qualifying Features: Annex II grey seal are a qualifying interest feature for this site (NPWS, 2011b).
Lundy SAC	251.48	The Lundy SAC is situated within the Bristol Channel. Relevant Qualifying Features: Annex II grey seal are a primary reason for site selection (JNCC, 2023s).
Roaringwater Bay and Islands SAC	445.50	The Roaringwater Bay and Islands SAC is located off the coast of Cork, Ireland, at the western edge of the regional marine mammal study are. Relevant Qualifying Features: Annex II harbour porpoise and grey seal are a qualifying interest features for this site (NPWS, 2011c).

7.8.3.8 IEFs

As detailed in section 7.7, the valuation of marine mammal and marine turtle IEFs is defined at four levels: international, national, regional, and local. Marine mammal and marine turtle IEFs identified within the regional marine mammal study area are presented in Table 7.20.

Table 7.20: Marine Mammal And Marine Turtle IEFs Within The Proposed Development Marine Mammal And Marine Turtle Study Area

IEF	Scientific Name	Importance within the Proposed Development Marine Mammal and Marine Turtle Study Area	Justification
Bottlenose dolphin	*Tursiops truncatus*	International	Listed as a SPI, EPS, and under Appendix I and II of the Bonn Convention, Appendix II of the Bern Convention, and Appendix II of CITES. Bottlenose dolphin are also protected in UK waters under the Wildlife and Countryside Act 1981 and in Manx waters under the Isle of Man Wildlife Act 1990. Bottlenose dolphin are also listed as Annex II species under the Habitats Directive and are qualifying features of numerous SACs within the regional marine mammal study area.
Common dolphin	*Delphinus delphis*	International	Listed as a SPI, EPS, and under Appendix I and II of the Bonn Convention, Appendix II of the Bern Convention, and Appendix II of CITES. Common dolphin are also protected un UK waters under the Wildlife and Countryside Act 1981 and in Manx waters under the Isle of Man Wildlife Act 1990.
Grey seal	*Halichoerus grypus*	International	Listed as a EPS, and under Appendix I and II of the Bonn Convention, Appendix III of the Bern Convention, and Appendix II of CITES. Grey seal are also protected un UK waters under the Wildlife and Countryside Act 1981 and in Manx waters under the Isle of Man Wildlife Act 1990. Grey seal are also listed as Annex II species under the Habitats Directive and are qualifying features of numerous SACs within the regional marine mammal study area.
Harbour porpoise	*Phocoena phocoena*	International	Listed as a SPI, EPS, and under Appendix I and II of the Bonn Convention, Appendix II of the Bern Convention, and Appendix II of CITES. They are listed on the OSPAR list of threatened and declining species within OSAPR Region III (Celtic Seas). Harbour porpoise are also protected un UK waters under the Wildlife and Countryside Act 1981 and in Manx waters under the Isle of Man Wildlife Act 1990. Harbour porpoise are also listed as Annex II species under the Habitats Directive and are qualifying features of numerous SACs within the regional marine mammal study area.
Harbour seal	*Phoca vitulina*	International	Listed as a SPI, EPS, and under Appendix I and II of the Bonn Convention, Appendix III of the Bern Convention, and Appendix II of CITES. Harbour seal are also protected un UK waters under the Wildlife and Countryside Act 1981 and in Manx waters under the Isle of Man Wildlife Act 1990. Grey seal are also listed as Annex II species under the Habitats Directive and are qualifying features of numerous SACs within the regional marine mammal study area.
Marine turtles	Green (*Chelonia mydas*), hawksbill	International	Leatherback turtle are listed on the OSPAR List of threatened and declining species within OSPAR Region III (Celtic Seas). Loggerhead turtle are also on the OSPAR list, but not within OSPAR Region III (Celtic Seas). Both leatherback and loggerhead turtle are also listed as SPIs. Leatherback, loggerhead, green, hawksbill, and Kemp's ridley turtle are all classed as EPSs.

IEF	Scientific Name	Importance within the Proposed Development Marine Mammal and Marine Turtle Study Area	Justification
	(*Eretmochelys imbricata*), Kemp's ridley (*Lepidochelys kempii*), leatherback (*Dermochelys coriacea*), loggerhead (*Caretta caretta*), and olive ridley (*Lepiodchelys olivacea*)		All marine turtles are proteced under CITES and in UK waters under the Wildlife and Countryside Act 1981. Olive ridley turtles are only protected under section 9 (as ammended) of the Wildlife and Countryside Act 1981.
Minke whale	*Balaenoptera acutorostrata*	International	Listed as a SPI, EPS, and under Appendix I and II of the Bonn Convention, Appendix II of the Bern Convention, and Appendix II of CITES. Minke whale are also protected in UK waters under the Wildlife and Countryside Act 1981 and in Manx waters under the Isle of Man Wildlife Act 1990.
Risso's dolphin	*Grampus griseus*	International	Listed as a SPI, EPS, and under Appendix I and II of the Bonn Convention, Appendix II of the Bern Convention, and Appendix II of CITES. Risso's dolphin are also protected in UK waters under the Wildlife and Countryside Act 1981 and in Manx waters under the Isle of Man Wildlife Act 1990.

7.8.3.9 Future Baseline Scenario

As stated in section 7.8.1.9, an assessment of the future baseline conditions has been carried out in the event that the Proposed Development does not come forward, in line with the Offshore Oil & Gas Exploration, Production, Unloading and storage (Environmental Impact Assessment) Regulations 2020 and the Marine Works (Environmental Impact Assessment) Regulations 2007.

The baseline environment presented in this section and in volume 3, RPS Group (2024a) is extensive, and accurately representative, accounting for seasonality and interannual variability. However, this baseline is not static, and will exhibit larger degrees of natural change over longer time periods, due to naturally occurring cycles and processes and any potential changes resulting from climate change. This long-term change will occur even if the Proposed Development does not come forward. Thus, it will be necessary to contextualise any potential impacts that might occur over the expected 25-year operational lifetime of the Proposed Development when undertaking impact assessments.

Marine mammals and marine turtles are known to be impacted by various anthropogenic activities, such as offshore developments, fisheries, and shipping. For example, Avila *et al*. (2018) reported that between 1991 and 2016, globally almost all marine mammals species (98%) were documented to be affected by at least one threat. Bycatch of marine mammals in active fishing gear was the most common threat category for odontocetes (toothed whales) and mysticetes (baleen whales), followed by pollution (solid waste), commercial hunting, and vessel collisions. For pinnipeds, the main threats were entanglement in ghost-net (lost or discarded fishing gear), solid and liquid wastes, and infections (Avila *et al.,* 2018). Similarly, fisheries bycatch and coastal development are major threats to marine turtles (Donlan *et al.,* 2010), along with entanglement in ghost-nets and debris (Duncan *et al.,* 2017).

In addition to anthropogenic impacts, marine mammals are also vulnerable to indirect impacts, such as climate change, which can result in increasing sea temperatures. Shifts in spatial distribution is one of the most common responses to temperature changes by marine species and has the potential to modify their ranges. For example, common dolphin are a wide ranging species with a capacity for range expansion (Murphy *et al.,* 2013), and they appear to be extending their shelf sea range further north off western Britain and around the northern North Sea (Evans *et al.,* 2003; MacLeod *et al.,* 2005). This species shows a positive relationship with increasing temperature (Evans and Waggit, 2020), and thus increasing sea temperatures may lead to a shift in the range of common dolphin (MacLeod *et al.,* 2005). Warming sea temperatures may also alter the life cycles of marine mammal and marine turtle prey species through changes in prey abundance and distribution, and enhanced stratification forcing earlier occurrence of the spring phytoplankton bloom and potential cascading effects through the food chain (Evans and Bjørge, 2013). This may result in a predator-prey mismatch, (a discrepancy between the abundances of prey species and predators), affecting migratory species and species which display some site fidelity. For example, the impacts of climate change on marine predator-prey distributions in Sadykova *et al.* (2020) predicted a large future distribution shift in sandeel and harbour porpoise habitat overlap (164 km) but a small shift (16 km) in overlap between herring and porpoise. Loss of predator–prey population overlap was also predicted for harbour seal, with large declines in the common spatial trend for both sandeel (71 km) and herring (91 km) prey (Sadykova *et al.,* 2020). In grey seal, the authors predicted a future distribution shift in overlap with sandeel (71 km) and herring (41 km) populations (Sadykova *et al.,* 2020).

Additionally, climate change could affect survival rates of marine mammals and marine turtles by affecting reproductive success, increasing stress levels, and fostering the development of pathogens (Albouy *et al*., 2020). Further, Evans and Waggitt (2020) highlighted both the frequency and severity of toxic algal blooms are also predicted to increase due to increased temperature (via climate change) and nutrient enrichment (via increased rainfall and freshwater runoff) and salinity. Consequently, mass die-offs due to fatal poisonings from toxic algal blooms have been reported in bottlenose dolphin (Fire *et al*., 2007, 2008).

There are many uncertainties around how climate change will affect the marine environment, which makes the future baseline scenario difficult to accurately predict. Any changes that may occur during the lifespan of the

Proposed Development should be considered in the context of both greater variability and sustained trends occurring on national and international scales in the marine environment.

7.9 Key Parameters for Assessment

7.9.1 Maximum Design Scenario

The Project Design Parameters identified in Table 7.21, Table 7.22, and Table 7.23 have been selected as those having the potential to result in the greatest effect on an identified receptor or receptor group. These scenarios have been selected from the details provided in the project description (volume 1, chapter 3). Effects of greater adverse significance are not predicted to arise should any other development scenario, based on details within the Project Description (e.g. different infrastructure layout), to that assessed here be taken forward in the final design scheme.

Table 7.21: Project Design Parameters Considered For The Assessment Of Potential Impacts On Benthic Subtidal And Intertidal Ecology

Potential impact	Phase			Project Design Parameters	Justification
	C	O	D		
Temporary subtidal habitat loss and/or disturbance	✓	✓	✓	**Construction phase** Up to 1.91 km^2 of subtidal habitat loss due to: • Footprints of jack-up vessels: - Up to 736 m^2 of disturbance from the use of jack-up vessels during the installation of the new Douglas Platform • Up to 1.89 km^2 of disturbance from the installation of up to 126.04 km of subsea power cables (MDS assumes 100% will be buried). This value of 1.89 km^2 includes 18,000 m^2 of disturbance along the 1,200 m of cables installed within the intertidal zone (between MHWS and MLWS). • Up to 21,000 m^2 of disturbance due to dredging at West Hoyle Bank for the installation of subsea power cables between the PoA terminal and the new Douglas platform. A dredged channel with a length of 1,000 m, width of 21 m, and depth of 7 m is to be excavated using a backhoe dredger. • A channel cleared through a length of 115 m of sand waves, with a width of 10 m and height of 3 m, using a max flow excavator. **Operation and Maintenance Phase** Up to 72,000 m^2 of subtidal habitat loss due to: • Footprints of jack-up vessels for routine maintenance works. Up to 15 events per year over the 25-year lifecycle of the Proposed Development, resulting in a total value of 34,500 m^2 over the lifecycle. • Up to 37,500 m^2 due to the reburial of up to 500 m of cable every 5 to 10 years, over the 25-year lifecycle. Only a smaller portion of this (7,500 m^2 will occur at any one time). **Decommissioning Phase** Temporary subtidal habitat loss and/or disturbance due to:	The MDS represents the maximum footprint which would be affected during the construction, operations and maintenance and decommissioning phases. **Construction phase** For cable installation, the MDS assumes a trench width of 15 m. The MDS assumes that the width of disturbance for sand wave clearance also includes subsequent burial. The total footprint of seabed affected has been calculated, for the purposes of the MDS, assuming a mound of uniform thickness of 0.5 m height. The MDS assumes temporary loss of benthic habitat is beneath this. **Operations and maintenance phase** The MDS for this impact includes the use of jack-up vessels for maintenance of offshore infrastructure and cable repair and reburial. Reburial of up to 500 m of cable every 5 to 10 years in anticipated (assuming 15 m width of seabed disturbance). **Decommissioning phase** Parameters for decommissioning will be lower or equal to that of the construction phase as sand wave clearance will not be required in advance of cable removal. The MDS assumes that cable removal in the intertidal will involve open cut trenching and that all cables would be removed. The MDS assumes the removal of all infrastructure except that which will remain *in situ* for reservoir modelling (which will eventually be removed – to be confirmed at a later date in the Decommissioning Plan). This includes removal of some foundations, cables, and cable crossing protection. Rock placement will be left *in situ.*

<table>
<tr><th rowspan="2">Potential impact</th><th colspan="3">Phase</th><th rowspan="2">Project Design Parameters</th><th rowspan="2">Justification</th></tr>
<tr><th>C</th><th>O</th><th>D</th></tr>
<tr><td></td><td></td><td></td><td></td><td>• Footprint of affected seabed from the use of jack-up vessels during infrastructure removal.</td><td></td></tr>
<tr><td>Increased SSCs and associated deposition</td><td>✓</td><td>×</td><td>✓</td><td>Construction phase
Sand wave clearance:
• A channel cleared through a length of 115 m of sand waves, with a width of 10 m and height of 3 m, using a max flow excavator.
• Dredging a 1,000 m channel at West Hoyle Bank for the installation of subsea power cables between the PoA terminal and the new Douglas platform. A dredged channel with a length of 1,000 m, width of 21 m, and depth of 7 m is to be excavated using a backhoe dredger.
Drilling of two new monitoring wells at Hamilton Main and Hamilton North
• Clearance of 30.48 m of sand and silt and 84.43 m of coarser sediment (assuming a 100% washout).
Subsea power cable installation
• Installation of up to 126.04 km of subsea power cables, with a trench width of 15 m and a depth of at least 2 m. This includes 1,200 m of cable within the intertidal zone (between MHWS and MLWS).
Decommissioning Phase
Increased SSCs and associated deposition due to:
• Removal of up to 126.04 km of cables and 121.77 km pipelines.</td><td>Construction phase
Boulder and debris clearance activities will not be required. The MDS assumes that sand wave clearance will be limited and that the volume of material to be cleared from individual sand waves will vary according to the local dimensions of the sand wave (height, length and shape) and the level to which the sand wave must be reduced.
Cable routes inevitably include a variety of seabed material and in some areas, 2 m depth may not be achieved or may be of a coarser nature which settles in the vicinity of the cable route. The assessment therefore considers the upper bound in terms of suspended sediment and dispersion potential. Cables are proposed to be buried by ploughing.
The use of open trenching in the intertidal area releases the greatest volume of material into the water column and therefore provides the upper bound of impacts as compared with Horizontal Directional Drilling (HDD) installation.
Decommissioning phase
The removal of cables may be undertaken using similar techniques to those employed during installation, therefore the potential increases in SSC and deposition would be in-line with the construction phase.</td></tr>
<tr><td>Long-term subtidal habitat loss</td><td>✓</td><td>✓</td><td>✓</td><td>Construction and Operation and Maintenance Phases
Up to 64,169 m^2 of subtidal long-term habitat loss due to:
• The installation of the foundations for the new Douglas platform, which represents up to 169 m^2
• The installation of cable crossings and their protection, which represents up to 58,800 m^2. Cable crossing protection will have a maximum height of 0.8 m and width of 7 m and will be required at up to 32 crossings. The cable</td><td>The MDS represents the maximum footprint which would be affected during the construction, operations and maintenance and decommissioning phases.
Construction and Operation and Maintenance phase
The maximum area of long-term subtidal habitat loss due to the installation of the foundations for the new Douglas platform, cable crossings and protection, and rock placement in the construction phase, persisting into the operation and maintenance phase. There is potential for cable crossing protection installed during the construction phase to impact seabed morphology and cause secondary scour. These could have long-term impacts to available habitats given that cable</td></tr>
</table>

Potential impact	Phase			Project Design Parameters	Justification
	C	O	D		
				crossings will be required within a range of depths between 5.8 to 30.3 m (Chart Datum (CD)). • The installation of 2,400 m^2 of pipeline spools and 2,800 m^2 of pipeline mattresses • Rock placement. **Decommissioning Phase** Minor permanent subtidal habitat loss due to rock placement that will remain *in situ* after the lifecycle of the Proposed Development.	crossing protection will be consistently present throughout the operation and maintenance phase. Cable crossing protection is the only cable protection measure proposed for the Proposed Development, as the nature of the seabed sediment within the Proposed Development accommodates cable burial to the required depth (and thus does not require protection). Therefore, buried cables are not anticipated to become exposed and require additional protection throughout the operation and maintenance phase. **Decommissioning Phase** This long-term habitat loss will persist throughout the operation and maintenance phase and into the decommissioning phase, as some rock placement will be left *in situ.* The MDS for decommissioning (and permanent habitat loss following decommissioning) assumes removal of the foundations, cables, and cable crossing protection, if any additional infrastructure is decommissioned, this will result in a reduced area of permanent habitat loss.
Introduction of artificial habitat and colonisation of hard structures	×	✓	×	**Operation and Maintenance Phase** Up to 64,169 m^2 of artificial hard habitat introduced due to: • The installation of the foundations for the new Douglas platform, which represents up to 169 m^2 • The installation of cable crossings and their protection, which represents up to 58,800 m^2. Cable crossing protection will have a maximum height of 0.8 m and width of 7 m and will be required at up to 32 crossings. The cable crossings will be required within a range of depths between 5.8 to 30.3 m (CD). • The installation of 2,400 m^2 of pipeline spools and 2,800 m^2 of pipeline mattresses • Rock placement.	Maximum number of foundations, length of cables, and cable crossing protection resulting in greatest surface area for colonisation. The estimate of habitat creation from the presence of foundations has been calculated as if the foundations were a solid structure. This is, therefore, likely to be a conservative estimate of habitat creation on the basis that the jacket foundations will have a lattice design rather than a solid surface.

Potential impact	Phase			Project Design Parameters	Justification
	C	O	D		
Increased temperature impacting benthic communities	×	✓	×	**Operation and Maintenance Phase** Subsea power cables: • Installation of up to 126.04 km of subsea power cables with a voltage of 33 kV, at a target depth of 2 to 3 m. This includes 1,200 m of cable within the intertidal zone (between MHWS and MLWS). Subsea gas pipelines for CO_2 transport • Utilisation of up to 121.77 km of existing subsea gas pipelines for the transportation of liquid CO_2, which will be transported at a maximum temperature of up to 50ºC and pressure of up to 72.3 bara. • These pipelines are buried at a target depth of 2 to 3 m.	The MDS is based on the maximum length of subsea gas pipelines and power cables.
Impacts resulting from the release of sediment bound contaminants	✓	×	✓	**Construction Phase** The MDS is as described above for increased SSCs and associated deposition during the construction phase. **Decommissioning Phase** The MDS is as described above for increased SSCs and associated deposition during the decommissioning phase.	**Construction and Decommissioning Phases** The MDS for this impact is the same as presented for 'Increased SSC and associated deposition above', as the MDS of the latter results in the release of the largest volume of sediment and its associated contaminants.
Accidental pollution to the surrounding area	✓	✓	✓	**Construction phase** There will be a total of 236 round trips of vessels associated with the construction phase. This includes a total of 219 round trips of vessels associated with installation of the new Douglas platform and wells (return trips are presented as total across construction period). This includes the following: • up to 2 heavy lift vessel return trips; • up to 14 tug/anchor handler return trips; • up to 12 cargo barge return trips; • up to 80 support vessel return trips; • up to 4 survey vessel return trips;	**All Phases** There is a risk of pollution to water and sediment through accidental release of chemicals and pollutants from vessels/vehicles and equipment/machinery during all stages of installation of the development area.

Potential impact	Phase			Project Design Parameters	Justification
	C	O	D		
				• up to 4 pre-comm vessel return trips; • up to 1 seabed preparation vessel return trips; and • up to 104 crew vessel return trips. A total of 17 round trips of vessels associated with installation of the cables (return trips are presented as total across construction period): • up to 4 cable lay and installation and support vessels making up to 4 return trips; • up to 1 jack-up vessel making up to 1 return trip; • up to 2 multicat vessels making up to 2 return trips; • up to 3 working boats making up to 3 return trips; • up to 1 support vessel (for trenching) making up to 1 return trip; • up to 1 vessel for cable pull-in making up to 1 return trip; • up to 1 survey vessel making up to 1 return trip; • up to 1 seabed preparation vessel making up to 1 return trip; • up to 1 crew transfer vessel making up to 4 return trips; • up to 1 cable crossing protection installation vessel making up to 1 return trip; and • up to 1 cable burial installation vessel making up to 1 return trip. Other activities: • laying of 126.04 km of the cable (including 1,200 m within the intertidal zone); • drilling of 11 wells for co_2 injection; total duration of drilling per well is 15 days; and • use of jack-up rigs **Operation and Maintenance Phase** There will be a total of 750 vessel round trips over the entire operation and maintenance phase. This encompasses vessels used during routine inspections, geophysical surveys, removal of marine growth, replacement of corrosion protection anodes, replacement of access ladders and boat landings, modification to/replacement of J tubes at platforms,	

Potential impact	Phase			Project Design Parameters	Justification
	C	O	D		
				topsides, inter-platform cables/pipelines and PoA terminal to the new Douglas platform cables/pipelines. Maximum vessels on site at any one time: • up to 1 jack-up vessel making up to 15 return trips per year; and • up to 3 multi-purpose support vessels making up to 15 return trips per year. Other activities: • potential for cable maintenance in the subtidal and intertidal zone. **Decommissioning Phase** A total of 128 round trips of vessels associated with the decommissioning phase (return trips are presented as total across construction period): • up to 4 decommissioning and support vessel making up to 7 return trips; • up to 6 tug/anchor handlers making up to 8 return trips; • up to 4 cargo barges making up to 5 return trips; • up to 1 survey vessel making up to 1 return trip; and • up to 2 crew transfer vessels making up to 108 return trips. Other activities: • removal of infrastructure within the Proposed Development.	
Increased risk of introduction and spread of Invasive Non-Native Species (INNS)	✓	✓	✓	**Construction Phase** • Creation of up to 64,169 m^2 of habitat as described in 'long-term habitat loss' above • A total of up to 236 return trips made by vessels during the construction phase (as described above for accidental pollution). **Operation and Maintenance Phase** Increased risk of INNS due to: • Presence of up to 64,169 m^2 of artificial habitat described in 'Introduction of artificial habitat and colonisation of hard structures' above (including cable crossing protection)	**All Phases** The maximum surface area created by installed infrastructure and rock placement, and the maximum number of vessel movements during all phases of development. Vessels have the potential to transport INNS to and/or from the Proposed Development via ballast water or attached to their hulls. The MDS assumes the removal of all infrastructure except that which will remain *in situ* for reservoir modelling (which will eventually be removed – to be confirmed at a later date in the Decommissioning Plan). This includes removal of some foundations, cables, and cable crossing protection. Rock

Potential impact	Phase			Project Design Parameters	Justification
	C	O	D		
				• Up to 750 return trips made by vessels over the 25-year operation and maintenance phase (as described above for accidental pollution). **Decommissioning Phase** Increased risk of INNS due to: • Creation of permanent artificial habitat due to rock placement remaining *in situ,* as described in 'long-term habitat loss' above. • A total of up to 128 round trips made by vessels during the decommissioning phase (as described above for accidental pollution).	placement will be left *in situ*. Infrastructure removal will result in a lower risk of available substrate for INNS to colonise.

Table 7.22: Project Design Parameters Considered For The Assessment Of Potential Impacts On Fish And Shellfish Ecology

Potential impact	Phase			Project design parameters	Justification
	C	O	D		
Temporary habitat loss and/or disturbance	✓	✓	✓	**All Phases** The MDS for this impact is as described above for benthic subtidal and intertidal ecology (Table 7.21).	The justification for this impact is as described above for benthic subtidal and intertidal ecology (Table 7.21).
Long-term subtidal habitat loss	✓	✓	✓	**All Phases** The MDS for this impact is as described above for benthic subtidal and intertidal ecology (Table 7.21).	The justification for this impact is as described above for benthic subtidal and intertidal ecology (Table 7.21).
Underwater noise impacting fish and shellfish receptors	✓	×	×	**Construction phase** Piling during installation of the new Douglas platform foundations • Up to 4 piled jacket foundations, with one leg per foundation and up to 2 x 1.524 m diameter piles per leg (8 piles); • Maximum hammer energy up to 3,000 kJ; • Up to 100 minutes piling per pile; and • Piling of up to two adjacent piles at the same platform at one time. Clearance of UXOs within the Proposed Development • Maximum UXO size of up to 907 kg; • Intention for low order clearance of all UXOs using low order techniques with a single donor charge of up to 80 g net explosive quantity (NEQ) for each clearance event; • Up to 500 g NEQ clearance shot for neutralisation of residual explosive material at each location; • Risk of potential for unintended consequence of low order techniques to result in high order detonation of UXO (maximum size = 907 kg); • A maximum of one UXO clearance within 24 hours; • Total duration of clearance activities up to 12 days; and • Clearance during daylight hours only. Geophysical and seismic site-investigation surveys • Site investigation surveys will involve the use of up to 2 survey vessels (1 shallow water and 1 deep	Impact piling, UXO clearance, and geophysical and seismic site investigation surveys during construction may result in in injury and/or behavioural disturbance/displacement of sensitive fish and shellfish receptors. The largest hammer energy could lead to the largest area of ensonification at any one time. The longest duration of piling at any location results in the greatest number of days when piling could occur. Duration of piling assumes single vessel piling at any one time. UXO donor charge is maximum required to initiate low order detonation. Assumption of a clearance shot of up to 500 g NEQ at all locations although noting that this may not always be required. Maximum range of geophysical and seismic surveys likely to be undertaken using equipment typically employed for these types of surveys will result in the greatest potential impact.

Potential impact	Phase			Project design parameters	Justification
	C	O	D		
				water) carrying out 2 surveys each, and take place over a period of up to 3 months. • Vertical Seismic Profiling (VSP): - number of guns= 6; - total volume= 1,200 cu in; - source depth = 5 m; - firing pressure = 2,000 psi; - SEL = 220 dB re 1 µPa2s @1m; - 0-peak SPL = 238 db re. 1 µpa @ 1m; - pulse interval = 20 s (during operations); and - total number of pulses per 24 h period = 4,320 (three per minute).	
Increased SSCs and associated deposition	✓	×	✓	**Construction and Decommissioning Phases** The MDS for this impact is as described above for benthic subtidal and intertidal ecology (Table 7.21)	The justification for this impact is as described above for benthic subtidal and intertidal ecology (Table 7.21).

Table 7.23: Project Design Parameters Considered For The Assessment Of Potential Impacts On Marine Mammals And Marine Turtles

Potential impact	Phase			Project design parameters	Justification
	C	O	D		
Injury and disturbance from underwater noise generated from piling	✓	×	×	**Construction phase** New Douglas platform foundations: • up to 4 piled jacket foundations, with one leg per foundation and up to 2 x 1.524 m diameter piles per leg (8 piles); • maximum hammer energy up to 3,000 kJ; • up to 100 minutes piling per pile; and • piling of up to two adjacent piles at the same platform at one time.	Impact piling during construction may result in hearing damage/auditory injury, behavioural disturbance/displacement of marine mammals and marine turtles as well as barrier affects. The largest hammer energy could lead to the largest area of ensonification at any one time. The longest duration of piling at any location results in the greatest number of days when piling could occur.
Injury and disturbance from underwater noise generated from UXO detonation	✓	×	×	**Construction phase** Clearance of UXOs within the Proposed Development; • maximum uxo size of up to 907 kg; • intention for low order clearance of all UXOs using low order techniques with a single donor charge of up to 80 g NEQ for each clearance event; • up to 500 g NEQ clearance shot for neutralisation of residual explosive material at each location; • risk of potential for unintended consequence of low order techniques to result in high order detonation of UXO (maximum size = 907 kg); • a maximum of one UXO clearance within 24 hours; • total duration of clearance activities up to 12 days; and • clearance during daylight hours only	Marine mammals and marine turtles are sensitive to increased subsea noise generated during UXO clearance, which can lead to auditory injury, behavioural disturbance as well as barrier effects. UXO Donor charge is maximum required to initiate low order detonation. Assumption of a clearance shot of up to 500 g NEQ at all locations although noting that this may not always be required.
Injury and disturbance from underwater noise generated during geophysical and seismic surveys	✓	✓	×	**Construction phase** Site investigation surveys will involve the use of up to 2 survey vessels (1 shallow water and 1 deep water) carrying out 2 surveys each and take place over a period of up to 3 months. • MBES (170 to 450 kHz; 220 dB re 1 μPa (Root Mean Squared (rms); pulse rate up to 60 Hz). • SBP (85 to 115 kHz, 247 dB re 1μPa (rms), pulse rate up to 40 Hz). • VSP: – Number of guns= 6;	Geophysical and seismic surveys have the potential to cause direct and/or indirect effects (including injury or disturbance) on marine mammals and marine turtles as well as barrier effects. Maximum range of geophysical and seismic surveys likely to be undertaken using equipment typically employed for these types of surveys will result in the greatest potential impact.

<table>
<tr><th rowspan="2">Potential impact</th><th colspan="3">Phase</th><th rowspan="2">Project design parameters</th><th rowspan="2">Justification</th></tr>
<tr><th>C</th><th>O</th><th>D</th></tr>
<tr><td></td><td></td><td></td><td></td><td>– total volume= 1,200 cu in;
– source depth = 5 m;
– firing pressure = 2,000 psi;
– SEL = 220 dB re 1 µPa2s @1m;
– 0-Peak SPL = 238 dB re. 1 µPa @ 1m;
– pulse interval = 20 s (during operations); and
– total number of pulses per 24 h period = 4,320 (three per minute).
Operation and maintenance phase
Routine geophysical and seismic survey are estimated to occur annually.</td><td></td></tr>
<tr><td>Injury and disturbance from vessel activity and other noise producing activities</td><td>✓</td><td>✓</td><td>✓</td><td>All phases
The MDS for this impact is as described in ‘Accidental pollution to the surrounding area’ upon benthic subtidal and intertidal ecology (Table 7.21).</td><td>Injury and disturbance of marine mammals and marine turtles may arise during the construction, operation and maintenance and decommissioning phases of the Proposed Development from vessel use and other noise producing activities (e.g. seabed preparation, drilling, and rock placement over the cable crossings). Underwater noise from vessels and other activities may also result in barrier effects.
Maximum numbers of vessels on site at any one time and largest numbers of round trips during each phase of the Proposed Development and broad range of vessel types representative of vessels to be used during construction, operation and maintenance and decommissioning will result in the greatest potential impact.
Range of other activities including maximum timescales (where available) during which activities are conducted.</td></tr>
<tr><td>Injury to marine mammals from collision risk with marine vessels</td><td>✓</td><td>✓</td><td>✓</td><td>All phases
The MDS for this impact is as described in ‘Accidental pollution to the surrounding area’ upon benthic subtidal and intertidal ecology (Table 7.21).</td><td>An increase in vessel activity during construction, operation and maintenance and decommissioning phases of the Proposed Development, may result in increased vessel collisions with marine mammals and marine turtles.
Maximum numbers of vessels on site at any one time and largest numbers of round trips during each phase of the Proposed Development and broad range of vessel types representative of vessels to be used during construction, operation and maintenance and decommissioning will result in the greatest potential impact.</td></tr>
</table>

<table>
<tr><th rowspan="2">Potential impact</th><th colspan="3">Phase</th><th rowspan="2">Project design parameters</th><th rowspan="2">Justification</th></tr>
<tr><th>C</th><th>O</th><th>D</th></tr>
<tr><td>Effects on marine mammals due to changes in prey availability</td><td>✓</td><td>✓</td><td>✓</td><td>Construction Phase
The MDS for impacts to prey species are presented in Table 7.22, for fish and shellfish ecology. In the construction phase, these impacts are:
• temporary habitat loss and/or disturbance;
• long-term subtidal habitat loss;
• underwater noise impacting fish and shellfish receptors; and
• increased SSCs and associated deposition.
Operation and Maintenance Phase
The MDS for impacts to prey species are presented in Table 7.22, for fish and shellfish ecology. In the operation and maintenance phase, these impacts are:
• temporary habitat loss and/or disturbance; and
• long-term subtidal habitat loss.
Decommissioning Phase
The MDS for impacts to prey species are presented in Table 7.22, for fish and shellfish ecology. In the decommissioning phase, these impacts are:
• temporary habitat loss and/or disturbance;
• long-term subtidal habitat loss; and
• increased SSCs and associated deposition.</td><td>There is potential for changes in prey abundance resulting from activities during the construction and decommissioning phase of the Proposed Development, which could have an indirect impact on the foraging success of marine mammals and marine turtles within the Proposed Development and surrounding vicinity.
Maximum design scenarios described for fish and shellfish receptors (Table 7.22) will result in the greatest potential impact.</td></tr>
</table>

7.9.2 Impacts Scoped out of the Assessment

Based on the marine biodiversity existing baseline description presented in section 7.8, one impact is proposed to be scoped out of the assessment for benthic subtidal and intertidal ecology, four for fish and shellfish ecology, and five for marine mammals. This was either agreed with key stakeholders through consultation as discussed in section 7.3.3, or the impact was proposed to be scoped out in the HyNet Carbon Dioxide transportation and Storage Project - Offshore Scoping Report (Eni, 2022). These impacts are outlined, together with a justification for scoping it out, in Table 7.24, Table 7.25 and Table 7.26.

Table 7.24: Impacts Scoped Out Of The Assessment For Benthic Subtidal And Intertidal Ecology (Tick Confirms The Impact Is Scoped Out)

Potential Impact	Phase			Justification
	C	O&M	D	
Impacts to benthic ecology due to EMF	×	✓	×	**Operation and maintenance phase** Low-frequency EMFs are present along subsea cables used to transmit electricity from the Proposed Development to the appropriate substation and terminal locations. There are limited findings on the electro sensitivity of benthic organisms and on the associated impact of EMFs on the surrounding benthic invertebrates. Bochert and Zettler (2006) studied the effects of EMF on the survival and physiology of various crustaceans, marine worms, and echinoderms in the context of cables associated with OWFs in the Baltic Sea. The authors demonstrated no significant effects for any species after three months of exposure. Furthermore, Wilhelmsson *et al.* (2010) demonstrated that there were no differences between benthic community assemblages observed in visual surveys of OWF subsea cables and their peripheral areas. Finally, the presence of diverse and seemingly healthy benthic communities on existing offshore infrastructure indicates that EMF is unlikely to cause a long-term significant effect upon benthic receptors (Linley *et al.,* 2007; Walker *et al.,* 2009). Embedded mitigation for this impact includes cable burial and/or protection when not available (such as at cable crossings). The target cable burial depth of 2 to 3 m is sufficient to reduce the potential for impacts from EMF on benthic invertebrates. Based on this, and the literature provided above, it is proposed to scope this impact out of the assessment on benthic subtidal and intertidal ecology.

Table 7.25: Impacts Scoped Out of the Assessment for Fish and Shellfish ecology (Tick Confirms the impact is Scoped Out)

Potential Impact	Phase			Justification
	C	O&M	D	
Underwater noise from marine vessels during construction, operation and maintenance and decommissioning phases	✓	✓	✓	**All phases** The potential for underwater noise generated from marine vessels will only occur within the Proposed Development and the immediate vicinity. Fish and shellfish receptors are unlikely to remain in the area for long periods of time during offshore construction, maintenance, and decommissioning activities.
Impacts to fish and shellfish ecology due to EMF	×	✓	×	**Operation and maintenance phase** Low-frequency EMFs are present along subsea cables used to transmit electricity from the Proposed Development to the appropriate substation and terminal locations. Fish and shellfish receptors may be receptive to EMF; however a recent study has demonstrated that increased cable burial depth reduces the intensity of EMF for receptive species (Hutchison *et al*., 2021). As an embedded mitigation measure, cables within the Proposed Development will be buried (target cable burial depth of 2 to 3 m) and/or protected therefore, there is limited scope for impacts from EMF on fish and shellfish ecology.

Potential Impact	Phase			Justification
	C	O&M	D	
Accidental pollution during construction, operation and maintenance, and decommissioning phases	✓	✓	✓	**All phases** The potential for accidental pollution to be released during the construction, operation and maintenance, and decommissioning phases of the Proposed Development is present. This pollution could potentially result from sources including vessels/vehicles and equipment/machinery. However, the risk of these events is managed through embedded mitigation, such as an EMP, which includes Marine Pollution Contingency Plans (MPCPs).

Table 7.26: Impacts Scoped Out Of The Assessment For Marine Mammals And Marine Turtles (Tick Confirms The Impact Is Scoped Out)

Potential Impact	Phase			Justification
	C	O&M	D	
Impacts to marine mammal ecology due to EMF	×	✓	×	**Operation and maintenance phase** Low-frequency EMFs are present along subsea cables used to transmit electricity from the Proposed Development to appropriate substations and terminal locations. Cables within the development area will be buried (to a minimum of 2 m), and/or protected therefore, there is little expected impact on marine mammals and marine turtles. Additionally, there is limited data illustrating marine mammals and turtles being affected by or responding to EMF.
Accidental pollution during construction, operation and maintenance, and decommissioning phases	✓	✓	✓	**All phases** The potential for accidental pollution to be released during the construction, operation and maintenance, and decommissioning phases of the Proposed Development is present. This pollution could potentially result from sources including vessels/vehicles and equipment/machinery. However, the risk of these events is managed through EMP, including MPCPs.
Injury, disturbance, and displacement to marine mammals from operational noise	×	✓	×	**Operation and maintenance phase** The operational noise expected to occur from the Proposed Development will be minimal due to the nature of the infrastructure; there will only be heaters on the platforms. Additionally, the Proposed Development exhibits varying levels of subsea ambient noise sources, the most dominant being offshore shipping. Operational noise is unlikely to add to the existing underwater noise baseline in any significant manner given the context of industrial shipping in the vicinity.
Increased Suspended Sediment Concentrations (SSCs) and associated deposition	✓	×	✓	**Construction and decommissioning phase** Increased suspended sediment concentrations and sediment deposition from construction and decommissioning activities related to subsea pipeline refurbishment and cable installation may potentially result in indirect impacts on marine mammal ecology related to effects on prey species; however, marine mammals are well known to forage in tidal areas where water conditions are turbid and visibility conditions are subsequently poor. Whilst elevated levels of SSCs arising during construction of the Proposed Development may decrease light availability in the water column and produce turbid conditions, the maximum impact range is expected to be localised with sediments rapidly dissipating over one tidal excursion. Therefore, it is proposed to scope this impact out for marine mammals and marine turtles.

7.10 Methodology for Assessment of Effects

The methodology for the assessment of effects follows that set out in volume 1, chapter 5. The following guidance and legislation have also been considered:

- Environmental Protection Agency (EPA) (2022) Guidelines on the Information to be Contained in Environmental Impact Assessment Reports;
- CIEEM (2022) Guidelines for Ecological Impact Assessment (EcIA) in the UK and Ireland;
- Natural England and JNCC (2022) Nature conservation consideration and environmental best practice for subsea cables in English Inshore and UK offshore waters;
- Tougaard (2021) Thresholds for behavioural responses to noise in marine mammals;
- Natural England and JNCC (2019) advice on key sensitivities of habitats and MPAs in English Waters to offshore wind farm cabling within Proposed Round 4 leasing areas;
- Institute of Environmental Management and Assessment (IEMA) (2016) Environmental Impact Assessment Guide to Delivering Quality Development;
- NPWS (2014) Guidance to Manage the Risk to Marine Mammals from Man-Made Sound in Irish Waters;
- European Communities (Birds and Natural Habitats) Regulations 2011;
- Marine Strategy Framework Directive (MSFD) 2008/56/EC; and
- The Wildlife Act 1997 (Amendment 2000).

7.10.1 Magnitude of Impact

Determining the significance of effects is based on a matrix containing the magnitude of the impact and the sensitivity of the receptors. Therefore, the magnitude of the impact and the sensitivity of the receptors must be defined against set criteria. The terms used to define the magnitude of impact and sensitivity of the receptors are presented briefly in the following sections and are described in further detail in volume 1, chapter 5. The criteria used for defining the magnitude of impact are presented in Table 7.27.

Table 7.27: Definition Of Terms Relating To The Magnitude Of Impact

Magnitude of Impact	Definition	
	Adverse Effect(s)	**Beneficial Effect(s)**
High	Loss of resource and/or quality and integrity of resource; severe damage to key characteristics, features, or elements	Large scale or major improvement or resource quality; extensive restoration or enhancement; major improvement of attribute quality
Medium	Loss of resource, but not adversely affecting integrity of resource; partial loss of/damage to key characteristics, features, or elements	Benefit to, or addition of, key characteristics, features, or elements; improvement of attribute quality
Low	Some measurable change in attributes, quality or vulnerability, minor loss of, or alteration to, one (maybe more) key characteristics, features, or elements	Minor benefit to, or addition of, one (maybe more) key characteristics, features, or elements; some beneficial impact on attribute or a reduced risk of adverse impact occurring
Negligible	Very minor loss or detrimental alteration to one or more characteristics, features, or elements	Very minor benefit to, or positive addition of one or more characteristics, features, or elements
No change	No loss or alterations of characteristics, features, or elements and no observable adverse impact	No loss or alterations of characteristics, features, or elements and no observable beneficial impacts

7.10.2 Sensitivity of Receptors

Benthic Subtidal and Intertidal Ecology

The Marine Evidence Based Sensitivity Assessment (MarESA) has been used to define the sensitivity of benthic subtidal and intertidal ecology IEFs. MarESA involves the likelihood or damage (thus resistance) due to the pressure of an effect and the rate of recovery (i.e. recoverability) once said pressure is removed. Resistance is defined as the level at which a receptor can absorb disturbance or stress without changing character. Recoverability is defined as the ability of the habitat to return its state that existed prior to the effect which caused the change. However, full recovery does not necessarily mean that every species component of the habitat has recovered to its prior condition, abundance, and/or extent. Instead, full recovery is reached if the relevant functional components are present, and the habitat is structurally and functionally recognisable as it was prior to the change.

MarESA is a database developed through the Marine Life Information Network (MarLIN) of Britain and Ireland and maintained by the Marine Biological Association (MBA). The MarESA database consists of a detailed review of available evidence on the effects of pressures on marine species and habitats. Subsequently, it also contains a scoring of sensitivity against a standard list of pressures, and their benchmark levels of effect. The MarESA evidence base is peer reviewed and is the largest review undertaken to date on the effects of human activities and natural events on marine species and habitats. It is one of the best available sources of evidence regarding the recovery of seabed species and habitats.

The MarESA sensitivity assessment correlates resistance and recoverability in order to characterise sensitivity of benthic subtidal and intertidal receptors (Table 7.28.). This has been used to define the sensitivity of benthic subtidal and intertidal receptors in this ES chapter, as set out in Table 7.29.

Table 7.28: Matrix Used To Determine The Sensitivity Of Benthic Subtidal And Intertidal Receptors (Reproduced From MarESA Sensitivity Assessment)

		Resistance			
		None	Low	Medium	High
Recoverability	Very Low	High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
	Low	High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
	Medium	Medium sensitivity	Medium sensitivity	Medium sensitivity	Low sensitivity
	High	Medium sensitivity	Low sensitivity	Low sensitivity	Not sensitive (Negligible)

Table 7.29: Definition Of Terms Relating To The Sensitivity Of The Receptor

Sensitivity	Definition
Very High	Nationally and internationally important receptors with high vulnerability and low to no recoverability.
High	Regionally important receptors with high vulnerability and no ability to recover.
Medium	Nationally and internationally important receptors with medium vulnerability and medium recoverability. Regionally important receptors with medium to high vulnerability and low recoverability. Locally important receptors with high vulnerability and no ability to recover.

Sensitivity	Definition
Low	Nationally and internationally important receptors with low vulnerability and high recoverability. Regionally important receptors with low vulnerability and medium to high recoverability. Locally important receptors with medium to high vulnerability and low recoverability.
Negligible	Locally important receptors with low vulnerability and medium to high recoverability. Receptor is not vulnerable to impacts regardless of value/importance.

7.10.2.1 Fish and Shellfish Ecology

In a similar approach to Benthic Subtidal and Intertidal Ecology, an assessment of the combined vulnerability of the receptor to a given impact and the likely rate of recoverability to pre-impact conditions has been used to determine the sensitivity of fish and shellfish IEFs.

Vulnerability is defined as the susceptibility of a species to disturbance, damage, or death, from a specific external factor. Recoverability is the species' ability to return to a state close to that which existed prior to the damage caused by the activity or event. Recoverability is defined by the receptor's ability to recover or recruit after subjected to the extent of disturbance/damage incurred. Information on these factors informing sensitivity of the fish and shellfish IEFs to given impacts has been informed by the best available evidence, including the MarESA, where available. This is derived from evidence of environmental impact and/or experimental manipulation in the field from offshore industries, such as oil and gas activities, electrical cabling, offshore wind farms, and aggregate extraction. These sensitivity assessments have been combined with the assessed conservation status of the fish and shellfish IEFs (section 7.7; Table 7.7). The criteria for defining receptor sensitivity in this ES chapter are outlined in Table 7.29.

Marine Mammals and Marine Turtles

Similar to the approaches outlined above for the other Marine Biodiversity topics, the sensitivity of marine mammal and turtle IEFs has been defined by an assessment of the following:

- the ability of the receptor to adapt to the effect of an impact;
- the receptor's tolerance to that impact; and
- the receptor's ability to recover back to pre-impact conditions.

Tolerance is defined as the susceptibility of the receptor to disturbance, damage, or death, caused by a specific external factor. Recoverability is the ability of the receptor to return to a state close to that which existed prior to the activity or event which caused change. Recoverability is dependent on the ability of the local population to recover, subject to the extent of disturbance/damage incurred. The sensitivity of the marine mammal and turtle IEFs to given impacts has been informed by the best available evidence, such as studies on captive animals and observations from field studies. In particular, evidence of environmental impact and/or experimental manipulation in the field from offshore industries, such as oil and gas activities, electrical cabling, offshore wind farms, and aggregate extraction have been used, where available. The review of vulnerability and recoverability of marine mammal and turtle IEFs has been combined with their assessed conservation status (section 7.7; Table 7.7). The criteria for defining receptor sensitivity in this ES chapter are outlined in Table 7.30.

Table 7.30: Definition Of Terms Relating To The Sensitivity Of The Receptor For Marine Mammal And Turtle IEFs

Sensitivity	Definition
Very High	No ability to adapt behaviour so that survival and reproduction rates may be affected. No tolerance; effect is very likely to cause a change in both reproduction and survival of individuals.

Sensitivity	Definition
	No ability for the animal to recover from the effect
High	No or limited ability to adapt behaviour so that survival and reproduction rates may be affected. No or limited tolerance; effect may cause a change in both reproduction and survival of individuals. No or limited ability for the animal to recover from the effect.
Medium	Ability to adapt behaviour so that reproduction rates may be affected but survival rates not likely to be affected. Some tolerance; effect unlikely to cause a change in both reproduction and survival rates. Ability for the animal to recover from the effect.
Low	Receptor is able to adapt behaviour so that survival and reproduction rates are not affected. Receptor is able to tolerate the effect without any impact on reproduction and survival rates. Receptor is able to return to previous behavioural states/activities once the impact has ceased.
Negligible	Very little or no effect on the behaviour of the receptor.

7.10.3 Significance of Effect

The significance of the effect upon Marine Biodiversity is determined by correlating the magnitude of impact (Table 7.27) and the sensitivity of the receptor, as presented in Table 7.31. Where a range of significances of effect are presented (i.e. 'moderate or major') the final assessment for each effect is based upon expert judgement, with clear justification, and evidence, if necessary, provided. For the purposes of this assessment, any effects with a significance level of 'minor' or less will be considered to be insignificant.

Table 7.31: Matrix Used To Assess The Significant Of Effect

	Magnitude of Impact				
		Negligible	Low	Medium	High
Sensitivity of Receptor	Negligible	Negligible	Negligible or Minor	Negligible or Minor	Minor
	Low	Negligible or Minor	Negligible or Minor	Minor	Minor or Moderate
	Medium	Negligible or Minor	Minor	Moderate	Moderate or Major
	High	Minor	Minor or Moderate	Moderate or Major	Major or Substantial
	Very High	Minor	Moderate or Major	Major or Substantial	Substantial

7.10.4 Designated Sites

This chapter summarises the assessments made on the interest features of internationally designated sites as described in sections 7.8.1.7, 7.8.2.8, and 7.8.3.7 (with the assessment on the site itself deferred to the RIAA). With respect to nationally and locally designated sites, where these sites fall within the boundaries of an internationally designated site (e.g. Sites of Special Scientific Interest (SSSIs) which have not been assessed within the RIAA), only the international site has been taken forward for assessment. This is because potential effects on the integrity and conservation status of the nationally designated site are assumed to be inherent within the assessment of the internationally designated site (i.e. a separate assessment for the national site is not undertaken).

For benthic subtidal and intertidal ecology, two designated sites have been included in this assessment as IEFs, as they overlap with the Proposed Development: the Dee Estuary/Aber Dyfrdwy SAC and the Fylde MCZ (see section 7.8.1.7). Although Annex II sea lamprey and river lamprey are also present as qualifying features of the Dee Estuary/Aber Dyfrdwy SAC (JNCC, 2023a) (Table 7.12), these species are assessed under 'Diadromous fish' within the assessment for fish and shellfish ecology. Thus, the Dee Estuary/Aber Dyfrdwy SAC has not been assessed as an IEF for fish and shellfish ecology. Fish and shellfish which are qualifying interest features of designated sites have been defined as IEFs and are assessed as such (where relevant). Finally, for marine mammals and marine turtles, there are no designated sites which overlap with the Proposed Development. However, all Annex II species which are qualifying interest features of designated sites within the regional marine mammal study area (Table 7.19) have also been defined as IEFs and are assessed as such (where relevant).

7.11 Embedded Mitigation

For the purposes of the EIA process, the term 'Embedded Mitigation' is used to include the following measures (adapted from IEMA, 2016):

- Measures included as part of the project design. These include modifications to the location or design envelope of the Proposed Development which are integrated into the application for consent. These measures are secured through the consent itself throughout the description of the development and the parameters secured in the Development Consent Order (DCO) and/or marine licence (referred to as 'primary mitigation' in IEMA, 2016).
- Measures required to meet legislative requirements, or actions that are standard practice used to manage commonly occurring environmental effects and are secured through the DCO requirements and/or the conditions of the marine licences (referred to as 'tertiary mitigation' in IEMA, 2016).

A number of embedded mitigation measures (primary and tertiary) have been adopted as part of Proposed Development to reduce the potential for impacts on marine biodiversity. These are outlined in Table 7.32 below. As there is a secured commitment to implementing these measures, they are considered inherently part of the design of the Proposed Development. Therefore, these measures have been considered in the assessment of significance, presented in section 7.12 below. This means that the determination of magnitude and therefore significance assumes implementation of these measures.

Where significant effects have been identified in section 7.12 below, further mitigation measures (referred to as 'secondary mitigation' in IEMA 2016) have been identified to reduce the significance of effect to acceptable levels following the initial assessment. These are measures that could further prevent, reduce and, where possible, offset any adverse effects on the environment.

Table 7.32: Embedded Mitigation Measures Adopted As Part Of The Proposed Development

Embedded Mitigation	Justification	How these Measures will be Secured
Primary Mitigation: Measures Embedded into the Project Design		
Development of, and adherence to, a Cable Specification and Installation Plan (CSIP) which will include cable burial where possible (in accordance with the specific policies set out in the North West Inshore and North West Offshore Marine Plan (MMO, 2021)) and cable protection, as necessary.	The CSIP will set out appropriate cable burial depth in accordance with industry good practice, minimising the risk of cable exposure. The CSIP will also ensure that cable crossings are appropriately designed to mitigate environmental effects, these crossings will be agreed with relevant parties in advance of CSIP submission. The CSIP will include a detailed Cable Burial Risk Assessment (CBRA) to enable informed judgements regarding burial depth to maximise the chance of cables remaining buried whilst limiting the amount of sediment disturbance to that which is necessary. Measures will seek to reduce the amount of EMF which benthic and fish and shellfish receptors are exposed to during the operations and maintenance phase by increasing the distance between the seabed surface and the surface of the cables.	Proposed to be secured as a condition of the marine license(s).
Implementation of piling initiation, soft-start, and ramp-up measures within the Marine Mammal Mitigation Protocol (MMMP). An initiation stage and soft starts will be used during the installation of pin piles. This involves the implementation of an initial low hammer energy with a low number of strikes, followed by lower hammer energies at a higher strike rate at the beginning of the piling sequence before energy input is 'ramped up' (increased) over time to required higher levels.	This measure will minimise the risk of injury to fish, marine mammal, and marine turtle species in the immediate vicinity of piling activities, allowing individuals to move away from the area before noise levels reach a level at which injury may occur.	
Inclusion of low order techniques as a UXO clearance option noting, however, that it is not possible to fully commit to this measure at this stage. Low order techniques are not always possible and are dependent upon the individual situations surrounding each UXO. Given that high order detonation may be required, the MMMP will also include mitigation to reduce the risk of injury from UXO clearance.	Low order techniques generate less underwater noise than high order techniques and therefore present a lower risk to sound-sensitive receptors such as fish, marine mammals, and marine turtles during UXO clearance.	

Embedded Mitigation	Justification	How these Measures will be Secured
Development of and adherence to an EMP that will be prepared and implemented during the construction, operational and maintenance and decommissioning phases of the Proposed Development. The EMP will include appendices detailing actions to minimise INNS (the INNS Management Plan (INNSMP)), and a MPCP will be developed which will include planning for accidental spills, address all potential contaminant releases and include key emergency contact details	Measures will be adopted to ensure that the potential for release of pollutants from construction, operational and maintenance and decommissioning plant is minimised. These will likely include designated areas for refuelling where spillages can be easily contained, storage of chemicals in secure designated areas in line with appropriate regulations and guidelines, double skinning of pipes and takes containing hazardous substances, and storage of these substances in impenetrable bunds. All vessels will be required to comply with the standards set out in the International Convention for the Prevention of Pollution from Ships (MARPOL).	
Tertiary Mitigation: Measures Required to meet Legislative Requirements, or Adopted Standard Industry Practice		
Development of and adherence to a MMMP, based on a draft MMMP submitted alongside the ES. The MMMP will present appropriate mitigation for activities that could potentially lead to injurious effects on marine mammals including: piling, UXO clearance and some types of geophysical activities. The MMMP will be developed on the basis of the most recent published statutory guidance and in consultation with key stakeholders.	**Piling:** for the purpose of developing the MMMP, a mitigation zone of 500 m will be applied, following the JNCC (2010a) guidance. The Draft MMMP will set out the measures to apply in advance of and during piling activity including the use of Marine Mammal Observers (MMObs), Passive Acoustic Monitoring (PAM), and Acoustic Deterrent Devices (ADD), thereby following the latest JNCC guidance (JNCC, 2010a). **UXO Clearance:** Measures including visual and acoustic monitoring (MMObs and PAM), the use of an ADD, and soft start charges will be applied to deter animals from the mitigation zone as defined by sound modelling for the largest possible UXO following the latest JNCC (2010b) guidance. **Geophysical and Seismic Surveys:** Mitigation for injury during high resolution geophysical and seismic site-investigation surveys using a sub-surface sensor from a conventional vessel will involve the use of MMObs and PAM to ensure that the risk of injury over the defined mitigation zone is reduced in line with JNCC (2017) guidance (500 m). Soft start is not possible for SBP equipment but will be applied for other high-resolution surveys where possible. It should be noted that some multi-beam surveys in shallow waters (<200m) are not subject to the requirements of mitigation.	Proposed to be secured through a condition in the marine licence(s).
Development of, and adherence to, a CMS.	This measure will confirm the actual methodology that will be employed to construct the Proposed Development, provide details on aspects of the methodology not known at the application stage and confirm that the methodology falls within the parameters assessment in the ES.	

Embedded Mitigation	Justification	How these Measures will be Secured
Actions to minimise INNS, including a biosecurity plan to limit spread and introduction of INNS	These measures will aim to manage and reduce the risk of potential introduction and spread of INNS so far as reasonably practicable to best protect the biological integrity of the local natural environment and communities.	
Development of, and adherence to, an EMP, which will be issued to all vessel operators, requiring them to: • not deliberately approach marine mammals, marine turtles, and basking sharks; • keep vessel speed to a minimum; and • avoid abrupt changes in course or speed should marine mammals approach the vessel to bow-ride.	To minimise the potential for collision risk, or potential injury to, marine mammals and megafauna this code of conduct outlines in the EMP will be adhered to at all times.	An EMP will be issued to all Project vessel operators. Proposed to be secured through a condition in the marine licence(s).
Development of, and adherence to, a Decommissioning Plan	The aim of this plan is to adhere to the relevant UK and international legislation and guidance in place at the time, with decommissioning industry practice applied to reduce the amount of long-term disturbance to the environment so far as reasonably practicable.	Proposed to be secured as a condition of the marine license(s).

7.12 Assessment of Significance

The potential impacts of the construction, operation and maintenance, and decommissioning of phases of the Proposed Development have been assessed for benthic subtidal and intertidal ecology, fish and shellfish, and marine mammals and marine turtles. These potential impacts are presented in Table 7.21, Table 7.22, and Table 7.23, alongside the MDS against which impact has been assessed.

Benthic Subtidal and Intertidal Ecology

7.12.1 Temporary Subtidal Habitat Loss and/or Disturbance

Temporary habitat loss and/or disturbance of subtidal and intertidal habitats will occur during the construction, operations and maintenance, and decommissioning phases of the Proposed Development. The MDS for temporary habitat loss/disturbance is summarised in Table 7.21. The relevant MarESA pressures and their benchmarks which have used to inform this impact assessment are described here:

- Habitat structure changes - removal of substratum (extraction): the benchmark for which is the extraction of substratum to 30 cm. This pressure is considered to be analogous to the impacts associated with sand wave clearance and the construction of exit pits.
- Abrasion/disturbance at the surface of the substratum or seabed: the benchmark for which is damage to surface features (e.g. species and physical structures within the habitat). This pressure corresponds to the impacts associated with jack-up vessel operations and anchor placements.
- Penetration and/or disturbance of the substratum subsurface: the benchmark for which is damage to sub-surface features (e.g. species and physical structures within the habitat). This pressure corresponds to the impacts associated with cable installation and jack-up vessel operations.
- Smothering and siltation rate changes (heavy): the benchmark for which is heavy deposition of up to 30 cm of fine material added to the habitat in a single discrete event. This pressure corresponds to impacts associated with the deposition of dredged sand wave material and drill cutting deposits.

7.12.1.1 Construction Phase

There is potential for temporary subtidal habitat loss and/or disturbance in the Proposed Development due to site preparation activities and the installation of development infrastructure (such as subsea power cables and the new Douglas platform).

Magnitude of Impact

Subtidal Habitats and Species

The MDS accounts for up to a total of 1.91 km^2 of temporary subtidal habitat loss and/or disturbance during the construction phase (Table 7.21). The represents 0.32% of the total Proposed Development.

Temporary habitat disturbance in the construction phase is likely to result from seabed preparations (e.g. sand wave clearance and associated deposition), jack-up events, and cable installation. Any mounds of cleared material will erode over time and displaced material will re-join the natural sedimentary environment, gradually reducing the size of the mounds. As the sediment type deposited on the seabed will be similar to that of the surrounding areas, benthic assemblages would be expected to recolonise these areas (see 'Sensitivity of the Receptor' section below). The use of jack-up vessels at the new Douglas platform will result in 736 m^2 of temporary habitat loss and/or disturbance during the construction phase (Table 7.21). There will be four foundations, and two jack-up events required per foundation.

Temporary habitat loss and/or disturbance will result due to depressions formed during jack-up events, which may remain for multiple years. For example, monitoring studies at Barrow Offshore Wind Farm demonstrated that depressions were almost entirely infilled 12 months post construction, while monitoring at the Lynn and Inner Dowsing Offshore Wind Farm demonstrated some evidence of infilling but visible depressions two years post construction (Barrow Offshore Wind, 2008; EGS, 2011). Jack-up depressions are likely to be temporary in areas with mobile sands, such as the Proposed Development. For example, monitoring of the Walney Wind Farm Extension, showed that fine sands and muds within this area were highly mobile and likely to return to a relatively undisturbed habitat within a period of months to a few years (CMACS, 2014).

Subsea cable installation will result in 1.89 km^2 of temporary habitat loss and/or disturbance due to trenching within the construction phase (Table 7.21). This will include the installation of 126.04 km of subsea power cables with a trench width of 15 m. For the purposes of modelling the MDS, the total footprint of affected seabed has been calculated, assuming a mound of uniform thickness of 0.5 m height. However, it should be noted that, mounds may be taller and more unevenly distributed. Any mounds of cleared material will, however, erode over time and displaced material will re-join the natural sedimentary environment, gradually reducing the size of the mounds.

A recent study by RPS (2019) reviewed the effects of cable installation on subtidal sediments and habitats, drawing on monitoring reports from over 20 UK offshore wind farms. Sandy sediments were shown to recover quickly following cable installation, with little or no evidence of disturbance in the years following cable installation. It also presented evidence that remnant cable trenches in coarse and mixed sediments were conspicuous for several years after installation. However, these shallow depressions were of limited depth (i.e. tens of centimetres) relative to the surrounding seabed, over a horizontal distance of several metres and therefore did not represent a large shift from the baseline environment (RPS, 2019). Remnant trenches (and anchor drag marks) were observed years following cable installation within areas of muddy sand sediments, although these were relatively shallow features (i.e. a few tens of centimetres).

The majority of sand wave clearance and cable installation may potentially take place within the Subtidal mixed muddy sediment IEF. However, as detailed above by the RPS (2019) study, this habitat is likely to recover from activities of this nature. There is unlikely to be any disturbance to the Annex I Reef IEF identified within this assessment due to its distance from the area of project physical work (see Figure 7.4).

Dredging will be undertaken at West Hoyle Bank, which is a sandbank situated off the coast of the PoA, to install subsea power cables between the new Douglas platform and the PoA terminal. This will require dredging a channel (most likely with the backhoe dredger) approximately 1,000 m in length, 21 m in width, and 7 m in depth (~3m to take bank down to LAT, then ~3m depth for cable burial). The excavated material will be side cast along the length of the trench, and then backfilled after cable installation. It would take approximately two to three weeks to excavate the trench. Even if the cable was routed further to the east of West Hoyle Bank, the water remains extremely shallow. It will, therefore, still require pre-lay dredging to allow for a self-beaching cable lay vessel to ground itself at low tide on a ‘flat’ area of sandbank. It would take approximately four to seven days to excavate the area depending on dredging technique applied. In total, dredging at West Hoyle Bank will result in 21,000 m^2 of disturbance. Physical processes modelling demonstrated that much of the material is deposited along the dredge path itself, supporting the fact the sediment will remain within the sediment cell and minimising loss to West Hoyle Bank. Taking into account the eastward migration of the existing channel through West Hoyle Bank, it is recommended as a mitigating measure that the placement of dredged material directly to the west of seabed preparation operations would aid in the recovery of morphological features, and further encourage the feature to naturally infill. The temporary change to the morphology of West Hoyle Bank will have minimal impact on the feature’s ability to act as a natural breakwater for waves propagating towards the Dee Estuary/Aber Dyfrdwy SAC. Given the location and orientation of the channel, cutting through the middle of the bank from its southern face to its northern face, there will be no change to the waves breaking on the west of the sand bank.

The maximum duration of the offshore construction phase for the Proposed Development is up to two years. Within this maximum construction period, construction activities are anticipated to occur intermittently. They will be spread out across the full allotted timeframe with only a small proportion of the MDS footprint being affected at any one time.

The 'Subtidal mixed muddy sediment', 'Subtidal sands and gravels', 'Mud habitats in deep water' and Annex I Reef IEFs have been assigned national importance (Table 7.10). The impact on these IEFs is predicted to be of local spatial extent (0.32% of the Proposed Development), short term duration (up to two years), intermittent (due to the construction schedule), and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore considered to be low.

Ross worm was identified as an IEF of local importance within this assessment as individual animals, not reefs. As there were only several individual animals recorded during the site-specific benthic characterisation survey and no reefs identified, it is unlikely that the Proposed Development represents an important habitat for this species at a population level. The impact on the Ross worm IEF is predicted to be of highly local spatial extent (due to no reefs observed), short term duration (up to two years), intermittent (due to the construction schedule), and high reversibility. The magnitude is therefore considered to be negligible.

Intertidal Habitats and Species

As outlined in the MDS, the installation of 1,200 m of subsea power cables within the intertidal area, via ploughing or cable trenching techniques, may result in temporary habitat loss and/or disturbance. If using the cable trenching machine (which represents the worst-case scenario) and in the absence of any additional mitigation, an area of approximately 18,000 m^2 (1.8 ha) would be impacted. This includes the area of sediment directly disturbed by the installation of the cable and the area of sediment potentially compacted under the tracks of the machine. The MDS assumes a trench width of 15 m (Table 7.21). Sediment disturbed during the installation will be backfilled by the machine, subsequent infilling from deposited suspended sediments, as well as natural deposition, so disturbance would be temporary and localised.

Temporary disturbance to the 'Mudflats and sandflats not covered by seawater at low tide' IEF may also arise as a result of the movement of machinery, equipment, vehicles and personnel. These activities are likely to result in surface level abrasion and disturbance or compaction of sediments. The area of sediment potentially compacted under the tracks of the cable trenching machine is included within the 18,000 m^2 above.

The 'Mudflats and sandflats not covered by seawater at low tide' IEF has been assigned international importance (Table 7.10). The impact on this IEF is predicted to be of local spatial extent (up to 18,000 m^2), short term duration (up to two years), intermittent (due to the construction schedule), and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.

Designated Sites

The Dee Estuary/Aber Dyfrdwy SAC and the Fylde MCZ overlap with the Proposed Development in parts and have been assessed as IEFs of international and national importance, respectively, as a result (Table 7.10). The Proposed Development overlaps with 0.21 km^2 of the Dee Estuary/Aber Dyfrdwy SAC, corresponding to 0.13% of the SAC's total area. The Proposed Development overlaps with 260.60 km^2 of the Fylde MCZ, corresponding to 15.87% of the MCZ's total area. Therefore, there is a small overlap between the Proposed Development and these two designated sites, particularly the Dee Estuary/Aber Dyfrdwy SAC.

As above for the intertidal IEF (Mudflats and sandflats not covered by seawater at low tide), temporary habitat loss and/or disturbance may arise in the Dee Estuary/Aber Dyfrdwy SAC due to installation of 1,200 m of offshore export cables within the intertidal area, and as a result of the movement of machinery, equipment, vehicles and personnel. The installation of 1,200 m of subsea power cables within the intertidal area may result in up to 18,000 m^2 of temporary habitat disturbance. This includes the area of sediment directly disturbed by the installation of the cable and the area of sediment under the tracks of the machine. Based on this information, the area of habitat within the Proposed Development with the potential to be temporarily disturbed is expected to be 18.40% of the total intertidal mudflats and sandflats habitat area, although only 0.017% of the extent of the Annex I mudflats and sandflats habitat within the Dee Estuary/Aber Dyfrdwy SAC.

As stated above for the subtidal habitats and species IEFS, dredging at the West Hoyle Bank prior to cable installation is highly recoverable due to natural and mitigated infilling. Temporary changes to the morphology of West Hoyle Bank are not expected to impact its ability to act as a natural breakwater for waves propagating towards the Dee Estuary/Aber Dyfrdwy SAC and its Annex I mudflat and sandflat feature.

As the Fylde MCZ overlaps with the Proposed Development offshore, potential impacts that may arise are the same as those identified above for 'Subtidal Habitats and Species'. However, there is unlikely to be any disturbance to the Fylde MCZ as it is a minimum 1.82 km away from the area of project physical work (see Figure 7.4).

Overall, the impact on the designated site IEFs is predicted to be of local spatial extent, short term duration, intermittent, and high reversibility. For the designated sites IEFs, it is predicted that the impact will affect the receptors directly. The magnitude is therefore, considered to be low.

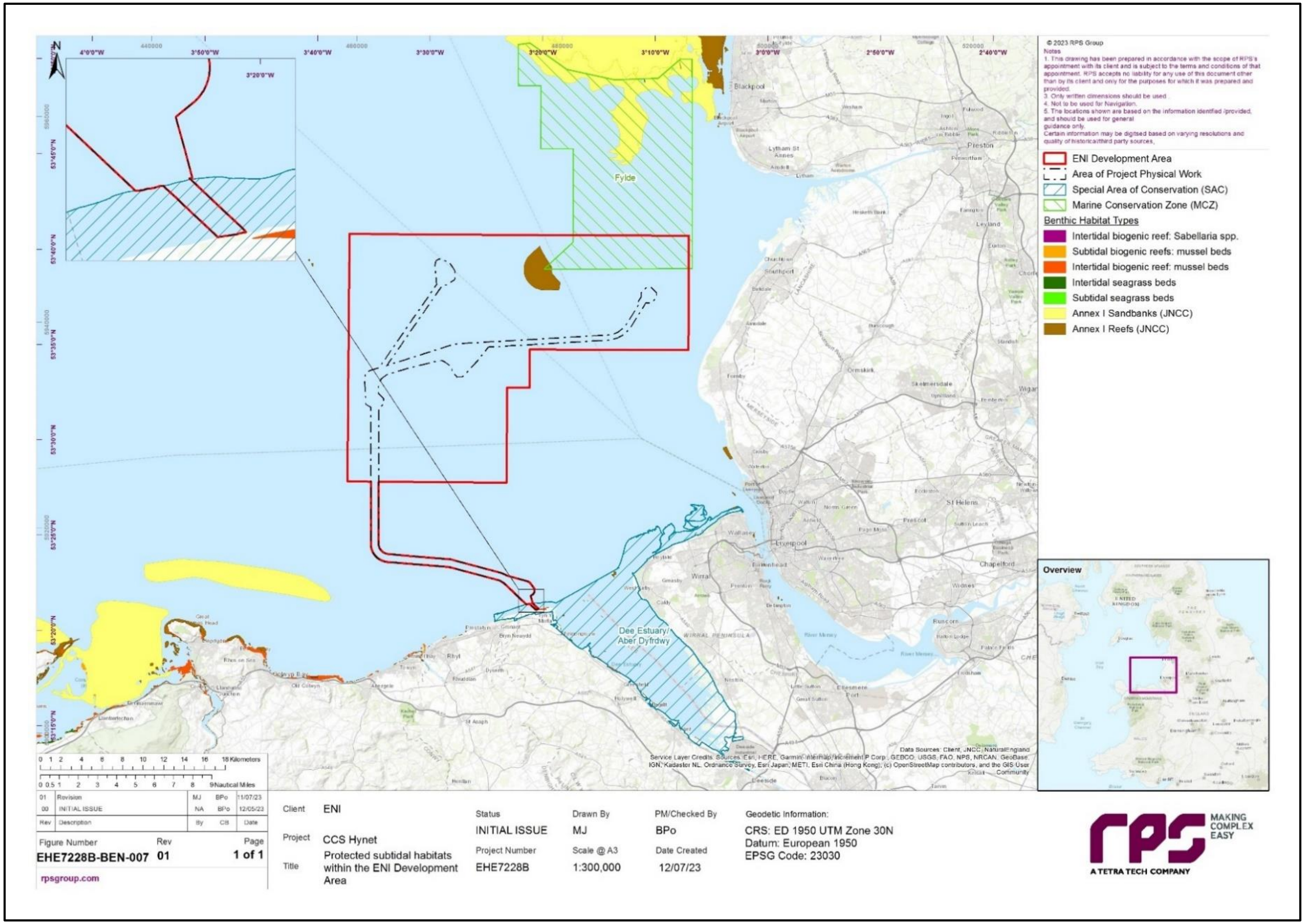

Figure 7.4: Protected Habitats Identified Within The Proposed Development

Sensitivity of Receptor

Subtidal Habitats and Species

The sensitivity of the IEFs to temporary subtidal habitat loss and/or disturbance are presented in Table 7.33. These sensitivities are based on assessments made by the MarESA (where available).

The subtidal habitats and species IEFs have an overall medium sensitivity to this impact. The biotopes within these IEFs have no to medium sensitivity to abrasion and penetration related disturbance because these habitats are largely characterised by infauna (Table 7.33). Resilience is thought to be high although abrasion or penetration may result in damage or mortality to some epifaunal organisms (De-Bastos and Marshall, 2016; Tillin, 2022a; 2022b). Sensitivity to habitat structure change was assessed as medium, as sedimentary communities are likely to be intolerant of substratum removal, which will lead to partial or complete defaunation (Dernie *et al.,* 2003). Infilling would allow for recovery of these sedimentary habitats, although some recovery of the biological assemblage may take place before the original topography is restored, if the exposed, underlying sediments are similar to those that were removed. This recovery will be site-specific, following construction activities such as sand wave clearance and will be influenced by currents, wave action, and sediment availability (Desprez, 2000). The sensitivity of these IEFs to heavy smothering, such as that which might result from the deposition of sand wave clearance material, has been assessed as sensitive to medium. Many of the bivalves and polychaete species in these IEFs are able to migrate through depositions of sediment greater than the benchmark (30 cm of fine material added to the seabed in a single discrete event) (Maurer *et al.,* 1982; Bijkerk, 1988; Powilleit *et al.,* 2009). The effects of smothering have also been found to depend upon the volume and type of sediment involved, however the mortality of some amphipods and isopods is likely. Individuals are however more likely to escape from smothering if the sediments are similar to those in which the species is found (Tillin, 2016). As the sediment which will be deposited from this impact will be deposited close to its original location. It is likely that it will be similar to the seabed sediment increasing the potential for survival and recolonisation making resilience high. It is considered probable that Ross worm can tolerate smothering for several weeks, although feeding and growth will be curtailed (Jackson and Hiscock, 2008).

Overall, all the subtidal habitats and species IEFs are deemed to be of medium vulnerability, high recoverability, and local to national value. The sensitivity of these receptors is therefore, considered to be medium.

Intertidal Habitats and Species

The sensitivity of the 'Mudflats and sandflats not covered by seawater at low tide' IEF to temporary subtidal habitat loss and/or disturbance is presented in Table 7.33. These sensitivities are based on assessments made by the MarESA and were overall assessed as 'not sensitive' to 'high' to the defined MarESA pressures.

Each of the representative biotopes were assessed as 'medium' to habitat structure changes (removal of substratum) (Table 7.33). For example, the biotope '*M. balthica* and *A. marina* in littoral muddy sand (LS.Lsa.MuSa.MacAre)', requires substratum to return to fine sand and muddy sand with scattered pebbles, boulders, and cobbles (Ashley *et al.,* 2023). The characterising species for this biotope have been shown to be less impacted by habitat structure changes (removal of substratum) on a smaller scale, as *A. marina* rapidly recolonises basins left by bait digging, while *M. balthica* was unaffected by bait digging (McLusky *et al.,* 1983). This biotope was also assessed as medium sensitivity to 'Abrasion/disturbance of the surface of the substratum or seabed' and to 'Smothering and siltation rate changes (heavy)' and high to 'Penetration or disturbance of the substratum subsurface'. The burrowing traits of *A. marina* and *M. balthica* may provide some resistance to these pressures, however Boldina and Beninger (2014) reported decreases in naturally occurring aggregations of *A. marina* in trawled areas, which suggests that these pressures may have consequences on reproduction, recruitment, growth, and feeding. Further, Collie *et al*. (2000) identified that well established sand and muddy sand intertidal communities (such as this biotope) suffered the greatest impact from bottom towed fishing activities (which have similar effects as temporary habitat loss and/or disturbance). This biotope was most sensitive to the 'Penetration or disturbance of the substratum subsurface' pressure, as *A. marina* and *M. balthica* are burrowing species. Thus, damage to the subsurface would cause greater damage than damage to the substratum (Ashley *et al.,* 2023). However, as the disturbance to the intertidal zone as a result of the Proposed Development is proposed to be limited, and it is not likely that this area represents a significant portion of this biotope's distribution around the UK and Ireland, the overall sensitivity of is proposed to be medium.

The biotope 'Talitrids on the upper shore and strand-line (LS.Lsa.St.Tal)', was assessed as medium sensitivity to habitat structure changes (removal of substratum) and to smothering and siltation rate changes (heavy). These pressures could both destroy the habitat, however refugia are important in maintaining populations of characterising species (talitrid amphipods) (Fanini *et al.,* 2005). Therefore, the overall sensitivity was assessed as medium. This biotope was also assessed as low sensitivity to the abrasion and penetration pressures (Table 7.33). This is because this biotope is typically subjected to physical disturbance due to tidal and wave action, and the movement of marine debris. Characterising species (talitrid amphipods) are susceptible to abrasion and penetration (Ugolini *et al.,* 2008), however overall sensitivity is low due to migration from adjacent populations and *in situ* reproduction (Tillin and Budd, 2004).

The biotope 'Polychaete/bivalve-dominated muddy sand shores (LS.Lsa.MuSa)' was assessed as medium sensitivity to habitat structure changes (removal of substratum) and low for the other pressures. The sedimentary communities, characteristic of this biotope, are likely to be highly intolerant of substratum removal, which will lead to partial defaunation, exposure of the underlying sediment and changes in the topography of the area (Dernie *et al.,* 2003). However, this biotope can recover once substratum returns to prior conditions, pits or trenches are filled, and species recolonization can occur. This has been observed over a range of time periods, such as 40 days (Hall, 1994), 50 days, and 111 days (Ferns *et al.,* 2000), depending on the species. This subsequent recovery was the rationale behind the low sensitivity assessment to abrasion and smothering pressures.

The biotope 'Barren or amphipod-dominated mobile sand shores (LS.Lsa.MoSa)' was only assessed as sensitive to 'habitat structure changes (removal of substratum)' but as 'not sensitive' to the other three pressures relevant to the impact of temporary habitat loss and/or displacement (Table 7.33). For this biotope, removal of substratum would mean removal of the abiotic habitat. However, infilling is likely to be rapid and recovery from habitat structure changes would occur in less than a year (Tillin, 2018). As this biotope is characterised by the absence of species through sediment mobility rather than the presence of characteristic species, abrasion and penetration of the substratum and smothering would not alter the biotope's character (Tillin, 2018). Thus, this biotope is not sensitive to these pressures.

Overall, the 'Mudflats and sandflats not covered by seawater at low tide' IEF is deemed to be of medium vulnerability, high recoverability, and international value. The sensitivity of the receptor is therefore, considered to be medium.

Designated Sites

The Annex I habitat 'Mudflats and sandflats not covered by seawater at low tide' is extensive throughout the site and are present in the intertidal sections which overlap with the Proposed Development. Therefore, the sensitivities presented for the 'Mudflats and sandflats not covered by seawater at low tide' IEF in the preceding section is applicable to the Dee Estuary/Aber Dyfrdwy SAC IEF. Thus, the Dee Estuary/Aber Dyfrdwy SAC IEF is deemed to be of medium vulnerability, high recoverability, and international value. The sensitivity of the receptor is therefore, considered to be medium.

As detailed in Table 7.10, the area of the Fylde MCZ which overlaps with the Proposed Development has been assigned the biotope 'Sublittoral sands and muddy sands (SS.Ssa)' (Envision Mapping, 2015), however has not been assigned more specific biotopes. As this area overlaps with the 'Subtidal sands and gravels' IEF identified during the site-specific survey within the Proposed Development, the representative biotopes identified for this IEF have also been used to characterise the Fylde MCZ IEF in the assessment. Therefore, the Fylde MCZ IEF is deemed to be of medium vulnerability, high recoverability, and national value. The sensitivity of the receptor is therefore, considered to be medium.

Table 7.33: Sensitivity Of The Benthic Subtidal And Intertidal Ecology IEFs To Temporary Subtidal Habitat Loss And/Or Disturbance

IEF	Representative Biotopes Identified	Sensitivity to Defined MarESA Pressure				Overall Sensitivity (Based on Table 7.29)
		Habitat structure changes – removal of substratum	Abrasion/disturbance of the surface of the substratum or seabed	Penetration or disturbance of the substratum subsurface	Smothering and siltation rate changes (heavy)	
Subtidal Habitats and Species						
Subtidal Sands and Gravels	*M. fragilis, Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel (SS.SCS.CCS.MedLumVen)	Medium	Low	Low	Medium	Medium
	N. cirrosa and *Bathyporeia* spp. In infralittoral sand (SS.Ssa.IfiSa.NcirBat)	Medium	Low	Low	Low	Medium
Mud Habitats in Deep Water	*A. filiformis, K. bidentata* and *A. nitida* in circalittoral sandy mud (SS.Smu.CsaMu.AfilKurAnit)	Medium	Medium	Medium	Medium	Medium
Subtidal Mixed Muddy Sediment	*O. fragilis* and/or *O. nigra* brittlestar beds on sublittoral mixed sediment (SS.SMx.CMx.OphMx)	Medium	Medium	Medium	Medium	Medium
Ross Worm *S. spinulosa*	-	Medium	Low	Not assessed	Not sensitive	Medium
Intertidal Habitats and Species						
Mudflats and sandflats not covered by seawater at low tide	Talitrids on the upper shore and strand-line (LS.Lsa.St.Tal)	Medium	Low	Low	Medium	Medium
	M. balthica and *A. marina* in littoral muddy sand (LS.Lsa.MuSa.MacAre)	Medium	Medium	High	Medium	Medium
	Barren or amphipod-dominated mobile sand shores (LS.Lsa.MoSa)	Medium	Not sensitive	Not sensitive	Not sensitive	Medium
	Polychaete/bivalve-dominated muddy sand shores (LS.Lsa.MuSa)	Medium	Low	Not assessed	Low	Medium

Significance of Effect

Subtidal Habitats and Species

Overall, the magnitude of this impact on all subtidal habitats and species IEFs except Ross worm was deemed to be low and the sensitivity of the receptor was considered to be medium. Therefore, the effect of temporary habitat loss and/or disturbance will be of **minor adverse** significance, which is **not significant** in EIA terms.

For the Ross worm IEF, the magnitude this impact was deemed to be negligible, and the sensitivity of the receptor was considered to be medium. As per Table 7.31, this results in a 'negligible or minor' significance of effect. As there were no Ross worm reefs identified, there is unlikely to be any loss or detrimental alteration to the Ross worm IEF due to this impact (see Table 7.27). Therefore, it has been concluded that the effect of temporary habitat loss and/or disturbance will be of **negligible adverse** significance, which is **not significant** in EIA terms.

Intertidal Habitats and Species

Overall, the magnitude this impact on the intertidal habitats and species IEF was deemed to be low and the sensitivity of the receptor was considered to be medium. Therefore, the effect of temporary habitat loss and/or disturbance will be of **minor adverse** significance, which is **not significant** in EIA terms.

Designated Sites

Overall, the magnitude this impact on the designated sites IEFs was deemed to be low and the sensitivity of the receptor was considered to be medium. Therefore, the effect of temporary habitat loss and/or disturbance will be of **minor adverse** significance, which is **not significant** in EIA terms.

7.12.1.2 Operation and Maintenance Phase

Temporary habitat loss and/or disturbance may occur during the operation and maintenance phase, via use of jack-up vessels for repair and maintenance activities.

Magnitude of Impact

Subtidal Habitats and Species

The MDS accounts for up to 72,000 m^2 of temporary habitat loss and/or disturbance within this phase (Table 7.21). This equates to a small proportion (0.01%) of the Proposed Development. It should also be noted that only a small proportion of the total temporary habitat loss and/or disturbance is likely to occur at any one time, with the MDS for this impact spread over the 25-year lifetime. Therefore, individual maintenance activities will be small scale and intermittent events.

These operation and maintenance activities may impact an area up to 34,500 m^2 due to jack-up events at the infrastructure and up to 37,500 m^2 due to cable reburial over the 25-year lifetime of the Proposed Development.

The impacts of jack-up vessel activities will be similar to those identified for the construction phase above and will be restricted to the immediate area where the spud cans are placed on the seabed, with recovery occurring following removal of spud cans. The impacts of cable reburial will be similar to those identified for the construction phase above, but will only impact up to 7,500 m^2 at any one time.

The spatial extent of this impact is small in relation to the whole Proposed Development, although there is the potential for repeat disturbance to the habitats in the immediate vicinity the infrastructure because of these activities. However, these effects are expected to be similar to the construction phase, but of a much lower magnitude.

The impact on all the subtidal habitats and species IEFs except Ross worm is predicted to be of local spatial extent (0.01% of the Proposed Development), short term duration, intermittent over the lifecycle of the

Proposed Development, and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore considered to be low.

As only individual Ross worm were recorded in places during the site-specific subtidal benthic characterisation survey and no reefs were identified, it is unlikely that the Proposed Development represents an important habitat for this species at a population level. Thus, the impact on the Ross worm IEF is predicted to be of highly local spatial extent (due to no reefs observed and only 0.01% of the Proposed Development potentially affected), short term duration, intermittent over the lifecycle of the Proposed Development, and of high reversibility. The magnitude is therefore considered to be negligible.

Intertidal Habitats and Species

Temporary disturbance to the ‘Mudflats and sandflats not covered by seawater at low tide’ IEF may arise as a result of the movement of machinery, equipment, vehicles and personnel involved in operation and maintenance activities. These activities are likely to result in surface level abrasion and disturbance or compaction of sediments. It should also be noted that only a small proportion of the total temporary habitat loss and/or disturbance is likely to occur at any one time, with the MDS for this impact spread over the 25-year lifetime. Therefore, individual maintenance activities will be small scale and intermittent events.

The impact on the ‘Mudflats and sandflats not covered by seawater at low tide’ IEF is predicted to be of highly local spatial extent, short term duration, intermittent over the lifecycle of the Proposed Development, and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.

Designated Sites

As stated above for the construction phase, the Dee Estuary/Aber Dyfrdwy SAC and the Fylde MCZ overlap with the Proposed Development in parts and have been assessed as IEFs of international and national importance, respectively, as a result (Table 7.10). The Proposed Development overlaps with 0.21 km^2 of the Dee Estuary/Aber Dyfrdwy SAC, corresponding to 0.13% of the SAC’s total area. The Proposed Development overlaps with 260.60 km^2 of the Fylde MCZ, corresponding to 15.87% of the MCZ’s total area. Therefore, there is a small overlap between the Proposed Development and these two designated sites, particularly the Dee Estuary/Aber Dyfrdwy SAC.

As above for the intertidal IEF (Mudflats and sandflats not covered by seawater at low tide), temporary habitat loss and/or disturbance may arise in the Dee Estuary/Aber Dyfrdwy SAC as a result of the movement of machinery, equipment, vehicles and personnel. These activities are likely to result in surface level abrasion and disturbance or compaction of sediments. As the Fylde MCZ overlaps with the Proposed Development offshore, potential impacts that may arise are the same as those identified above for the Subtidal habitats and species IEFs. However, there is unlikely to be any disturbance to the Fylde MCZ as it is a minimum of 1.82 km from the area of project physical work (see Figure 7.4).

Overall, the impact on the designated site IEFs is predicted to be of local spatial extent, short term duration, intermittent, and high reversibility. For the Dee Estuary/Aber Dyfrdwy SAC IEF, it is predicted that the impact will affect the receptor directly, but not for the Fylde MCZ IEF due to no overlap. The magnitude is therefore, considered to be low.

Sensitivity of Receptor

All IEFs

The sensitivity of all IEFs is considered to be medium, as defined above for the construction phrase (see Table 7.33).

Significance of Effect

Subtidal Habitats and Species

Overall, the magnitude this impact on all subtidal habitats and species IEFs except Ross worm was deemed to be low and the sensitivity of the receptor was considered to be medium. Therefore, the effect of temporary habitat loss and/or disturbance will be of **minor adverse** significance, which is not significant in EIA terms.

For the Ross worm IEF, the magnitude this impact was deemed to be negligible, and the sensitivity of the receptor was considered to be medium. As per Table 7.31, this results in a ‘negligible or minor’ significance of effect. As there were no Ross worm reefs identified, minor loss or detrimental alteration to the Ross worm IEF is considered unlikely due to this impact (see Table 7.27). Therefore, it has been concluded that the effect of temporary habitat loss and/or disturbance will be of **negligible adverse** significance, which is **not significant** in EIA terms.

Intertidal Habitats and Species

Overall, the magnitude this impact on the intertidal habitats and species IEF was deemed to be low and the sensitivity of the receptor was considered medium. Therefore, the effect of temporary habitat loss and/or disturbance will be of **minor adverse** significance, which is **not significant** in EIA terms.

Designated Sites

Overall, the magnitude this impact on the designated sites IEFs was deemed to be low and the sensitivity of the receptor was considered to be medium. Therefore, the effect of temporary habitat loss and/or disturbance will be of **minor adverse** significance, which is **not significant** in EIA terms.

7.12.1.3 Decommissioning Phase

Decommissioning activities within the Proposed Development will result in temporary habitat loss and/or disturbance in this phase.

Magnitude of Impact

All IEFs

The MDS for the decommissioning phase assumes that all infrastructure will be removed (except some rock placement which may remain *in situ*) (Table 7.21). The extent of temporary habitat loss and/or disturbance during this phase will be significantly lower than that of the construction phase, as seabed preparation activities will not be required.

The spatial extent of this impact is small in relation to the whole Proposed Development and effects on seabed habitats and associated benthic communities are expected to be similar to the construction phase, but of a much lower magnitude.

Overall, for all IEFs except Ross worm, this impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptors directly. The magnitude is therefore, considered to be low.

As only individual Ross worm were recorded in places during the site-specific subtidal benthic characterisation survey and no reefs identified, it is unlikely that the Proposed Development represents an important habitat for this species at a population level. Thus, the impact on the Ross worm IEF is predicted to be of highly local spatial extent (due to no reefs observed), short term duration, intermittent over the decommissioning phase, and of high reversibility. The magnitude is therefore considered to be negligible.

Sensitivity of Receptor

All IEFs

The sensitivity of all IEFs is considered to be medium, as defined above for the construction phrase (see Table 7.33).

Significance of Effect

Subtidal Habitats and Species

Overall, the magnitude this impact on all subtidal habitats and species IEFs except Ross worm was deemed to be low and the sensitivity of the receptor was considered to be medium. Therefore, the effect of temporary habitat loss and/or disturbance will be of **minor adverse** significance, which is **not significant** in EIA terms.

For the Ross worm IEF, the magnitude this impact was deemed to be negligible, and the sensitivity of the receptor was considered to be medium. As per Table 7.31, this results in a ‘negligible or minor’ significance of effect. As there were no Ross worm reefs identified, loss or detrimental alteration to the Ross worm IEF is unlikely to occur due to this impact (see Table 7.27). Therefore, it has been concluded that the effect of temporary habitat loss and/or disturbance will be of **negligible adverse** significance, which is **not significant** in EIA terms.

Intertidal Habitats and Species

Overall, the magnitude this impact on the intertidal habitats and species IEF was deemed to be low and the sensitivity of the receptor was considered to be medium. Therefore, the effect of temporary habitat loss and/or disturbance will be of **minor adverse** significance, which is **not significant** in EIA terms.

Designated Sites

Overall, the magnitude this impact on the designated sites IEFs was deemed to be low and the sensitivity of the receptor was considered to be medium. Therefore, the effect of temporary habitat loss and/or disturbance will be of **minor adverse** significance, which is **not significant** in EIA terms.

7.12.2 Increased SSCs and Associated Deposition

Increased suspended sediment concentrations and sediment deposition from construction and decommissioning activities related to subsea pipeline refurbishment, cable installation/protection, and release of drill cuttings may potentially result in indirect impacts on the benthic habitats and communities. In addition, seabed preparation (such as sand wave clearance) in the construction phase may also cause increased SSCs and associated deposition. These indirect impacts include increased turbidity and smothering effects, which could affect the water quality in the surrounding area and habitat degradation affecting spawning and nursery grounds. A full description of the physical assessment, including numerical modelling used to inform the predictions made with respect to increases in suspended sediment and subsequent deposition, is provided in volume 2, RPS Group (2024c).

The benchmarks for the relevant MarESA pressures which have been used to inform this impact assessment are:

- Changes in suspended solids (water clarity): the benchmark for which is a change in one rank on the WFD scale (e.g. from clear to intermediate for one year, caused by activities disturbing sediment or organic particulate material and mobilising it into the water column such as dredging, disposal at sea, cable and pipeline burial).
- Smothering and siltation rate changes (light): the benchmark for light deposition is up to 5 cm of fine material added to the habitat in a single discrete event.

These pressures correspond to the impacts associated with sand wave clearance, the installation of foundations the new Douglas platform, and the installation of cables via ploughing.

With regards to background SSC, the Cefas Climatology Report 2016 (Cefas, 2016) and associated dataset provides the spatial distribution of average non-algal Suspended Particulate Matter (SPM) for the majority of the UK Continental Shelf. Between 1998 and 2005, the greatest plumes are associated with large rivers such as those that discharge into the Thames Estuary, The Wash and Liverpool Bay, which show mean values of SPM above 30 mg/l. Based on the data provided within this study, the SPM associated with the Proposed Development has been estimated as approximately 0.9mg/l to 3mg/l over 1998 to 2005.

7.12.2.1 Construction Phase

Magnitude of Impact

All IEFs

A numerical modelling study was undertaken to inform and qualify the potential impacts of the Proposed Development on physical processes (see volume 3, RPS Group (2024c)). This included tidal current, wave climate, and sediment transport under both calm and storm conditions. Numerical modelling has been used to quantify the changes in physical processes, predominantly suspended sediment concentrations, due to seabed preparation activities, the drilling of new monitoring wells, and laying of cables. The following activities in the construction phase have been considered:

- seabed preparation (such as sand wave clearance);
- drill cuttings; and
- cable installation.

Due to the nature of the seabed in the Proposed Development, the cable installation will require seabed preparation in the form of sand wave clearance. The MDS assumes that sand waves are to be cleared along the cable route in two locations, south of the existing Douglas platforms, and at West Hoyle Bank (Table 7.21). Clearance activities south of the new Douglas platform are set to be undertaken across two sections where sand waves are present with average heights of approximately 3 m and lengths of around 100 m and 15 m respectively. To enable the laying of cables, a corridor width of approximately 10 m will be excavated using a mass flow excavator/jet sled, which will suspend sediment at the seafloor. At West Hoyle Bank, in order to allow the laying of the cable directly across the feature, a dredged channel will be necessary. During clearance activities material will be side cast along around 1,000 m of channel, and backfilled after cable installation. The trench is expected to be approximately 21 m in width and 7 m in depth. Sediment plumes for seabed preparation activities were quantified during modelling. In all cases, the material released was native to the bed sediments and, although the model showed periods of increased turbidity, the material was retained in the Solway Firth sediment cell and would be subsequently assimilated into the existing sediment transport regime. Suspended sediments may reach into the estuary during cable trenching from the PoA to Douglas, but are generally expected to do so at background levels (i.e. 30 mg/l).

The MDS for this impact includes the drilling of two new monitoring wells situated at Hamilton Main and Hamilton North (Table 7.21). Both wells require the drilling of two sections the first of which is a 26” opening in which the 20” conductor will be encased, and a second and deeper 17” section. The first section will involve penetration of the surface sand and silt layer and then the use of seawater and sweeps drilling to penetrate the coarser Mercia Mudstone Group below. The first section will see the clearance of approximately 30.48 m of sand and silt and the drilling of 84.43 m of coarser sediment. The second section will be drilled with water-based mud and will also penetrate through the Mercia Mudstone Group, which is largely composed of claystone, over a vertical length of ~518.16 m. Both lengths of the 26” and 17” holes have been modelled with an assumed 100% washout, (i.e. twice the volume of the cavity is released as cuttings). The rate of drilling for both wells was 40 m/h with the individual operations taking approximately 16 hours each. Both SSC and deposition related to the drill cutting releases were more limited than the seabed preparation and cable installation activities both spatially and in magnitude. With sedimentation restrained to negligible levels across the drill site and along the tidal ellipse.

The third aspect of the construction phase is installation of up to 126.04 km of power cables between platforms and the onshore terminal PoA (this includes 1,200 m of cable within the intertidal zone). A trench width of 15 m was assumed in the MDS and numerical modelling. A number of trenching techniques may be suited to the ground conditions; however, it was assumed within the modelling that trenched material was mobilised into the lower water column as a result of the burial process, in line with the Business Enterprise and Regulatory Reform (BERR) guidelines (BERR, 2008). In reality, the installation technique implemented may result in less sediment being mobilised and the maximum depth may not always be achieved with a corresponding reduction in the amount of material disturbed. Trenching rates can vary widely depending on the bed material and equipment used; typically, rates are between 25 m/h and 780 m/h. For the simulation, a relatively high rate of 450 m/h was used over an extensive sample route ensuring that material was released at all tidal states over a number of tides and ensuring initial concentrations were not underestimated.

For the PoA Terminal to Douglas cable, during peak concentrations over the course of trenching, the plume may extend up to 15 km to the west, however, it reaches background levels (<1 mg/l) at approximately 1 km from the cable trenching. Average SSC values were greatest around the cable route, particularly over the shallow waters of West Hoyle Bank, where they may reach 1,000 mg/l in the shallowest water but are quickly reduced to background levels a short distance from the cable path. Average sedimentation was greatest at the location of the trenching and may be up to 160 mm in depth where the coarser material has settled within close proximity to the cable path. An analysis of sedimentation at slack water one day after the cessation of trenching, shows that some of the previously sedimented material has been re-suspended, only to settle again at slack water.

A large plume was also modelled for the trenching of the Douglas to Lennox platform cable. Average concentrations are <1,000 mg/l and are greatest in the direct vicinity of the cable path, and <10 mg/l at the extent of the Proposed Development benthic ecology study area. Average sedimentation is limited to <100 mm with peak values of 70 mm, however outside the area of project physical work, deposition is limited to negligible levels of <3 mm. Sedimentation one day after the cessation of trenching shows that fine sands and resuspended sediment settle during slack water. Overall, the largest SSC plumes are generated by cable installation activities given the magnitude of sediment disturbed and length of works. Due to the temporary nature and scale of cable laying works, combined with the cable laying works being located within a depositional area for sediment, any trenches will be quickly infilled over a short period of time. Furthermore, rapid recolonisation of disturbed sediment is expected within two years.

Based on this, disturbance due to increased SSCs and associated deposition is expected to affect only 0.017% of the extent of the Annex I mudflats and sandflats habitat within the Dee Estuary/Aber Dyfrdwy SAC SAC. Further, it was noted in the physical processes assessment (volume 3, RPS Group (2024c)) that the magnitude of impact upon West Hoyle Bank (not an IEF in this assessment) and the Dee Estuary/Aber Dyfrdwy SAC IEF was considered to be low.

Overall, for all IEFs, the increased SSCs and associated deposition due to the construction activities described above are predicted to be of local spatial extent within the Proposed Development, short-term duration over the two-year construction phase, intermittent in nature, and of high reversibility. It is predicted that the impact will affect the receptor directly. Therefore, for all IEFs, the magnitude of impact is predicted to be low.

Sensitivity of Receptor

Subtidal Habitats and Species

The sensitivity of the IEFs to increased SSCs and associated deposition are presented in Table 7.34. These sensitivities are based on assessments made by the MarESA and range from negligible to medium. For the ‘Subtidal sands and gravels’ IEF, both representative biotopes have low sensitivity to changes in suspended solids and low and no sensitivity to smothering and siltation rate changes (light). This is because the characterising species are adapted for burrowing and/or live in the sand and are therefore unlikely to be directly affected by the pressures associated with increased SSCs. Within the biotope '*M. fragilis, Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel (SS.SCS.CCS.MedLumVen)', venerid bivalves are shallow burring infauna and suspension feeders, which have been reported to typically escape something of up to 50 cm and burrow to their preferred depth (Kranz (1974), cited in Maurer *et al.,* 1986).

The representative biotopes for the 'Mud habitats in deep water' IEF and 'Subtidal mixed muddy sediment' IEF, and Ross worm were all assessed as not sensitive to changes in suspended sediments (water clarity). For Ross worm, tube growth is dependent on the presence of suspended particles, hence an increase in SSCs could facilitate growth and increase populations. Although, the MarESA accounts for the fact that increased siltation could clog feeding apparatus, with immediate recovery following recommencement of feeding (Jackson and Hiscock, 2008). Ross worm is also not sensitive to smothering and can tolerate this for up to several weeks (Jackson and Hiscock, 2008). The representative biotope identified for the 'Mud habitats and deep water' IEF (*A. filiformis, K. bidentata* and *A. nitida* in circalittoral sandy mud (SS.SMu.CSaMu.AfilKurAnit)) is characterised by a number of suspension feeding species (De-Bastos and Hill, 2016). These species are able to switch between feeding methods (Budd, 2007; Carter, 2008; Hill and Willson, 2008) and can change to deposit feeding in areas of low water flow or stagnant waters (Ockelmann and Muus, 1978). Thus, where a change in suspended solids results in increased turbidity and change of light, the community is unlikely to be directly affected (De-Bastos and Hill, 2016). Further, this biotope is not sensitive to smothering and siltation rate changes (light), as it is characterised by burrowing species, which can resist additional, fine sediments (De-Bastos and Hill, 2016). In contrast, however, the representative biotope identified for the 'Subtidal mixed muddy sediment' IEF (*O. fragilis* and/or *O. nigra* brittlestar beds on sublittoral mixed sediment (SS.SMx.CMx.OphMx)) was assessed as medium sensitivity to this pressure (Table 7.34). This is because dense brittlestar beds do not occur in areas of excessive sedimentation, as they are susceptible to suffocation and fouling of their feeding apparatus (Aronson, 1989,1992). These brittlestar species are not affected by changes in suspended solids (water clarity) due to limited visual perception (De-Bastos *et al.,* 2020).

Overall, the 'Subtidal sands and gravels' IEF is deemed to be of low vulnerability, medium to high recoverability, and national value. Therefore, the sensitivity of this receptor to this impact is considered to be **low.**

Overall, the 'Mud habitats in deep water' IEF and Ross worm IEF are deemed to be of low to no vulnerability, high recoverability, and national value. Therefore, the sensitivity of these receptors to this impact is considered to be **negligible.**

Overall, the 'Subtidal mixed muddy sediment' IEF is deemed to be of medium vulnerability, medium recoverability, and national value. Therefore, the sensitivity of this receptor to this impact is considered to be **medium.**

Intertidal Habitats and Species

The sensitivity of the Mudflats and sandflats not covered by seawater at low tide IEF to increased SSCs and associated deposition is presented in Table 7.34. These sensitivities are based on assessments made by the MarESA (where available) and range from negligible to low. Overall, three out of the four biotopes identified for this IEF were assessed as not sensitive to both pressures associated with this impact. Only the biotope 'Polychaete/bivalve-dominated muddy sand shores (LS.LSa.MuSa)', was assessed as having low sensitivity to both pressures. This is because although some species within this biotope may be impacted by these pressures, recovery would be high on the return to original conditions (Tyler-Walters and Marshall, 2006).

The biotope 'Talitrids on the upper shore and strand-line (LS.Lsa.St.Tal)' has been assessed as not sensitive to these pressures as it occurs on the limit of tidal inundation, thus exposure to the pressures would be limited to very short periods (Tillin and Budd, 2004). For the biotope '*M. balthica* and *A. marina* in littoral muddy sand (LS.LSa.MuSa.MacAre)', changes in suspended solids (water clarity) is not relevant, as the characteristic species live within the sediment to depths of 40 cm and 6 cm, respectively, and are thus adapted to increased SSCs and turbidity (Ashley *et al.,* 2023). Finally, the biotope 'Barren or amphipod-dominated mobile sand shores (LS.LSa.MoSa)' is also not sensitive to these pressures as it occurs in scoured habitats and is likely exposed to chronic or intermittent episodes of high levels of suspended solids (Tillin, 2018). It is characterised by the absence of species through sediment mobility, thus changes in suspended solids and smothering will not alter the biotope (Tillin, 2018).

Overall, the 'Mudflats and sandflats not covered by seawater at low tide' IEF is deemed to be of low vulnerability, high recoverability, and international value. Therefore, the sensitivity of this receptor to this impact is considered to be **low.**

Designated Sites

As detailed in Table 7.10, the sensitivities presented for the 'Mudflats and sandflats not covered by seawater at low tide' IEF in the preceding section is applicable to the Dee Estuary/Aber Dyfrdwy SAC IEF. Thus, the Dee Estuary/Aber Dyfrdwy SAC IEF is deemed to be of low vulnerability, high recoverability, and international value. The sensitivity of the receptor is therefore, considered to be low.

As detailed in Table 7.10, the area of the Fylde MCZ which overlaps with the Proposed Development has been assigned the biotope 'Sublittoral sands and muddy sands (SS.SSa)' (Envision Mapping, 2015), however has not been assigned more specific biotopes. As this area overlaps with the 'Subtidal sands and gravels' IEF identified during the site-specific survey within the Proposed Development, the representative biotopes identified for this IEF have also been used to characterise the Fylde MCZ IEF in the assessment. Therefore, the Fylde MCZ IEF is deemed to be of low vulnerability, medium to high recoverability, and national value. The sensitivity of the receptor is therefore, considered to be low.

Table 7.34: Sensitivity Of The Benthic Subtidal And Intertidal Ecology IEFs To Increased SSCs And Associated Deposition

IEF	Representative Biotopes Identified	Sensitivity to Defined MarESA Pressures		Overall Sensitivity (Based on Table 7.29)
		Changes in Suspended Solids (water clarity)	Smothering and Siltation Rate Changes (light)	
Subtidal Habitats and Species				
Subtidal Sands and Gravels	*M. fragilis, Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel (SS.SCS.CCS.MedLumVen)	Low	Low	Low
	N. cirrosa and *Bathyporeia* spp. in infralittoral sand (SS.SSa.IFiSa.NcirBat)	Low	Not sensitive	Low
Mud Habitats in Deep Water	*A. filiformis, K. bidentata* and *A. nitida* in circalittoral sandy mud (SS.SMu.CSaMu.AfilKurAnit)	Not sensitive	Not sensitive	Negligible
Subtidal Mixed Muddy Sediment	*O. fragilis* and/or *O. nigra* brittlestar beds on sublittoral mixed sediment (SS.SMx.CMx.OphMx)	Not sensitive	Medium	Medium
Ross Worm *S. spinulosa*	-	Not sensitive	Not sensitive	Negligible
Intertidal Habitats and Species				
Mudflats and sandflats not covered by seawater at low tide	Talitrids on the upper shore and strand-line (LS.Lsa.St.Tal)	Not sensitive	Not sensitive	Negligible
	M. balthica and *A. marina* in littoral muddy sand (LS.LSa.MuSa.MacAre)	Not sensitive	Not sensitive	Negligible
	Barren or amphipod-dominated mobile sand shores (LS.LSa.MoSa)	Not sensitive	Not sensitive	Negligible
	Polychaete/bivalve-dominated muddy sand shores (LS.LSa.MuSa)	Low	Low	Low

Significance of Effect

Subtidal Habitats and Species

Overall, for the ‘Subtidal sands and gravels IEF’, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the effect of increased SSCs and associated deposition is considered to be of **minor adverse** significance, which is **not significant** in EIA terms.

For the ‘Mud habitats in deep water’ IEF and Ross worm IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be negligible. Therefore, the effect of increased SSCs and associated deposition is considered to be of **negligible adverse** significance, which is **not significant** in EIA terms.

Overall, for the ‘Subtidal mixed muddy sediment’ IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the effect of increased SSCs and associated deposition is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

Intertidal Habitats and Species

Overall, for the ‘Mudflats and sandflats not covered by seawater at low tide’ IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the effect of increased SSCs and associated deposition is considered to be of **minor adverse** significance, which is **not significant** in EIA terms.

Designated Sites

Overall, for the Dee Estuary/Aber Dyfrdwy SAC and Fylde MCZ IEFs, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the effect of increased SSCs and associated deposition is considered to be of **minor adverse** significance, which is **not significant** in EIA terms.

7.12.2.2 Decommissioning Phase

Increased SSCs and associated deposition may occur during decommissioning activities, such as removal of foundations, cables, and cable crossing protection.

Magnitude of Impact

Subtidal Habitats and Species

Based on the MDS (Table 7.21), the removal of foundations, cables, and cable crossing protection would result in increased SSCs and associated deposition within the Proposed Development. It is assumed that the increases in SSCs and associated sediment deposition generated in the decommissioning phase would be of a lower extent than that of the construction phase. This is due to the absence of seabed preparation activities, drilling, and depositing of drill cuttings, which account for additional increases in SSCs and associated deposition in the construction phase.

The impact is predicted to be of local spatial extent within the Proposed Development, short term duration (for the individual decommissioning activities), intermittent, and of high reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Intertidal Habitats and Species

The MDS assumes that the 1,200 m of intertidal power cables that connect the new Douglas platform to the PoA terminal will be removed. Therefore, the impact to intertidal habitats and species is likely to be of a similar magnitude than that defined above for the construction phase.

The impact is predicted to be of local spatial extent within the Proposed Development, short term duration (for the individual decommissioning activities), intermittent, and high reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Designated Sites

As above for the intertidal IEF (Mudflats and sandflats not covered by seawater at low tide), increased SSCs and associated deposition may arise in the Dee Estuary/Aber Dyfrdwy SAC due to removal of 1,200 m of power cables within the intertidal area. As the Fylde MCZ overlaps with the Proposed Development offshore, potential impacts that may arise are the same as those identified above for 'Subtidal Habitats and Species'. However, there is unlikely to be any disturbance to the Fylde MCZ as it is a minimum of 1.82 km from the area of project physical work (see Figure 7.4).

Overall, the impact on the designated site IEFs is predicted to be of local spatial extent within the Proposed Development, short term duration, intermittent, and high reversibility. For the Dee Estuary/Aber Dyfrdwy SAC IEF, it is predicted that the impact will affect the receptor directly, but not for the Fylde MCZ IEF due to no overlap. The magnitude is therefore, considered to be low.

Sensitivity of Receptor

All IEFs

The sensitivities of all the IEFs are considered to be as previously described for the construction phase (Table 7.34) and range from negligible to medium.

Significance of Effect

Subtidal Habitats and Species

The significance of effect is considered to be as above for the construction phase. Overall, for the 'Subtidal sands and gravels' IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the effect of increased SSCs and associated deposition is considered to be of **minor adverse** significance, which is **not significant** in EIA terms.

For the 'Mud habitats in deep water' IEF and Ross worm IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be negligible. Therefore, the effect of increased SSCs and associated deposition is considered to be of **negligible adverse** significance, which is **not significant** in EIA terms.

Overall, for the 'Subtidal mixed muddy sediment' IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the effect of increased SSCs and associated deposition is considered to be of **minor adverse** significance, which is **not significant** in EIA terms.

Intertidal Habitats and Species

The significance of effect is considered to be as above for the construction phase. Overall, for the 'Mudflats and sandflats not covered by seawater at low tide' IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the effect of increased SSCs and associated deposition is considered to be of **minor adverse** significance, which is **not significant** in EIA terms.

Designated Sites

The significance of effect is considered to be as above for the construction phase. Overall, for the Dee Estuary/Aber Dyfrdwy SAC and Fylde MCZ IEFs, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the effect of increased SSCs and associated deposition is considered to be of **minor adverse** significance, which is **not significant** in EIA terms.

7.12.3 Long-term Subtidal Habitat Loss

7.12.3.1 Construction and Operation and Maintenance Phases

Long-term subtidal habitat loss within the Proposed Development will begin in the construction phase, as infrastructure is installed. Long-term subtidal habitat loss could potentially occur due to the installation of cable crossing protection and under the foundation structures for the new Douglas platform. Additionally, rock placement associated with the construction will also result in long-term subtidal habitat loss.

In this impact assessment, long-term subtidal habitat loss does not represent complete removal of habitat, but rather a physical change in a sedimentary habitat and replacement with a hard, artificial substrate. The relevant MarESA pressures and their benchmarks which have used to inform this impact assessment are described here:

- physical change (to another seabed type): the benchmark for which is change in sediment type by one Folk class and change from sedimentary or soft rock substrata to hard rock or artificial substrata or vice-versa.

These pressures are relevant to the installation of foundation structures for the new Douglas platform, cables and their associated protection which will replace the sedimentary seabed with hard structures for the duration of the operations and maintenance phase (25 years). The effects of long-term subtidal habitat loss are assessed in this section, however the potential for colonisation of hard substrates by benthic species have been assessed in section 7.12.4. The construction and operation and maintenance phases are assessed in combination as the impacts of long-term subtidal habitat loss from the construction phase will persist into the operation and maintenance phase and will be continuous over the 25-year lifetime of the Proposed Development.

Magnitude of Impact

The construction of infrastructure associated with the Proposed Development will result in long-term subtidal habitat loss. The MDS accounts for up to 64,169 m^2 of long-term subtidal habitat loss due to installation of foundations and cable crossing protection in the construction phase (Table 7.21), which equates to 0.01% of the overall Proposed Development. The total area subject to long-term subtidal habitat loss will be comprised from the installation of 58,800 m^2 of cable crossing protection, up to 169 m^2 from the jacket legs of the new Douglas platform, 2,400 m^2 from pipeline spools, and 2,800 m^2 from pipeline mattresses (Table 7.21).

Long-term subtidal habitat loss will occur during the construction phase and be continuous and irreversible throughout the 25-year operations and maintenance phase. Some long-term subtidal habitat loss will persist indefinitely after the operations and maintenance phase, such as that caused by rock placement which will be left *in situ* following decommissioning of the Proposed Development.

Subtidal Habitats and Species

There will be no infrastructure installed within, or in the nearby vicinity of the Annex I Reef IEF, and thus no long-term subtidal habitat loss (Figure 7.4). Overall, the MDS for this impact will result in no loss or alterations of characteristics, features, or elements and no observable adverse impact to the Annex I Reef IEF (see Table 7.27). The magnitude is therefore considered to be no change.

Offshore cable crossing protection will be required at up to 32 crossings, with each crossing up to 0.8 m in height and 7 m wide. The design of the cable crossing protection will have tapered profiles to reduce the impacts upon physical processes and seabed morphology. Cable crossing protection is the only cable protection measure proposed for the project, as the nature of the seabed sediment within the Proposed Development accommodates cable burial to the required depth. Therefore, no protection is required for buried cables, which are not anticipated to become exposed and require additional protection throughout the operation and maintenance phase. For example, cable crossings include one between the PoA to new Douglas platform cable and the Burbo Bank Offshore Wind Farm Extension Export Cable. Where practicable, the requirements will be compliant with the Maritime and Coastguard Agency (MCA) navigation guidance which includes that there will be no more than a 5% reduction in water depth (referenced to CD) at any point along the cable route (MCA, 2021), without prior written approval from the Licensing Authority in consultation with the MCA. In compliance with the MCA navigation guidance, the maximum height of the shallowest cable crossing would be restricted to 5% of the water depth and therefore exhibit no change in wave climate, however, given the majority of cable crossings fall in waters deeper than 25 m (CD) they will change water depths to a much lesser degree than the 5% limit. With most of the cable crossing protection installed in waters of approximately 25 m (CD), which equates to 28 m mid tide, the introduction of 0.8 m height cable crossing protection represents less than a 3% change in water depth and therefore likely < 3% change to tidal currents. This change is approximately a quarter of the size as exhibited in the natural variation between peak spring and peak neap tidal flows. Given the small scale of cable crossing protection to be installed, and further measures such as tapered profiles and compliance with the MCA navigation guidance, it is not expected that impacts from cable crossings would be sufficient to disrupt offshore bank morphological processes, experience significant secondary scour or destabilise coastal features.

Overall, for all other subtidal habitats and species IEFs, the MDS for this impact presents some measurable, minor loss of and alteration to the affected areas of the seabed within the Proposed Development. The impact is predicted to be of local spatial extent (0.01% of the Proposed Development), long-term duration over the lifecycle of the Proposed Development, continuous, and irreversible during the construction and operation and maintenance phases. It is predicted that the impact will affect the receptors directly. Therefore, the magnitude of impact is considered to be low.

Intertidal Habitats and Species

There will be no above surface cable or cable crossing protection placed in the intertidal zone. There will, therefore, be no long-term loss of intertidal habitats or IEFs as a result of cable or cable crossing protection. The MDS for the installation of the offshore export cable in the intertidal zone is for open cut trenching. This method will remove the top layers of sediment to create a trench, the majority of habitats within the intertidal zone will be able to recover from this potential impact. For the representative biotopes of the ‘Mudflats and sandflats not covered by seawater at low tide’ IEF, this has been assessed as temporary habitat loss/disturbance in section 7.12.1.

Overall, the MDS for this impact will result in no loss or alterations of characteristics, features, or elements and no observable adverse impact to the ‘Mudflats and sandflats not covered by seawater at low tide’ IEF (see Table 7.27). The magnitude is therefore considered to be no change.

Designated Sites

As above for the intertidal IEF (Mudflats and sandflats not covered by seawater at low tide), long term subtidal habitat loss will not arise within the Dee Estuary/Aber Dyfrdwy SAC due to the lack of above surface cable or cable crossing protection proposed for the intertidal zone. Although the Fylde MCZ overlaps with the Proposed Development offshore, there will be no infrastructure installed within it, and it is a minimum of 1.82 km from the area of project physical work (see Figure 7.4).

Therefore, the MDS for this impact will result in no loss or alterations of characteristics, features, or elements and no observable adverse impacts to the sites. The magnitude of impact on the Dee Estuary/Aber Dyfrdwy SAC and Fylde MCZ IEFs is therefore, considered to be no change.

Sensitivity of Receptor

Subtidal Habitats and Species

The sensitivity of the IEFs to increased SSCs and associated deposition are presented in Table 7.35. These sensitivities are based on assessments made by the MarESA (where available) and are assessed as high for all IEFs except Ross worm, which was assessed as moderate. It should be noted that the MarESA available for Ross worm is considered outdated and does not contain the ‘Physical change (to another seabed type)’ pressure. Therefore, Ross worm has been assessed against the pressure ‘substratum loss’, which was presented in the outdated MarESA available at the time of writing.

The ‘Subtidal sands and gravels’ IEF, ‘Mud Habitats in Deep Water’ IEF, and ‘Subtidal Mixed Muddy Sediment’ IEF were all assessed as highlight sensitive to physical change (to another seabed type) as the representative biotopes identified are characterised by the sedimentary habitat. Therefore, a change to an artificial or rock substratum would result in a fundamental change to the physical characteristic of the biotope and result in the loss of the sedimentary communities and characterising species. This would lead to loss or reclassification of the biotopes (De-Bastos and Hill, 2016; De-Bastos *et al.,* 2020; Tillin, 2022a; Tillin and Garrard, 2022). Although Ross worm does not have a MarESA for this specific pressure, it has been assessed as moderate sensitivity to ‘substratum loss’ (Jackson and Hiscock, 2008). This is because it is fixed to the substratum, so removal will cause mortality, however, recovery could be quite rapid due to high recruitment rates (Jackson and Hiscock, 2008).

Overall, all IEFs, except Ross worm, are deemed to be of high vulnerability, low recoverability, and national value. Therefore, the sensitivity of these receptors to this impact is considered to be high.

The Ross worm IEF is deemed to be of high vulnerability, medium recoverability, and local value. Therefore, the sensitivity of the receptor to this impact is considered to be medium.

Intertidal Habitats and Species

The sensitivity of the ‘Mudflats and sandflats not covered by seawater at low tide’ IEF to long-term habitat loss is presented in Table 7.35. These sensitivities are based on assessments made by the MarESA (where available) and are assessed as high for all biotopes except for ‘Polychaete/bivalve-dominated muddy sand shores’, which was assessed as moderate. It should be noted that the MarESA available for this biotope is outdated and does not contain the ‘Physical change (to another seabed type)’ pressure. This biotope has, therefore, been assessed against the pressure ‘substratum loss’, which was presented in the outdated MarESA available at the time of writing.

As above for the subtidal biotopes, the other three representative biotopes for the ‘Mudflats and sandflats not covered by seawater at low tide’ IEF are highly sensitive to physical change (to another seabed type). Under the same reasoning presented for the subtidal biotopes above, a change to an artificial or rock substratum would result in a fundamental change to the physical characteristic of the biotopes and result in the loss of the sedimentary communities and characterising species (Tillin and Budd, 2004; Tillin, 2018; Ashley *et al.,* 2023).

Overall, the ‘Mudflats and sandflats not covered by seawater at low tide’ IEF is deemed to be of high vulnerability, low recoverability, and international value. Therefore, the sensitivity of the receptor to this impact is considered to be high.

Designated Sites

As detailed in Table 7.10, the sensitivities presented for the ‘Mudflats and sandflats not covered by seawater at low tide’ IEF in the preceding section is applicable to the Dee Estuary/Aber Dyfrdwy SAC IEF. Thus, the Dee Estuary/Aber Dyfrdwy SAC IEF is deemed to be of high vulnerability, low recoverability, and international value. The sensitivity of the receptor is therefore, considered to be high.

As detailed in Table 7.10, the area of the Fylde MCZ which overlaps with the Proposed Development has been assigned the biotope ‘Sublittoral sands and muddy sands (SS.SSa)’ (Envision Mapping, 2015), however has not been assigned more specific biotopes. As this area overlaps with the ‘Subtidal sands and gravels’ IEF identified during the site-specific survey within the Proposed Development, the representative biotopes identified for this IEF have also been used to characterise the Fylde MCZ IEF in the assessment. Therefore, the Fylde MCZ IEF is deemed to be of high vulnerability, low recoverability, and international value. The sensitivity of the receptor is therefore, considered to be high.

Table 7.35: Sensitivity Of The Benthic Subtidal And Intertidal Ecology IEFs To Long Term Subtidal Habitat Loss

IEF	Representative Biotopes Identified	Sensitivity to Defined MarESA Pressure	Overall Sensitivity (Based on Table 7.29)
		Physical Change (to another seabed type)	
Subtidal Habitats and Species			
Subtidal Sands and Gravels	*M. fragilis, Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel (SS.SCS.CCS.MedLumVen)	High	High
	N. cirrosa and *Bathyporeia* spp. in infralittoral sand (SS.SSa.IFiSa.NcirBat)	High	High
Mud Habitats in Deep Water	*A. filiformis, K. bidentata* and *A. nitida* in circalittoral sandy mud (SS.SMu.CSaMu.AfilKurAnit)	High	High
Subtidal Mixed Muddy Sediment	*O. fragilis* and/or *O. nigra* brittlestar beds on sublittoral mixed sediment (SS.SMx.CMx.OphMx)	High	High
Ross Worm *S. spinulosa*	-	Moderate	Medium
Intertidal Habitats and Species			
Mudflats and sandflats not covered by seawater at low tide	Talitrids on the upper shore and strand-line (LS.Lsa.St.Tal)	High	High
	M. balthica and *A. marina* in littoral muddy sand (LS.LSa.MuSa.MacAre)	High	High
	Barren or amphipod-dominated mobile sand shores (LS.LSa.MoSa)	High	High
	Polychaete/bivalve-dominated muddy sand shores (LS.LSa.MuSa)	Moderate	Medium

Significance of Effect

Subtidal Habitats and Species

For the Ross worm IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the effect of long-term subtidal habitat loss is considered to be of **minor adverse** significance, which is **not significant** in EIA terms.

For the Annex I Reef IEF, the magnitude of impact is deemed to be no change, and the sensitivity of the receptor is considered to be high. Therefore, the effect of long-term subtidal habitat loss is considered to be of **minor adverse** significance, which is **not significant** in EIA terms.

For all other subtidal habitats and species IEFs, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be high. Therefore, the effect of long-term subtidal habitat loss is considered to be of **minor adverse** significance, which is **not significant** in EIA terms. As per the matrix used to assess the significance of effects, a low magnitude of impact and high sensitivity of receptor yields 'minor or moderate' significance (Table 7.31), this results A minor adverse significance has been concluded as the long-term habitat loss will only affect a small proportion of the Proposed Development (0.01%) in which these IEFs occupy. This is unlikely to compromise the integrity of these habitats such that they wouldn't be able to support their characterising communities or perform their ecosystem function.

Intertidal Habitats and Species

Overall, for the 'Mudflats and sandflats not covered by seawater at low tide' IEF, the magnitude of impact is deemed to be no change, and the sensitivity of the receptor is considered to be high. Therefore, the effect of long-term subtidal habitat loss is considered to be of **minor adverse** significance, which is **not significant** in EIA terms.

Designated Sites

Overall, for the Dee Estuary/Aber Dyfrdwy SAC and Fylde MCZ IEFs, the magnitude of impact is deemed to be no change, and the sensitivity of the receptor is considered to be high. Therefore, the effect of long-term subtidal habitat loss is considered to be of **minor adverse** significance, which is **not significant** in EIA terms.

7.12.3.2 Decommissioning Phase

The impacts of long-term subtidal habitat loss from the operation and maintenance phase will persist into the decommissioning phase and will be continuous after the 25-year lifetime of the Proposed Development. This will be of a lesser extent to the area of long-term subtidal habitat loss presented in the construction and operation and maintenance phases.

Magnitude of Impact

Subtidal Habitats and Species

In the decommissioning phase, some infrastructure will be left in place for reservoir modelling, before being removed. The current assumption is that all infrastructure will be removed over the decommissioning phase, and this will be confirmed within the Decommissioning Plan at the relevant time (Table 7.21). Some rock deposits may be left *in situ* during the decommissioning. Therefore, the MDS for this impact presents some measurable, minor loss of and alteration to the affected areas of the seabed within the Proposed Development (Table 7.21). The impact is predicted to be of local spatial extent, long-term duration, continuous, and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore, considered to be low for all IEFs except the Annex I Reef.

There will be no infrastructure installed within, or in the nearby vicinity of the Annex I Reef IEF, and thus no long-term subtidal habitat loss during the decommissioning stage either (Figure 7.4). Overall, the MDS for this impact will result in no loss or alterations of characteristics, features, or elements and no observable adverse impact to the Annex I Reef IEF (see Table 7.27). The magnitude is therefore considered to be no change.

Intertidal Habitats and Species

There will be no infrastructure left *in situ* within the intertidal zone, therefore, the MDS for this impact will result in no loss or alterations of characteristics, features, or elements and no observable adverse impact to the 'Mudflats and sandflats not covered by seawater at low tide' IEF (see Table 7.27). The magnitude is therefore considered to be no change.

Designated Sites

As above for the intertidal IEF (Mudflats and sandflats not covered by seawater at low tide), long term subtidal habitat loss will not arise within the Dee Estuary/Aber Dyfrdwy SAC due to the lack of infrastructure requiring removal or being left *in situ* in the intertidal zone. Although the Fylde MCZ overlaps with the Proposed Development offshore, there will be no infrastructure installed within it, therefore, none requiring removal or being left *in situ* (see Figure 7.4). Therefore, the MDS for this impact will result in no loss or alterations of characteristics, features, or elements and no observable adverse impacts to the site. The magnitude of impact on the Dee Estuary/Aber Dyfrdwy SAC and Fylde MCZ IEFs is therefore, considered to be no change.

Sensitivity of Receptor

All IEFs

The sensitivities of all the IEFs are considered to be as previously described for the construction phase (Table 7.35) and range from medium to high.

Significance of Effect

Subtidal Habitats and Species

Overall, for the Ross worm IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the effect of long-term subtidal habitat loss is considered to be of **minor adverse** significance, which is **not significant** in EIA terms.

For the Annex I Reef IEF, the magnitude of impact is deemed to be no change, and the sensitivity of the receptor is considered to be high. Therefore, the effect of long-term subtidal habitat loss is considered to be of **minor adverse** significance, which is **not significant** in EIA terms.

For all other subtidal habitats and species IEFs, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be high. Therefore, the effect of long-term subtidal habitat loss is considered to be of **minor adverse** significance, which is **not significant** in EIA terms. As per the matrix used to assess the significance of effects, a low magnitude of impact and high sensitivity of receptor yields 'minor or moderate' significance (Table 7.31). A minor adverse significance has been concluded as the long-term habitat loss will only affect a small proportion of the Proposed Development in which these IEFs occupy. This is unlikely to compromise the integrity of these habitats such that they wouldn't be able to support their characterising communities or perform their ecosystem function.

Intertidal Habitats and Species

Overall, for the 'Mudflats and sandflats not covered by seawater at low tide' IEF, the magnitude of impact is deemed to be no change, and the sensitivity of the receptor is considered to be high. Therefore, the effect of long-term subtidal habitat loss is considered to be of **minor adverse** significance, which is **not significant** in EIA terms.

Designated Sites

Overall, for the Dee Estuary/Aber Dyfrdwy SAC and Fylde MCZ IEFs, the magnitude of impact is deemed to be no change, and the sensitivity of the receptor is considered to be high. Therefore, the effect of long-term subtidal habitat loss is considered to be of **minor adverse** significance, which is **not significant** in EIA terms.

7.12.4 Introduction of Artificial Habitat and Colonisation of Hard Structures

7.12.4.1 Operation and Maintenance Phase

The introduction of new habitat, such as foundations and cable crossing protection, in the offshore marine environment may potentially affect the established benthic community by providing new habitat and ecosystem function. It is expected that the artificial structures will be colonised by a range of organisms which could lead to increases in biodiversity locally.

The environmental pressures associated with this impact are the same as those associated with long term subtidal habitat loss because the physical change (to another substratum type) pressure involves the permanent loss of one marine habitat type but has an equal creation of a different marine habitat type component such as the installation of foundations and cable crossing protection. The pressure is described for the MarESA in section 7.12.3.

Magnitude of Impact

Subtidal Habitats and Species

The MDS accounts for up to 64,169 m^2 of artificial habitat creation due to the installation of foundations for the new Douglas platform, cable crossing protection, pipeline spools, pipeline mattresses, and rock placement. This equates to approximately 0.01% of the total Proposed Development. This value however is likely an over estimation of habitat creation as it has been calculated assuming the foundations were a solid structure. In reality they will have a lattice design rather than a solid surface, which would result in a smaller surface area than has been assumed for the MDS. It is expected that the foundations and cable crossing protection will be colonised by epifaunal species already occurring in the Proposed Development benthic ecology study area (e.g. tunicates, bryozoans, mussels and barnacles which are typical of temperate seas).

The introduction of new artificial habitat will represent a shift in the baseline conditions from soft to hard substrate in the areas where infrastructure is present. This may result in beneficial effects. For example, increased biodiversity, individual abundance of reef species, and total number of species over time has been observed at the monopile foundations installed in Sweden (Bender *et al*., 2020). In general, colonising communities on offshore installations are dominated by mussels, macroalgae, and barnacles near the water surface, essentially creating a new intertidal zone. In intermediate depths, they are dominated by filter feeding arthropods, and by anemones in deeper locations (De Mesel *et al*., 2015). Colonisation by these species will likely represent an increase in biodiversity and a change compared to the baseline if no hard substrates were present (Lindeboom *et al.,* 2011). Furthermore, the structural complexity of the artificial substrate may provide refuge as well as increasing feeding opportunities for larger and more mobile species. For example, Mavraki *et al.* (2020), found higher food web complexity was associated with zones which had high accumulation of organic material (such as soft substrate or scour protection), suggesting potential reef effect benefits from the presence of the hard structures.

The increased biodiversity and reef effects may also provide greater foraging opportunities for some fish species. For example, a monitoring study of Beatrice OWF recorded fish and shellfish at the base of turbine foundations, although no biological material was recorded on the seabed (APEM, 2022). However, material may be rapidly consumed or relocated due to tidal currents and further monitoring is required to clarify if biological material builds up over time (APEM, 2022).

As detailed above in 'Long-term Subtidal Habitat Loss (section 7.12.3), offshore cable crossing protection will be required at up to 32 crossings, with each crossing up to 0.8 m in height and 7 m wide. Given the small scale of cable crossing protection to be installed (58,800 m^2), and further measures such as tapered profiles and compliance with the MCA navigation guidance, it is not expected that impacts from cable crossings would be sufficient to disrupt offshore bank morphological processes or experience significant secondary scour. Any colonisation of cable crossing protection is therefore not expected to be hindered or facilitated by changes in physical processes or secondary scour.

For all IEFs except the Annex I Reef, this impact is predicted to be of local spatial extent, long term duration, continuous and irreversible during the 25-year lifetime of the Proposed Development. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.

There will be no infrastructure installed within, or in the nearby vicinity of the Annex I Reef IEF, and thus no introduction of artificial habitat or subsequent colonisation of hard structures (Figure 7.4). Overall, the MDS for this impact will result in no loss or alterations of characteristics, features, or elements and no observable adverse impact to the Annex I Reef IEF (see Table 7.27). The magnitude is therefore considered to be no change.

Intertidal Habitats and Species

There will be no above surface cable protection placed in the intertidal zone. There will, therefore, be no introduction of artificial habitat or subsequent colonisation of hard structures.

Overall, the MDS for this impact will result in no loss or alterations of characteristics, features, or elements and no observable adverse impact to the 'Mudflats and sandflats not covered by seawater at low tide' IEF (see Table 7.27). The magnitude is therefore considered to be no change.

Designated Sites

As above for the intertidal IEF (Mudflats and sandflats not covered by seawater at low tide), introduction of artificial habitat and colonisation of hard structures will not arise within the Dee Estuary/Aber Dyfrdwy SAC due to the lack of above surface cable protection proposed for the intertidal zone. Although the Fylde MCZ overlaps with the Proposed Development offshore, there will be no infrastructure installed within it (1.82 km away; see Figure 7.4), similar to the Annex I Reef IEF. Therefore, the MDS for this impact will result in no loss or alterations of characteristics, features, or elements and no observable adverse impacts to the site. The magnitude of impact on the Dee Estuary/Aber Dyfrdwy SAC and Fylde MCZ IEFs is therefore, considered to be no change.

Sensitivity of Receptor

Subtidal Habitats and Species

Introduction of artificial, hard structures within the Proposed Development will represent a shift in community type and affect the subtidal habitats and species IEFs through colonisation of hard structures. In terms of the MarESA, the sensitivity of the IEFs to this impact are as previously described for physical change (to another seabed type) in the long term subtidal habitat loss assessment (section 7.12.3 and Table 7.35). The MarESA sensitivities were high for all IEFs except Ross worm (medium) and the Annex I Reef (MarESA not available due to no assigned biotope).

Colonisation of hard structures may have indirect adverse effects on the baseline communities and habitats identified within the Proposed Development due to increased predation on and competition with the existing soft sediment species. However, these effects are difficult to predict, especially as monitoring to date has focused on the colonisation and aggregation of species close to OWF turbine foundations rather than broad scale studies. Installing hard structures on the seabed not only creates new habitat but also modifies or removes existing habitat. Often it replaces an essentially two-dimensional (2D) sedimentary seabed, such as subtidal sandbanks, with a complex three-dimensional (3D) structure, thereby increasing surface area, surface complexity and number of niches (Dannheim *et al.,* 2019). The development of such surfaces and their role in connectivity of populations is dependent on suitable surface being created but also on the right location and distances from source populations. Surfaces may also only be suitable for colonisation after being suitably weathered, through the loss of any surface contaminants, the production of biofilms, and the sequence of development of the community after settlement. Rougher textures facilitate greater microhabitat diversity (Anderson and Underwood, 1994) and will likely induce greater colonisation.

Several studies have also shown that the installation of artificial habitat have no significant impact on the soft sediment environments. For example, the soft sediment epibenthos underwent no drastic changes eight to nine years after the installation of C-power and Belwind OWFs (Belgium) (De Backer *et al.*, 2020). Furthermore, the species originally inhabiting the sandy bottom substrate were still present and remained dominant in both OWFs (De Backer *et al.,* 2020). Additionally, monitoring from Block Island OWF in the US showed no strong gradients of change in sediment grain size, enrichment, or benthic macrofauna within 30 to 90 m distance bands of the wind turbines (Hutchison *et al*., 2020). Recent post-construction monitoring of the Beatrice OWF has found extensive biofouling on all the wind turbines with signs of zonation and successional development (APEM, 2022). Across all wind turbines, plumose anemones *Metridium senile* and tube worms *S. triqueter* were the most abundant species, with the highest biomass of 40 m depth (APEM, 2022). At the base of the wind turbines, hermit crab *Pagurus bernhardus*, flatfish, and common sea urchin *Echinus esculentus* were found with decreasing abundance further from the turbine foundations, indicating a source of food although no biological matter could be seen (APEM, 2022). Similarly, plumose anemones and tube worms *Spirobranchus* sp. dominated the bottom and mid-section of turbines at the Hywind Scotland Pilot Park, with a general increase in epifouling growth between 2018 to 2020 recorded (Karlsson *et al.,* 2022).

The introduction of artificial habitat can influence larval distribution, which may also have potential impacts on the distribution of species. Research from the oil and gas sector has examined the potential impact of infrastructure in the interception and production of larvae (McLean *et al.,* 2022). Larval settlement can be triggered by sound, chemical cues, light, and vibrations. Where artificial structures, such as platforms, exist in offshore waters far away from natural reefs, their influence on larval dispersal and settlement may be comparatively high, in relation to platforms in more naturally connected environments, therefore influencing geographic and population connectivity (McLean *et al.,* 2022). As species become established on oil and gas structures, they can start producing larvae, with one study demonstrating that networks of oil and gas infrastructure in the North Sea could facilitate ecological connectivity by acting as stepping stones for larval connectivity (Henry *et al*., 2018). Similarly, another North Sea study found interannual variability in the North Atlantic Oscillation results in cold-water coral *Lophelia pertusa* larvae being dispersed from oil and gas structures across distances of ~300 km (Fox *et al*., 2016). The influence of oceanographic features in species dispersal and distribution however emphasizes the importance in characterising the hydrodynamics underpinning potential connectivity (Boschetti *et al.,* 2020). Potential barriers to settlement, growth, reproduction and survival of larvae on offshore infrastructure also exist, including cleaning regimes, surface coatings (e.g. antifoulant), and operational discharges.

In addition, manmade artificial habitats can often support higher densities of INNS than natural environments, due to reduced competition from established native species, more-vacant habitat, and year-round settlement allowing opportunistic colonisation of vacant space (Mineur *et al.,* 2012). However, increased risk and spread of INNS is assessed separately in section 7.12.6.

Overall, all IEFs are deemed to be of high vulnerability, low recoverability, and local to national value. Therefore, the sensitivity of these receptors to this impact is considered to be high.

Intertidal Habitats and Species

Introduction of artificial, hard structures within the Proposed Development will represent a shift in community type and affect the subtidal habitats and species IEFs through colonisation of hard structures. In terms of the MarESA, the sensitivity of the intertidal habitats and species IEF to this impact are as previously described for physical change (to another seabed type) in the long term subtidal habitat loss assessment (section 7.12.3 and Table 7.35). These sensitivities are based on assessments made by the MarESA (where available) and are assessed as high for all biotopes except for ‘Polychaete/bivalve-dominated muddy sand shores’, which was assessed as moderate. It should be noted that the MarESA available for this biotope is outdated and does not contain the ‘Physical change (to another seabed type)’ pressure. This biotope has, therefore, been assessed against the pressure ‘substratum loss’, which was used in the outdated MarESA available at the time of writing.

As described above for the subtidal zone, intertidal species also colonise artificial hard structures installed within their habitat. For example, an experimental artificial structure was deployed in the intertidal zone in the English Channel and monitored for four years (Dauvin *et al.,* 2021). A total of 84 intertidal taxa were recorded to have colonised the structures over the study period, including 13 sessile and 71 motile taxa (Dauvin *et al.,* 2021). Artificial structures in the intertidal zone also have the ability to increase connectivity. For example, artificial coastal defences have been reported to act as stepping stones for rocky intertidal species across areas of soft sediment habitat, with species including black-footed limpet *Patella depressa*, flat top shell *Steromphala umbilicalis*, and small periwinkle *Melarhaphe neritoides* using structures to breach habitat barriers and colonise natural rocky habitat where they could not previously reach via natural dispersal (Mieszkowska *et al.,* 2020).

A study on artificial and natural structures in marinas in western Italy demonstrated that intertidal assemblages on seawalls were largely distinct from those on rocky shores or breakwaters, and that seawalls supported a smaller number of species than rocky shores or breakwaters (Bulleri and Chapman, 2004). This study provided evidence for differences between intertidal assemblages supported by artificial habitats and those on adjacent rocky shores. Differences in habitat-structure (and/or wave-exposure in the case of seawalls) could explain the occurrence of distinct intertidal assemblages (Bulleri and Chapman, 2004).

Overall, the ‘Mudflats and sandflats not covered by seawater at low tide’ IEF is deemed to be of high vulnerability, low recoverability, and international value. Therefore, the sensitivity of the receptor to this impact is considered to be high.

Designated Sites

As detailed in Table 7.10, the sensitivities presented for the Mudflats and sandflats not covered by seawater at low tide IEF in the preceding section is applicable to the Dee Estuary/Aber Dyfrdwy SAC IEF. Thus, the Dee Estuary/Aber Dyfrdwy SAC IEF is deemed to be of high vulnerability, low recoverability, and international value. The sensitivity of the receptor is therefore, considered to be high.

As detailed in Table 7.10, the area of the Fylde MCZ which overlaps with the Proposed Development has been assigned the biotope ‘Sublittoral sands and muddy sands (SS.SSa)’ (Envision Mapping, 2015), however has not been assigned more specific biotopes. As this area overlaps with the ‘Subtidal sands and gravels’ IEF identified during the site-specific survey within the Proposed Development, the representative biotopes identified for this IEF have also been used to characterise the Fylde MCZ IEF in the assessment. Therefore, the Fylde MCZ IEF is deemed to be of high vulnerability, low recoverability, and international value. The sensitivity of the receptor is therefore, considered to be high.

Significance of Effect

Subtidal Habitats and Species

Overall, for the Ross worm IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the effect of introduction of artificial habitat and colonisation of hard structures is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

For the Annex I Reef IEF, the magnitude of impact is deemed to be no change, and the sensitivity of the receptor is considered to be high. Therefore, the effect of introduction of artificial habitat and colonisation of hard structures is considered to be of **minor adverse** significance, which is **not significant** in EIA terms.

For all other subtidal habitats and species IEFs, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be high. Therefore, the effect of introduction of artificial habitat and colonisation of hard structures is considered to be of **minor adverse** significance, which is **not significant** in EIA terms. As per the matrix used to assess the significance of effects, a low magnitude of impact and high sensitivity of receptor yields 'minor or moderate' significance (Table 7.31). A minor adverse significance has been concluded as this impact will only affect a small proportion of the Proposed Development (0.01%) in which these IEFs occupy. This is unlikely to compromise the integrity of these habitats such that they wouldn't be able to support their characterising communities or perform their ecosystem function.

Intertidal Habitats and Species

Overall, for the 'Mudflats and sandflats not covered by seawater at low tide' IEF, the magnitude of impact is deemed to be no change, and the sensitivity of the receptor is considered to be high. Therefore, the effect of introduction of artificial habitat and colonisation of hard structures is considered to be of **minor adverse** significance, which is **not significant** in EIA terms.

Designated Sites

Overall, for the Dee Estuary/Aber Dyfrdwy SAC and Fylde MCZ IEFs, the magnitude of impact is deemed to be no change, and the sensitivity of the receptor is considered to be high. Therefore, the effect of introduction of artificial habitat and colonisation of hard structures is considered to be of **minor adverse** significance, which is **not significant** in EIA terms.

7.12.5 Increased Temperature Impacting Benthic Communities

7.12.5.1 Operation and Maintenance Phase

There is potential for increased temperatures from the subsea pipeline and power cables to impact the immediate environment, in-turn affecting the benthic species associated with the sediment.

The relevant MarESA pressures and their benchmarks which have used to inform this impact assessment are described here:

- temperature increase (local): the benchmark for which is a 5°C increase in temperature for one month or 2°C for an entire year.

Magnitude of Impact

Subtidal Habitats and Species

The MDS accounts for the utilisation of up to 121.77 km of existing subsea pipelines for transporting liquid carbon dioxide (CO_2) (Table 7.21). Additionally, up to 126.04 km of 33 kV subsea power cables will be used throughout the Proposed Development (Table 7.21). These subsea pipelines and power cables will be buried at a depth of at least 2 m and protected at cable crossings where burial is not possible (Table 7.21). CO_2 will be transported in a liquid state, at a range of temperatures and pressures. The MDS assumes a maximum temperature of 50°C at a pressure of 72.3 bara. The temperature of the subsea pipelines will be similar to or lower than when the pipelines were used for natural gas transportation, where pipeline temperatures of a maximum of 60°C were maintained. This was to prevent hydrate and wax deposition, which occurs at a critical temperature of approximately 40°C (Park and Seo, 2018). Subsea gas pipelines are designed to ensure that heat loss is low enough to avoid reaching this critical temperature of 40°C and can have internal temperatures as high as 100°C while the external temperature is as low as 5°C (Park and Seo, 2018).

The subsea power cables associated with the Proposed Development can generate heat through resistive heating. This is caused by energy loss as electrical currents flow, resulting in heating of the cable surface and potential warming of the surrounding environment. High voltage cables are used to minimise the amount of energy lost as heat, thus minimising the warming effect.

Schedule 4 of the EIA Regulations require a consideration of the LSE of the project resulting from emission of heat, light, and radiation. Soil and sand temperature modelling for the onshore pipeline has been conducted, the results of which are applicable to this impact (Wood, 2023). This study included onshore modelling alongside modelling in the intertidal zone at both high and low tide. It was therefore considered appropriate to represent the MDS for the offshore pipeline conditions, based on the modelled pipeline depth, water temperature, and external pipeline temperature. The results of this modelling concluded that pipeline temperature did not significantly impact sand temperature near the surface in either high or low tide conditions, due to the low thermal capacity of sand (Wood, 2023). Further, the presence of sea water at high tide resulted in a lower sand surface temperature, suggesting that the offshore pipeline would have similar results.

The results of other cable and pipeline projects showed similar results to those of the Proposed Development. For example, the Humber Low Carbon Pipelines (HLCP) is a similar project being developed by the National Grid. The HLCP project comprises dual pipelines to transport carbon dioxide for Carbon Capture, Usage, and Storage (CCUS) and hydrogen. Increased temperature due to the presence of pipelines was scoped out in the scoping stage for the HLCP (National Grid, 2022). There were no significant effects from the temperature of the carbon dioxide or hydrogen stream as the pipelines were below ground and no relevant pathways or receptors were identified (National Grid, 2022), however, it should be noted that these are onshore pipelines, thus potentially differing from those associated with the Proposed Development. However, in the EIA for the Nord Stream 2 subsea gas pipeline, generation of heat from gas flow through the pipelines was assessed as having negligible effects on water temperature. Only unburied sections of the pipeline could create a difference in temperature between the pipeline and the surrounding seawater, of up to 0.5^{o}C (Ramboll, 2017). However, natural mixing of seawater ensures that the temperature will reach equilibrium with the surrounding water within 0.5 to 1 m after crossing the pipeline (Ramboll, 2017). This impact was assessed as having negligible impacts upon biodiversity, including benthic species (Ramboll, 2017).

Subsea power cables also have negligible capacity to heat the surrounding water column due to the very high heat capacity of water. A field study at the Nysted Offshore Windfarm in Denmark demonstrated a mean temperature difference of 1^{o}C in sediment temperatures at the power cable and 25 cm away (Meißner *et al.,* 2007). Similarly, a high voltage power cable burial project in New York, USA, estimated that the 0.19^{o}C rise in temperature in the seabed immediately above the buried cable (Connecticut Sitting Council, 2001).

Overall, the temperature of the subsea pipelines will be lower than when the pipelines were used for natural gas transportation, and impacts are predicted to be minimal. Furthermore, temperatures generated by subsea power cables are also predicted to be minimal. Burial and cable crossing protection are embedded mitigation measures that will reduce the potential for this impact to affect benthic subtidal and intertidal IEFs. The impact on all benthic subtidal habitats and species IEFs (except the Annex I Reef IEF) is predicted to be of local spatial extent (within metres of the cables and pipelines), long term duration, continuous, and of high reversibility (as CO_2 and electricity will not be transmitted post decommissioning). It is predicted that there will be very minor loss or detrimental alteration to the characteristics, features, or elements of the IEFs. Therefore, the magnitude of impact is considered to be negligible.

There will be no cables or pipelines within, or in the nearby vicinity of the Annex I Reef IEF, and thus no potential for increased temperature as a result (Figure 7.4). Overall, the MDS for this impact will result in no loss or alterations of characteristics, features, or elements and no observable adverse impact to the Annex I Reef IEF (see Table 7.27). The magnitude is therefore considered to be no change.

Intertidal Habitats and Species

The MDS accounts for the presence of up to 1,200 m of power cables within the intertidal zone (Table 7.21). These subsea pipelines and power cables will be buried at a depth of a minimum of 2 m (Table 7.21). As described above for the subtidal habitats and species IEFS, the sand temperature study included modelling in the intertidal zone at both high and low tide (Wood, 2023). The results concluded that pipeline temperature did not significantly impact sand temperature near the surface in either high or low tide conditions, due to the low thermal capacity of sand (Wood, 2023).

Given the results of the site-specific modelling study and the results from similar projects presented above for the subtidal habitats and species IEFs, the impact on the 'Mudflats and sandflats not covered by seawater at low tide' IEF is predicted to be of local spatial extent (within metres of cables and pipelines), long term duration, continuous, and of high reversibility (as CO_2 and electricity will not be transmitted post decommissioning). It is predicted that there will be very minor loss or detrimental alteration to the characteristics, features, or elements of the IEFs. Therefore, the magnitude of impact is considered negligible.

Designated Sites

As above for the Annex I Reef IEF, there will be no cables or pipelines within, or in the nearby vicinity of the Fylde MCZ IEF, and thus no potential for increased temperature as a result (minimum of 1.82 km away; Figure 7.4). Overall, the MDS for this impact will result in no loss or alterations of characteristics, features, or elements and no observable adverse impact to the Fylde MCZ IEF (see Table 7.27). The magnitude is therefore considered to be no change.

As above for the intertidal IEF (Mudflats and sandflats not covered by seawater at low tide), introduction of artificial habitat and colonisation of hard structures will not arise within the Dee Estuary/Aber Dyfrdwy SAC due to the lack of above surface cable protection proposed for the intertidal zone. Although the Fylde MCZ overlaps with the Proposed Development offshore, there will be no infrastructure installed within it (see Figure 7.4), similar to the Annex I Reef IEF. Therefore, the MDS for this impact will result in no loss or alterations of characteristics, features, or elements and no observable adverse impacts to the site. The magnitude of impact on the Dee Estuary/Aber Dyfrdwy SAC and Fylde MCZ IEFs is therefore, considered to be no change.

Sensitivity of Receptor

All IEFs

For the subtidal and intertidal IEFs with a MarESA available, their sensitivity to increase in temperature is presented in Table 7.36. These sensitivities range from negligible to low.

The Renewables Grid Initiative (2016) conducted a literature review and collected stakeholder data on the effects of subsea power cables in the marine environment. They reported that there was a lack of field data on the effect of thermal radiation from subsea cables and concluded that increased temperature from subsea power cables is small and localised, with any potential impacts to benthic ecology only possible within a few centimetres from the cable (Renewables Grid Initiative, 2016). Similarly, a report on the potential thermal impacts of subsea power cables between Denmark and the UK concluded that only deep burrowing invertebrates could potentially be exposed to any non-trivial heating effects (such as the crustaceans *Callianassa subterranea* and *Upogebia deltaura,* and the sand gaper *Mya arenaria)* (National Grid and Viking Link, 2017). However, the modelling for the worst-case thermal scenario suggested that the footprint of temperature increases will be extremely narrow (National Grid and Viking Link, 2017). The MarESA for *C. subterranea* presents a high tolerance, high recoverability and low sensitivity to increased temperature, as it is distributed in a wide range of temperatures from Norway to the Mediterranean (Hill, 2005). For example, within North Sea waters, this species lives in temperatures varying between 6 and 15^{o}C (Rowden *et al.,* 1998). Similarly, a MarESA is available for sand gaper, which presents a high tolerance, very high recoverability, and very low sensitivity to increased temperature (Tyler-Walters, 2003). Again, this is due to the species wide distribution in the North Atlantic and the wide variation in natural temperatures it can survive, with a maximum temperature tolerance of 28^{o}C (Stickney, 1964; Kennedy and Mihursky, 1972; Strasser, 1999).

Similarly, a laboratory study on the effects of heat emission from subsea cables on two infaunal invertebrates, mud shrimp *Corophium volutator* and polychaete *Maranzellaria viridis,* illustrated that the distribution of mud shrimp was not correlated with the sediment temperature (Borrmann, 2006). *M. viridis* displayed a tendency to avoid areas of higher sediment temperatures (25 – 40^{o}C) (Borrmann, 2006), which suggests potential avoidance behaviour in this species. Both species have the potential to be present within the regional benthic ecology study area, with a MarESA available for the mud shrimp. This assessment proposes a high tolerance, very high recoverability, and very low sensitivity to increases in temperature (Neal and Avant, 2006). This is based on the natural fluctuations in temperature throughout the year, from 1°C in the winter to 17°C in the summer (Wilson and Parker, 1996), and that this species can tolerate higher temperatures (Meadows and Ruagh, 1981).

Overall, although temperature increases are unlikely to occur in the first place, it is likely that only deep burrowing species or sessile benthic species within centimetres from the pipelines could be impacted. Due to the natural fluctuations in temperature throughout the year, it is also likely that benthic subtidal and intertidal receptors will be tolerant to small temperature increases associated with this impact. All IEFs are deemed to be of low vulnerability, high recoverability, and of local to international importance. The sensitivity of the receptor is therefore considered to be low.

Table 7.36: Sensitivity Of The Benthic Subtidal And Intertidal Ecology IEFs To Increased Temperature

IEF	Representative Biotopes Identified	Sensitivity to Defined MarESA Pressure	Overall Sensitivity (Based on Table 7.29)
		Temperature Increase (local)	
Subtidal Habitats and Species			
Subtidal Sands and Gravels	*M. fragilis, Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel (SS.SCS.CCS.MedLumVen)	Low	Low
	N. cirrosa and *Bathyporeia* spp. in infralittoral sand (SS.SSa.IFiSa.NcirBat)	Not sensitive	Negligible
Mud Habitats in Deep Water	*A. filiformis, K. bidentata* and *A. nitida* in circalittoral sandy mud (SS.SMu.CSaMu.AfilKurAnit)	Not sensitive	Negligible
Subtidal Mixed Muddy Sediment	*O. fragilis* and/or *O. nigra* brittlestar beds on sublittoral mixed sediment (SS.SMx.CMx.OphMx)	Not sensitive	Negligible
Ross Worm *S. spinulosa*	-	Low	Low
Intertidal Habitats and Species			
Mudflats and sandflats not covered by seawater at low tide	Talitrids on the upper shore and strand-line (LS.Lsa.St.Tal)	Not sensitive	Negligible
	M. balthica and *A. marina* in littoral muddy sand (LS.LSa.MuSa.MacAre)	Low	Low
	Barren or amphipod-dominated mobile sand shores (LS.LSa.MoSa)	Not sensitive	Negligible
	Polychaete/bivalve-dominated muddy sand shores (LS.LSa.MuSa)	Not sensitive	Negligible

Significance of Effect

Subtidal Habitats and Species

Overall, for the Annex I Reef IEF, the magnitude of impact is deemed to be no change, and the sensitivity of the receptor is considered to be low. Therefore, the effect of increased temperature is considered to be of **negligible adverse** significance, which is **not significant** in EIA terms.

For all other subtidal habitats and species IEFs, the magnitude of impact is deemed to be negligible, and the sensitivity of the receptor is considered to be low. Therefore, the effect of increased temperature is considered to be of **negligible adverse** significance, which is **not significant** in EIA terms.

Intertidal Habitats and Species

For the 'Mudflats and sandflats not covered by seawater at low tide' IEF, the magnitude of the impact is deemed to be no change, and the sensitivity of the receptor is considered to be low. Therefore, the effect of increased temperature is considered to be of **negligible adverse** significance, which is **not significant** in EIA terms.

Designated Sites

For the Dee Estuary/Aber Dyfrdwy SAC and Fylde MCZ IEFs, the magnitude of the impact is deemed to be no change, and the sensitivity of the receptor is considered to be low. Therefore, the effect of increased temperature is considered to be of **negligible adverse** significance, which is **not significant** in EIA terms.

7.12.6 Increased Risk of Introduction and Spread of INNS

7.12.6.1 Construction Phase

Vessels utilised during all stages of the development area could inadvertently transport INNS resulting in significant impacts on the local fauna which have the potential to spread throughout the area. The relevant MarESA pressures and their benchmarks which have used to inform this impact assessment are described here:

- introduction or spread of INNS: the benchmark for which is the introduction of one or more INNS.
- This impact is linked with the impact 'introduction of artificial habitat and colonisation of hard structures' (section 7.12.4), which may lead to an increased risk of habitat that could be colonised by INNS.

Magnitude of Impact

Subtidal Habitats and Species

The installation of artificial hard substrates and the presence of construction vessels may lead to an increased risk of introduction and spread of INNS. The MDS is represented by up to 236 vessel round trips during the construction phase, including those required during site preparation activities (Table 7.21). There are however a number of existing vessel movements occurring within the Proposed Development. As ferries represent a large proportion of the vessel traffic in this region. These ferries primarily move between the mainland UK and Ireland or Northern Ireland (see volume 3, Anatec Limited and RPS Group (2023)). Shipping is also a major contributor with busy ports such as Liverpool in the vicinity. There is also an active fishing industry in this region, with fishing ports such as Amlwch, Conwy, Holyhead, and Fleetwood being the most active (see volume 3, Poseidon (2023)). The addition of the Proposed Development construction traffic to this region does not represent a level of vessel activity uncommon to this area, therefore it does not represent a large increase in risk as many of these vessels will be travelling further afield than the construction vessels potentially exposing themselves to INNS.

As presented in Table 7.21, the risk of introduction and spread of INNS will be increased through the construction phase due to the creation of 64,169 m^2 of artificial substrate from the installation of foundations for the new Douglas platform, cable crossing protection, pipeline spools, pipeline mattresses, and rock placement.

Many marine INNS that are now widespread and well established in this region of Wales and north-east England. The Welsh Government has published a monitoring and surveillance list for marine INNS to focus efforts on 'priority' marine species, representing those that do or could have a high environmental impact. The most recent list presents the following species as high risk of invasiveness:

- compass sea squirt *Asterocarpa humilis;*
- american slipper limpet *Crepidula fornicata;*
- carpet sea squirt *Didemnum vexillum;*
- chinese mitten crab *Eriocheir sinensis;*
- devil's tongue weed *Grateloupia turuturu;* and
- red ribbon bryozoan *Watersipora subatra* (Welsh Government, 2017).

The carpet sea squirt has been identified in the Holyhead region of northern Wales. It tends to colonise artificial structures, rocks, boulders, and even tide pools. It is usually found in low energy environments where water motion is limited (Gibson-Hall and Bilewitch, 2018). An experimental attempt to remove the carpet sea squirt from Holyhead harbour by isolating, smothering, and killing it using physical (plastic wrapping) and chemical (calcium hypochlorite) methods was documented by Holt and Cordingley (2011). This was largely successful following an eight-month treatment period however five months following cessation of removal activities survey work revealed large numbers of very small colonies of carpet sea squirt and rapidly growing larger colonies over a much larger proportion of the marina (Holt and Cordingley, 2011). Further efforts to remove the colonies were not pursued. This study highlights the intense, pervasive nature of this species once it is introduced, and the difficulty in removing it. The American slipper limpet has also been identified in the north of Cardigan Bay, in the Menai Strait and off the north and west coast of Anglesey. They are typically found attached to shells and stones on sedimentary substrata around the low water mark and the shallow sublittoral (Rayment, 2008).

There are several other INNS which can be found along the English coast to the west of the Proposed Development, including species such as wakame *Undaria pinnatifida* and leathery sea squirt *Styela clava* which have been recorded around Liverpool port (NBN Atlas, 2021).

The majority of the vessels used during the construction phase are likely to be from within the vicinity of the Proposed Development, therefore the introduction of species form outside the region is unlikely. Some of the INNS already in the region however are known to spread as fouling on ships hulls (such as compass sea squirt) which could introduce them to the Proposed Development.

As set out in Table 7.32, an INNS Management Plan will be implemented, which will aim to manage and reduce the risk of potential introduction and spread of INNS so far as reasonably practicable. The INNS Management Plan is presented in volume 4, RPS Group (2023b). Furthermore, vessels will be required to comply with the International Maritime Organisation (IMO) ballast water management guidelines. This will ensure that the risk of potential introduction and spread of INNS will be minimised.

Overall, for all subtidal habitats and species IEFs, the impact is predicted to be of local spatial extent, long term duration, intermittent (in terms of invasions), and low reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Intertidal Habitats and Species

As construction in the intertidal zone will be limited in comparison to the subtidal zone and will likely be conducted by onshore vehicles it is unlikely that they will introduce marine INNS to the intertidal zone. The risk from INNS from these activities is, therefore, considered to be minimal. No assessment of the 'Mudflats and sandflats not covered by seawater at low tide' IEF is therefore required for this impact.

Designated Sites

As above for the intertidal IEF (Mudflats and sandflats not covered by seawater at low tide), no impact to the Dee Estuary/Aber Dyfrdwy SAC IEF is likely to occur. No assessment of the Dee Estuary/Aber Dyfrdwy SAC IEF is therefore required for this impact.

As above for the subtidal habitats and species IEFs, the impact is predicted to be of local spatial extent, long term duration, intermittent (in terms of invasions), and low reversibility for the Fylde MCZ IEF. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Sensitivity of Receptor

Subtidal Habitats and Species

The sensitivities of the benthic subtidal habitats and species IEFs to this impact are presented in Table 7.37 and are based on the relevant MarESA pressure. The sensitivities of the two biotopes within the Subtidal Sands and Gravels IEF were assessed as negligible and high for the relevant MarESA pressure (Table 7.37). The remaining biotopes and species (Ross worm) were not able to be assessed due to insufficient evidence to support a MarESA for the relevant pressure for this impact (Table 7.37).

For the ‘subtidal sands and gravels’ IEF, the two representative biotopes identified had an overall high and negligible sensitivity to this impact. The biotope ‘*M. fragilis, Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel (SS.SCS.CCS.MedLumVen)’, was assessed as high sensitivity despite the fact that few INNS would be able to colonise mobile sands, due to high levels of sediment disturbance associated with them. However, two INNS, the American slipper limpet and carpet sea squirt, may be of concern to this biotope, hence the MarESA sensitivity of ‘high’ (Tillin, 2022a). Within this biotope, the American slipper limpet may settle on stones in substrates and hard surfaces such as bivalve shells. This species sometimes forms dense carpets which can smother bivalves and alter the seabed, making the habitat unsuitable for larval settlement (Tillin, 2022a). Few other bivalves can live amongst dense aggregations of American slipper limpet (Fretter and Graham, 1981; Blanchard, 1997). A study in south-west Wales found that American slipper limpet densities were highest in areas of high gravel content (grain sizes 16 to 2560 mm), suggesting that the availability of this substrata type is beneficial for its establishment (Bohn *et al.,* 2015). The American slipper limpet may colonize this biotope and potentially result in reclassification to the biotope ‘*C. fornicata* and *M. fragilis* in variable salinity infralittoral mixed sediment (SS.SMx.IMx.CreAsAn)’ (Tillin, 2022a). In addition to the American slipper limpet, the carpet sea squirt may also have the potential to colonize and smother offshore gravel habitats, such as this biotope. For example, this species appears to have rapidly colonized gravel areas on the Georges Bank (US/Canada boundary) (Valentine *et al.,* 2007). However, areas of mobile sand bordered communities of carpet sea squirt, which did not appear to be suitable habitats (Valentine *et al*., 2007). Therefore, the mobile sands associated with this biotope may exclude the carpet sea squirt (Tillin, 2022a). Overall, this biotope was assessed as having no resistance and very low resilience to invasion by American slipper limpet, giving an overall high sensitivity (Tillin, 2022a).

In contrast, the other representative biotope identified for the subtidal sands and gravels IEF (*N. cirrosa* and *Bathyporeia* spp. in infralittoral sand (SS.SSa.IFiSa.NcirBat)) had a negligible sensitivity to this impact (Tillin and Garrard, 2022). This is because the sediments characterizing this biotope are too mobile and frequent disturbance limits the establishment of marine and coastal INNS. The habitat conditions of this biotope are thus unsuitable for most species in general, as exemplified by the low species richness characterizing this biotope (Tillin and Garrard, 2022). This biotope is therefore considered to have a high resistance to this impact and high resilience, by default (Tillin and Garrard, 2022).

Ross worm, and the biotopes identified for the ‘Mud habitats in deep water’ IEF and ‘Subtidal mixed muddy sediment’ IEF were not assessed by the MarESA due to insufficient evidence (Table 7.37). The representative biotope for the Mud habitats in deep water IEF (*A. filiformis, K. bidentata* and *A. nitida* in circalittoral sandy mud (SS.SMu.CSaMu.AfilKurAnit)) was noted to be considered highly sensitive to INNS as subtidal muds have the potential for habitat change and due to the difficulty of removing INNS (De-Bastos and Hill, 2016). However, ultimately, evidence was not available for this biotope. Although not currently established in UK waters, the whelk *Rapana venosa* may spread to UK and Irish habitats from Europe (Tillin, 2022a). This species preys on bivalves and could therefore adversely affect bivalve species that are characteristic of biotope '*A. filiformis, K. bidentata* and *A. nitida* in circalittoral sandy mud (SS.SMu.CSaMu.AfilKurAnit)'.

Overall, due to the lack of available evidence for several biotopes and Ross worm, all subtidal habitats and species IEFs are deemed to be of high vulnerability, low recoverability, and local to national value as a precaution. The sensitivity of these IEFs is therefore, conservatively, considered to be high.

Designated Sites

As above for the subtidal habitats and species IEFs, the Fylde MCZ IEF is deemed to be of high vulnerability, low recoverability, and national value as a precaution. Therefore, the sensitivity is, conservatively, considered to be high.

Table 7.37: Sensitivity Of The Benthic Subtidal And Intertidal Ecology IEFs To Introduction Or Spread Of INNS

IEF	Representative Biotopes Identified	Sensitivity to Defined MarESA Pressure	Overall Sensitivity (Based on Table 7.29)
		Introduction or Spread of INNS	
Subtidal Habitats and Species			
Subtidal Sands and Gravels	*M. fragilis, Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel (SS.SCS.CCS.MedLumVen)	High	High
	N. cirrosa and *Bathyporeia* spp. in infralittoral sand (SS.SSa.IFiSa.NcirBat)	Not sensitive	Negligible
Mud Habitats in Deep Water	*A. filiformis, K. bidentata* and *A. nitida* in circalittoral sandy mud (SS.SMu.CSaMu.AfilKurAnit)	Not assessed, due to insufficient evidence	Not assessed, due to insufficient evidence
Subtidal Mixed Muddy Sediment	*O. fragilis* and/or *O. nigra* brittlestar beds on sublittoral mixed sediment (SS.SMx.CMx.OphMx)	Not assessed, due to insufficient evidence	Not assessed, due to insufficient evidence
Ross Worm *S. spinulosa*	-	Not assessed, due to insufficient evidence	Not assessed, due to insufficient evidence

Significance of Effect

Subtidal Habitats and Species

Overall, for the subtidal habitats and species IEFS, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be high. As per Table 7.31, this yields a minor or moderate significance. The effect will be of **minor adverse** significance (which is **not significant** in EIA terms) due to the small proportion of the Proposed Development that may be colonised and due to the precautionary high sensitivity of the receptor. Furthermore, embedded measures have been adopted to minimise the effects of introduction or spread of INNS, such as an EMP and INNS Management Plan (Table 7.32).

Designated Sites

Overall, for the Fylde MCZ IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be high. As per Table 7.31, this yields a minor or moderate significance. The effect will be of **minor adverse** significance (which is **not significant** in EIA terms) due to the small proportion of the Proposed Development that may be colonised and due to the precautionary high sensitivity of the receptor. Furthermore, embedded measures have been adopted to minimise the effects of introduction or spread of INNS, such as an EMP and an INNS Management Plan (Table 7.32).

7.12.6.2 Operation and Maintenance Phase

Magnitude of Impact

Subtidal Habitats and Species

The presence of artificial structures installed in the construction phase and the movement of vessels associated with the Proposed Development may lead to an increased risk of introduction and spread of INNS in the operations and maintenance phase. The MDS is represented by up to 750 vessel return trips during the 25-year operations and maintenance phase (Table 7.21). Furthermore, the long-term creation of 64,169 m^2 of artificial hard substrate, in the form of the new Douglas platform foundations, cable crossing protection, pipeline spools, pipeline mattresses, and rock placement, has the potential to contribute to the introduction and spread of INNS. As outlined in section 7.12.4 (Introduction of artificial habitat and colonisation of hard structures), this estimate for habitat creation is considered to be conservative as the lattice nature of jacket foundations will result in a smaller area of habitat created than has been assumed for a foundation with solid sides in the MDS.

Details of INNS of concern in the region are as outlined above for the construction phase. Overall, for all subtidal habitats and species IEFs, the impact is predicted to be of local spatial extent, long term duration, intermittent nature (based upon the numbers of vessel round trips across the project lifetime), and of low reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Intertidal Habitats and Species

As above for the construction phase, it is likely that the risk from INNS in the operation and maintenance phase is considered to be minimal. No assessment of the ‘Mudflats and sandflats not covered by seawater at low tide’ IEF is therefore required for this impact.

Designated Sites

As above for the intertidal IEF “Mudflats and sandflats not covered by seawater at low tide”, no impact to the Dee Estuary/Aber Dyfrdwy SAC IEF is likely to occur. No assessment of the Dee Estuary/Aber Dyfrdwy SAC IEF is therefore required for this impact.

As above for the subtidal habitats and species IEFs, the impact is predicted to be of local spatial extent, long term duration, intermittent (based upon the quantity of vessel round trips during the project lifetime), and low reversibility for the Fylde MCZ IEF. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered **low.**

Sensitivity of Receptor

All IEFs

The sensitivities of all the IEFs are considered to be as previously described for the construction phase (Table 7.37) and are assessed to be high.

Significance of Effect

Subtidal Habitats and Species

Overall, for the subtidal habitats and species IEFS, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be high. As per Table 7.31, this results in a minor or moderate significance. The effect will be of **minor adverse** significance (which is **not significant** in EIA terms) due to the small proportion of the Proposed Development that may be colonised and due to the precautionary high sensitivity of the receptor. Furthermore, embedded measures have been adopted to minimise the effects of introduction or spread of INNS, such as an EMP and an INNS Management Plan (Table 7.32).

Designated Sites

Overall, for the Fylde MCZ IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be high. As per Table 7.31, this yields a minor or moderate significance. The effect will be of **minor adverse** significance (which is **not significant** in EIA terms) due to the small proportion of the Proposed Development that may be colonised and due to the precautionary high sensitivity of the receptor. Furthermore, embedded measures have been adopted to minimise the effects of introduction or spread of INNS, such as an EMP and an INNS Management Plan (Table 7.32).

7.12.6.3 Decommissioning Phase

Magnitude of Impact

Subtidal Habitats and Species

In the decommissioning phase, some infrastructure will be left in place for reservoir modelling, before being removed. The current assumption is that all infrastructure will be removed over the decommissioning phase, and this will be confirmed within the Decommissioning Plan at the relevant time (Table 7.21). However, permanent habitat creation (i.e. persisting post-decommissioning) may occur as a some rock placement may be left in situ. This may contribute to an increased risk of introduction and spread of INNS.

Details of INNS of concern in the region are as outlined above for the construction phase. Overall, for all subtidal habitats and species IEFs, the impact is predicted to be of local spatial extent, long term duration, intermittent (in terms of exposure through vessel round trips), and of low reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Intertidal Habitats and Species

As above for the construction phase, it is likely that the risk from INNS in the decommissioning phase is considered to be minimal. No assessment of the ‘Mudflats and sandflats not covered by seawater at low tide’ IEF is therefore required for this impact.

Designated Sites

As above for the intertidal IEF (Mudflats and sandflats not covered by seawater at low tide), no impact to the Dee Estuary/Aber Dyfrdwy SAC IEF is likely to occur. No assessment of the Dee Estuary/Aber Dyfrdwy SAC IEF is therefore required for this impact.

As above for the subtidal habitats and species IEFs, the impact is predicted to be of local spatial extent, long term duration, intermittent (in terms of exposures via vessel round trips), and low reversibility for the Fylde MCZ IEF. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Sensitivity of Receptor

All IEFs

The sensitivities of all the IEFs are considered to be as previously described for the construction phase (Table 7.37) and are considered to be high.

Significance of Effect

Subtidal Habitats and Species

Overall, for the subtidal habitats and species IEFS, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be high. As per Table 7.31, this yields a minor or moderate significance. The effect will be of **minor adverse** significance (which is **not significant** in EIA terms) due to the small proportion of the Proposed Development that may be colonised and due to the precautionary high sensitivity of the receptor. Furthermore, embedded measures have been adopted to minimise the effects of introduction or spread of INNS, such as an EMP and an INNS Management Plan (Table 7.32).

Designated Sites

Overall, for the Fylde MCZ IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be high. As per Table 7.31, this yields a minor or moderate significance. The effect will be of **minor adverse** significance (which is **not significant** in EIA terms) due to the small proportion of the Proposed Development that may be colonised and due to the precautionary high sensitivity of the receptor. Furthermore, embedded measures have been adopted to minimise the effects of introduction or spread of INNS, such as an EMP and an INNS Management Plan (Table 7.32).

7.12.7 Impacts Resulting from the Release of Sediment Bound Contaminants

7.12.7.1 Construction Phase

Seabed disturbances due to construction activities could potentially lead to the remobilisation of previously sediment bound contaminants which could impact the surrounding benthic communities. The relevant MarESA pressures to inform this impact assessment are:

- transition elements and organo-metal contamination;
- Hydrocarbon and pah contamination; and
- synthetic compound contamination.

Magnitude of Impact

Subtidal Habitats and Species

The results of the numerical modelling study undertaken for the Physical Processes impact assessment (volume 3, RPS Group (2024c)) will be used to inform this impact. As presented above for ‘Increased SSCs and Associated Deposition’ (section 7.12.2) this modelling has been used to quantify the changes in physical processes, predominantly suspended sediment concentrations, due to seabed preparation activities, the drilling of new monitoring wells, and laying of cables. The following activities in the construction phase have been considered:

- seabed preparation (such as sand wave clearance);
- drill cuttings; and
- cable installation.

As per the MDS for 'Increased SSCs and Associated Deposition' (section 7.12.2; Table 7.21), it is assumes that sand waves are to be cleared along the cable route in two locations, south of the existing Douglas platforms, and at West Hoyle Bank. For the drilling of two new monitoring wells, the MDS assumes clearance of up to 30.48 m of sand and silt and 84.42 m of coarser sediment (assuming 100% washout). Finally, the MDS assumes that suspended sediments will be released due to the installation of up to 126.04 km of subsea power cables.

As stated in section 7.8.1.3, sediment contamination within the subtidal Proposed Development was assessed during the site-specific benthic characterisation survey in 2022, and the following results were recorded:

- As and Cd exceeded Cefas AL1 at one sampling station each.
- Hg was above the OSPAR BAC levels in seven sampling stations but did not exceed Cefas ALs.
- Zn was the most abundant metal across all samples but concentrations never exceeded any reference levels. All metals occurred in concentrations comparable to existing background data or in line with the range of concentrations known for areas located in proximity of active platforms.
- No PAHs exceeded Cefas AL1 at any of the CCS and full decommissioning sampling stations, while chrysene and benzo[a]pyrene were above Cefas AL1 at one partial decommissioning station (GS36). A positive correlation was observed between chrysene, benzo[a]pyrene and mud content with higher PAHs concentrations in muddier sediments apart from station GS36 which had the highest chrysene and benzo[a]pyrene concentrations but an average mud content. No relationship was observed between the concentration of PAHs and proximity to platforms that could have indicated dispersal of drill cuttings.
- THC was also highest at partial decommissioning station GS36 (30,600 µg/kg). In the North Sea, THC concentrations at locations between 1 to 2 km from an active platform range between 32,710 µg/kg to 33,810 µg/kg, in line with the findings at station GS36 which was located in proximity of a platform.
- PCBs and did not exceed Cefas AL1 at any sampling stations.
- Organotins (dibutyltin and tributyltin) were below the limit of detection at all sampling stations.

Based on these sediment contamination results, it is not likely that significant levels of sediment bound contaminants could be released as a result of the construction activities assessed under 'Increased SSCs and Associated Deposition'. Furthermore, the magnitude of impact for 'Increased SSCs and Associated Deposition' was concluded to be low (see section 7.12.2).

Overall, for all subtidal habitats and species IEFs, 'Impacts Resulting from the Release of Sediment Bound Contaminants' is predicted to be of local spatial extent, short-term duration (for the individual activities), intermittent (due to the construction schedule), and of high reversibility. It is predicted that this impact will affect the receptor directly. Therefore, the magnitude of impact is concluded to be negligible.

Intertidal Habitats and Species

There were no sediment samples taken from the intertidal zone during the site-specific benthic characterisation survey or intertidal survey. Therefore, there are no site-specific sediment chemistry values available for the intertidal zone. No assessment of the 'Mudflats and sandflats not covered by seawater at low tide' IEF is therefore possible for this impact.

Designated Sites

As above for the intertidal IEF (Mudflats and sandflats not covered by seawater at low tide), no assessment of the Dee Estuary/Aber Dyfrdwy SAC IEF is possible for this impact.

As above for the subtidal habitats and species IEFs, the impact is predicted to be of local spatial extent, short term (for the individual activities), intermittent (due to the construction schedule), and of high reversibility for the Fylde MCZ IEF. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be negligible.

Sensitivity of Receptor

Subtidal Habitats and Species

The four biotopes and were not assessed for any of the defined MarESA pressures for this impact, as shown in Table 7.38, however evidence has been provided where available. Ross worm was assessed for synthetic compound contamination but not for heavy metal or hydrocarbon contamination (Jackson and Hiscock, 2008). Although Ross worm larvae are known to be highly intolerant to some oil dispersants, adult populations been found to thrive in polluted areas, particularly those polluted with an acidified halogenated effluent (Hoare and Hiscock, 1974; Jackson and Hiscock, 2008). The species has been assessed as tolerant to synthetic compound contamination in the MarESA (Table 7.38; Jackson and Hiscock, 2008) but may have differing sensitivities to other contaminants, where information is lacking.

The capacity of bivalves to accumulate heavy metals in their tissues, far exceeding environmental levels, is well known. It has been stated that Hg is the most toxic metal to bivalves while Copper (Cu), Cd and Zn seem to be most problematic in the field (Bryan, 1984). Hg has been reported to have the highest toxicity in bivalves, with mortalities occurring above 0.1 to 1 g/l after four to 14 days exposure (Crompton, 1997). Limited evidence was found directly relating to the bivalves characteristic of the representative biotopes (*K. bidentata, A. nitida,* and venerid bivalves), however, inferences may be drawn from studies of other species. Burial of the venerid bivalve, *Venerupis senegalensis*, was inhibited by sediments spiked with Cu, and at very high concentrations, individuals closed up and did not bury at all (Kaschl and Carballeira, 1999). Similarly, Stirling (1975) investigated the effect of exposure to Cu on the bivalve *Tellina tenuis* and demonstrated that exposure to Cu concentrations of 250 µg/l and above also inhibited burrowing behaviour, which would presumably result in greater vulnerability to predators. Hiscock *et al*. (2004; from Rygg, 1985 and Olsgard, 1999) recorded that *A. nitida, Ennacula tenuis,* and *Nucula sulcata* were not tolerant to Cu contamination in sediments.

Echinoderms (such as brittlestars) are also regarded as being intolerant of heavy metals (Bryan, 1984). They are also known to be efficient concentrators of heavy metals including those that are toxic (Silver (Ag), Zn, Cd, and Cobalt (Co)) (Hutchins *et al.,* 1996), although there is no information available regarding the effects of this bioaccumulation. Deheyn and Latz (2006) reported that heavy metal accumulation in brittlestars in San Diego (Untied States (US)) occurs both through dissolved metals as well as through diet, to the arms and disc, respectively. Similarly, concentrations of heavy metals (Cu, Nickel (Ni), Cd, Co, Chromium (Cr), and Lead (Pb)) in the body of brittlestar *Ophiocoma scolopendrina* were most concentrated in the central disc rather than arms (Sbaihat *et al.*, 2013).

The tolerance of polychaetes to metal contamination varies throughout the literature. For example, Rygg (1985) classified polychaetes of the *Lumbrineris* genus as not tolerant of Cu, as individuals were only occasionally found at stations in Norwegian fjords where Cu concentrations were >200 Parts per Million (ppm) (mg/kg). It should be noted that the highest Cu concentration recorded in the site-specific sediment contamination analysis was 20.5 mg/kg, which is considerably lower than the value presented in Rygg (1985) (see volume 3, Ocean Ecology and RPS Group (2023)). However, the polychaete *Nereis diversicolor* has been reported to display some tolerance to Cu contamination, with tolerant individuals displaying significantly different gene expression profiles compared to those from a nearby population living without elevated Cu levels (McQuillan *et al.,* 2014). In addition, exposure to sediment contaminated with 40 mg/kg of Cd did not result in statistically significant differences in burrowing times of three polychates (*Alitta virens, Glycera dibranchiata,* and *Nephtys caeca*) compared to control conditions (Olla *et al.,* 1988). Cd uptake also varied between the three species, with the highest loads present in *N. virens* tissues after 28 days, followed by *G. dibranchiata,* and *N. cacea* (Olla *et al.,* 1988). Some polychaetes have also been recorded to accumulate toxic metals, such as As, and biotransform them through methylation (reviewed in Fattorini *et al.,* 2005), such as *Laeonereis acuta* (Ventura-Lima *et al.,* 2007).

Overall, the characterisitic species of the representative biotopes have varying tolerance levels to metal contamination, with bivalves and brittlestars likely to be sensitive, and polychaetes to be more tolerant. In terms of hydrocarbon and PAH contamination, sensitivites also vary between taxa and contaminants. Echinoderms are especially intolerant to hydrocarbons and PAH contamination, likely due to the large amounts of exposed epidermis they possess (Suchanek, 1993). Brittlestars in particular host symbiotic sub-cuticular bacteria, which have been demonstrated to reduce in number following hydrocarbon exposure (Newton and McKenzie, 1995). A study on *O. fragilis* demonstrated that exposure to 30,000 ppm of oil reduced this sub-cuticular bacterial load by 50%, resulting in mortality of the brittlestar host (Newton and McKenzie, 1995). Olsgard and Gray (1995) found *A. filiformis* to be very intolerant to oil pollution. Similarly, Addy *et al.* (1978) suggested that lower *A. filiformis* numbers within 2 to 3 km of the Ekofisk oilfield (North Sea) was related to oil discharches from plaforms. Diesel oil has been shown to be acutely toxic to brittlestars *O. fragilis* and *O. nigra,* although no field observations of damage to brittlestar beds because of hydrocarbon pollution have been documented (Hughes, 1998). Shortly after the Amoco Cadiz oil spill (France) mass mortality of the urchin *Echinocardium cordatum* through hydrocarbons exposure was observed down to about 20 m depth, suggesting high intolerance (Cabioch *et al.,* 1978). Similarly, amphipods *Ampelisca* sp., were also very intolerant to oil contamination and the recovery of the populations in the fine sand community took up to 15 years following the Amoco Cadiz oil spill (Poggiale and Dauvin, 2001).

Bivalves are also known to be sensitive to hydrocarbon and PAH contamination. They increase their energy expenditure and decrease their feeding rate after contact with oil, which results in less available energy for growth and reproduction (reviewed in Suchanek, 1993). Sublethal hydrocarbon concentrations also weaken attachment (through reduced byssal thread production) and infaunal burrowing rates (Suchanek, 1993). For example, two years following the Amoco Cadiz oil spill, recruitment of bivable *Fabulina fabula* was very much reduced (Conan, 1982). The author noted that populations of species with long and short-term life expectancies (e.g. *F. fabula*, urchin *E. cordatum,* and amphipod *Ampelisca* sp.) either vanished or displayed long-term decline following the oil spill (Conan, 1982). However, polychaetes (including *Nephtys hombergii*, cirratulids and capitellids) were largely unaffected, and *M. fragilis* increased in abundance after the spill (Dauvin, 2000). Other studies have also supported the conclusion that polychaetes are generally a tolerant taxa to hydrocarbon and PAH contamination. For example, Hiscock *et al.* (2004; from Levell *et al.,* 1989) described the polychates *Capitella capitata, Phloe inomata, Rhaphidrilus nemasoma,* and *Ophryotrocha* spp. as extremely tolerant species, present in high abundances in hydrocarbon contaminated sediments. Similar to metals, there is also evidence that some polychaetes can biotransform PAHs from both particulate and dissolved phases (Jørgensen *et al.,* 2007).

There is less information available on the sensitivities of benthic organisms to organotins and PCBs than for metals, hydrocarbons, and PAHs. One study by Dahllöf *et al.* (1999) investigated the long-term effects of tributyltin (TBT) on the function of a marine sediment system dominated by brittlestars *Amphiura* spp., heart urchin *Brissopsis lyrifera,* polychaetes (*Maldane sarsi* and *Heteromastus filiformis*), and white furrow shell. Within two days of treatment with a TBT concentration above 13.7 µmol/m² brittlestars, *B. lyrifera,* and white furrow shell had crept up to the surface, and after six weeks these fauna had started to decay (Dahllöf *et al.,* 1999). Thus, contamination from organotins, such as TBT, is likely to result in the death of some non-resistant species such as brittlestars. Furthermore, inhibition of arm regeneration in another brittlestar, *Ophioderma brevispina*, following exposure to TBT has been observed (Walsh *et al.,* 1986). Brittlestars are also known to bioaccumulate PCBs (Gunnarsson and Sköld, 1999), and may play an important role in the accumulation, remobilization, and transfer of PCBs to other trophic levels. For example, between 8 to 15% of PCB burden in dab from the Bay of Seine (France) could be explained by brittlestar consumption (Loizeau and Menesguen 1993).

Overall, there is a lack of information available on the sensitivities of the subtidal habitats and species IEFs to the contaminants mentioned, with the majority of available sources now somewhat dated. This has resulted in no MarESA available for the relevant pressures for this impact for any IEFs. Therefore, based on the absence of information, and the potential intolerance of many benthic species to contamination (bivalves and echinoderms in particular), the sensitivity of these receptors will be assessed on a precautionary basis. Overall, all subtidal habitat and species IEFs, are deemed to be of high vulnerability, low recoverability, and local to national value. Therefore, the sensitivity of these receptors to this impact is, precautionarily, considered to be **high.**

Designated Sites

As above for the subtidal habitats and species IEFs, the Fylde MCZ IEF is deemed to be of high vulnerability, low recoverability, and national value as a precaution. Therefore, the sensitivity is, precautionarily, considered to be high.

Table 7.38: Sensitivity Of The Benthic Subtidal And Intertidal Ecology IEFs To The Release Of Sediment Bound Contaminants

IEF	Representative Biotopes Identified	Sensitivity to Defined MarESA Pressures			Overall Sensitivity (Based on Table 7.29)
		Transition Elements and Organo-metal Contamination	Hydrocarbon and PAH Contamination	Synthetic Compound Contamination	
Subtidal Habitats and Species					
Subtidal Sands and Gravels	*M. fragilis, Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel (SS.SCS.CCS.MedLumVen)	Not assessed	Not assessed	Not assessed	Could not be defined by the MarESA, refer to text for sensitivity assessment
	N. cirrosa and *Bathyporeia* spp. in infralittoral sand (SS.SSa.IFiSa.NcirBat)	Not assessed	Not assessed	Not assessed	Could not be defined by the MarESA, refer to text for sensitivity assessment
Mud Habitats in Deep Water	*A. filiformis, K. bidentata* and *A. nitida* in circalittoral sandy mud (SS.SMu.CSaMu.AfilKurAnit)	Not assessed	Not assessed	Not assessed	Could not be defined by the MarESA, refer to text for sensitivity assessment
Subtidal Mixed Muddy Sediment	*O. fragilis* and/or *O. nigra* brittlestar beds on sublittoral mixed sediment (SS.SMx.CMx.OphMx)	Not assessed	Not assessed	Not assessed	Could not be defined by the MarESA, refer to text for sensitivity assessment
Ross Worm *S. spinulosa*	-	Not assessed due to insufficient evidence	Not assessed due to insufficient evidence	Not Sensitive	Could not be defined by the MarESA, refer to text for sensitivity assessment

Significance of Effect

Subtidal Habitats and Species

Overall, for the subtidal habitats and species IEFs, the magnitude of impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high. The effect will be of **minor adverse** significance (which is **not significant** in EIA terms) due to the small proportion of the Proposed Development that may be impacted by the release of sediment-bound contaminants, and the relatively low levels of contamination recorded during the site-specific benthic characterisation survey.

Designated Sites

Overall, for the Fylde MCZ IEF, the magnitude of impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high. The effect will be of **minor adverse** significance (which is **not significant** in EIA terms) due to the small proportion of the Proposed Development that may be impacted by the release of sediment-bound contaminants and the relatively low levels of contamination recorded during the site-specific benthic characterisation survey.

7.12.7.2 Decommissioning Phase

Seabed disturbances due to construction activities could potentially lead to the remobilisation of previously sediment bound contaminants which could impact the surrounding benthic communities.

Magnitude of Impact

Subtidal Habitats and Species

Based on the MDS (Table 7.21), the removal of foundations, cables, and cable crossing protection would result in increased SSCs within the Proposed Development during the decommissioning phase. It is assumed that the increases in SSCs generated in the decommissioning phase would be of a lower extent than that of the construction phase. This is due to the absence of seabed preparation activities, drilling, and depositing of drill cuttings, which account for additional increases in SSCs in the construction phase. These increased SSCs may potentially remobilise previously sediment bound contaminants present within the Proposed Development, which are outlined in section 7.12.2, and above for the construction phase. It is therefore anticipated that this impact will be of a lower extent to that of the construction phase.

Overall, for all subtidal habitats and species IEFs, this impact is predicted to be of local spatial extent, short-term duration (for the individual decommissioning activities), intermittent, and of high reversibility. It is predicted that this impact will affect the receptor directly. Therefore, the magnitude of impact is concluded to be negligible.

Intertidal Habitats and Species

As above for the construction phase, no assessment of the ‘Mudflats and sandflats not covered by seawater at low tide’ IEF is possible for this impact.

Designated Sites

As above for the intertidal IEF (Mudflats and sandflats not covered by seawater at low tide), no assessment of the Dee Estuary/Aber Dyfrdwy SAC IEF is possible for this impact.

As above for the subtidal habitats and species IEFs, this impact is predicted to be of local spatial extent, short-term duration (for the individual decommissioning activities), intermittent, and of high reversibility for the Fylde MCZ IEF. It is predicted that this impact will affect the receptor directly. Therefore, the magnitude of impact is concluded to be negligible.

Sensitivity of Receptor

All IEFs

The sensitivities of all the IEFs are considered to be as previously described for the construction phase (Table 7.38) and are considered to be high.

Significance of Effect

Subtidal Habitats and Species

Overall, for the subtidal habitats and species IEFS, the magnitude of impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high. The effect will be of **minor adverse** significance (which is **not significant** in EIA terms) due to the small proportion of the Proposed Development that may be impacted by the release of sediment-bound contaminants, and the relatively low levels of contamination recorded during the site-specific benthic characterisation survey.

Designated Sites

Overall, for the Fylde MCZ IEF, the magnitude of impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high. The effect will be of **minor adverse** significance (which is **not significant** in EIA terms) due to the small proportion of the Proposed Development that may be impacted by the release of sediment-bound contaminants and the relatively low levels of contamination recorded during the site-specific benthic characterisation survey.

7.12.8 Accidental Pollution to the Surrounding Area

7.12.8.1 Construction Phase

There is a risk of pollution to water and sediment through accidental release of chemicals and pollutants from vessels, equipment, and machinery used during construction activities. The relevant MarESA pressures to inform this impact assessment are:

- transition elements and organo-metal contamination;
- Hydrocarbon and PAH contamination; and
- synthetic compound contamination.

- These pressures are the same as those used in the assessment of 'Impacts Resulting from the Release of Sediment Bound Contaminants' (section 7.12.7).

Magnitude of Impact

Subtidal Habitats and Species

The MDS for this impact assumes a total of 236 round trips by vessels over the duration of the construction phase (Table 7.21). These include cable installation vessels, jack-ups, and support vessels (see Table 7.21 for all details). There is also potential for accidental pollution through discharges of drill cuttings, drilling mud, and cement, during the drilling of monitoring wells.

However, as stated in Table 7.32, embedded mitigation (e.g. an EMP) will reduce the likelihood of accidental pollution occurring. The of development and adherence to an EMP (including a MPCP) will include planning for accidental spills, address all potential contaminant releases, and include key emergency details. Measures will also be adopted to ensure that the potential for release of pollutants is reduced so far as reasonably practicable. These will likely include designated areas for refuelling where spillages can be easily contained, storage of chemicals in secure designated areas in line with appropriate regulations and guidelines, double skinning of pipes and tanks containing hazardous substances, and storage of these substances in impenetrable bunds. Finally, all vessels will be required to comply with the MARPOL regulations.

Therefore, for all subtidal habitats and species IEFs, this impact is predicted to be of local spatial extent, short-term duration, intermittent, and of high reversibility. It is predicted that this impact will affect the receptor directly. Due to the embedded mitigation measures, this impact will result in very minor loss or detrimental alteration to one or more characteristics, features, or elements. Therefore, as per Table 7.27, the magnitude of impact is concluded to be negligible.

Intertidal Habitats and Species

The MDS for this impact involves the use of cable installation ploughs to within the intertidal zone (Table 7.21). Due to the lack of other vessel and equipment usage within the intertidal zone in comparison to the subtidal zone, the risk of accidental pollution is lower for the ‘Mudflats and sandflats not covered by seawater at low tide’ IEF. Furthermore, the embedded mitigation described above for ‘Subtidal Habitats and Species’ is also relevant to the intertidal zone.

Therefore, for the ‘Mudflats and sandflats not covered by seawater at low tide’ IEF, this impact is predicted to be of local spatial extent, short-term duration, intermittent, and of high reversibility. It is predicted that this impact will affect the receptor directly. Due to the embedded mitigation measures and limited vessel and equipment usage within the intertidal zone, this impact will result in very minor loss or detrimental alteration to one or more characteristics, features, or elements. Therefore, as per Table 7.27, the magnitude of impact is concluded to be negligible.

Designated Sites

As above for the intertidal IEF (Mudflats and sandflats not covered by seawater at low tide), accidental pollution may arise in the Dee Estuary/Aber Dyfrdwy SAC due to the use of cable installation ploughs within the intertidal zone. Although the Fylde MCZ overlaps with the Proposed Development offshore, there is unlikely to be any disturbance to the Fylde MCZ as it is a minimum of 1.82 km from the area of project physical work (see Figure 7.4). Furthermore, the embedded mitigation described above for ‘Subtidal Habitats and Species’ is also relevant to the intertidal zone.

Overall, the impact on the designated site IEFs is predicted to be of local spatial extent, short-term duration, intermittent, and of high reversibility. It is predicted that this impact will affect the receptor directly. Due to the embedded mitigation measures, this impact will result in very minor loss or detrimental alteration to one or more characteristics, features, or elements. Therefore, as per Table 7.27, the magnitude of impact is concluded to be negligible.

Sensitivity of Receptor

Subtidal Habitats and Species

The sensitivity of the subtidal habitats and species IEFs is as presented for ’Impacts Resulting from the Release of Sediment Bound Contaminants’ (section 7.12.7; Table 7.39). Overall, there is a lack of information available on the sensitivities of the subtidal habitats and species IEFs to the contaminants that may be released as a result of this impact, with the majority of available sources now somewhat dated. This has resulted in no complete MarESA available for the relevant pressures for this impact for any IEFs. Therefore, based on the absence of information, and the potential intolerance of many benthic species to contamination (bivalves and echinoderms in particular), the sensitivity of these receptors will be assessed on a precautionary basis. Overall, all subtidal habitat and species IEFs, are deemed to be of high vulnerability, low recoverability, and local to national value. Therefore, the sensitivity of these receptors to this impact is, precautionarily, considered to be high.

Intertidal Habitats and Species

The representative biotopes for the 'Mudflats and sandflats not covered by seawater at low tide' IEF were not assessed for 'Impacts Resulting from the Release of Sediment Bound Contaminants' (section 7.12.7; Table 7.38) as that impact was not required for the intertidal zone. For Accidental Pollution to the Surrounding Area, however, these biotopes could be impacted. For the four representative biotopes identified for the 'Mudflats and sandflats not covered by seawater at low tide' IEF, a MarESA was only available for *M. balthica* and *A. marina* in littoral muddy sand (LS.LSa.MuSa.MacAre)' and 'Polychaete/bivalve-dominated muddy sand shores (LS.LSa.MuSa)' (Table 7.38).

The characteristic species *M. balthica* and *A. marina* have been demonstrated to be sensitive to various pollutants. Evidence suggests that *A. marina* can experience severe mortality due to exposure to Cd, Cu, and Zn. For example, 100% mortality has been demonstrated after exposure to Cu, Zn and Cd (Bat and Raffaelli, 1998), and Rasmussen and Andersen (2000) reported that Cd contamination increased the susceptibility of *A. marina* to hypo-osmotic stress. Cd and Cu were reported to result in severe mortality of *Macoma* spp., while Ag, As, Cr, Hg, Ni, and Zn were reported to result in significant mortality of *Macoma* spp. (Barlow and Kingston, 2001). Barite (in the form of drilling mud barite) was shown to cause 100% mortality of *M. balthica* within 12 days at a depth but the cause may have been due to physical damage of their gill filaments rather than chemical toxicity (Barlow and Kingston, 2001). Beaumont *et al.* (1989) reported that *A. marina* only occurred in the low-level TBT and the control treatments but not in high-level TBT treatments.

These species are also susceptible to oil and other hydrocarbon and PAH pollution. Hailey (1995) reported substantial mortality of *Macoma* spp., and *Arenicola* spp., after the Sivand oil spill in the Humber estuary in 1983. Levell (1976) examined the effects of crude oil and oil-dispersant mixtures on *A. marina*. Single spills caused 25 to 50% reduction in abundance and an additional reduction in feeding activity. Up to four repeated spillages (over a 10-month period) resulted in complete eradication of the affected population either due to death or migration out of the sediment. The author noted that recolonization was inhibited but not prevented (Levell, 1976). Prouse and Gordon (1976) examined the effects of surface fuel oil contamination and fuel oil sediment mixtures on the *A. marina* in the laboratory. They demonstrated that individuals were drawn out of the sediment by a waterborne concentration of >1 mg/l or sediment concentration of >100 µg/g. Individuals forced out of sediment may be able to migrate out of the affected area but will be exposed to severe predation risk, especially in daylight. Morales-Caselles *et al.* (2008) noted that sediment contaminated with fuel oil from a sunken tanker caused significant mortality in *A. marina*, with 8% fuel oil/dry weight sediment resulting in 100% mortality after 21 days. Stekoll *et al.* (1980) demonstrated that that chronic exposure of *M. balthica* to oil-in-seawater concentrations even as low as 0.03 mg/l would lead to population decreases over time. The individuals in this study were not subjected to any of the stresses that normally occur in their natural environment on mudflats such as changes in salinity, temperature, oxygen availability and wave action, therefore, it is possible that exposure of *M. balthica* to oil under field conditions results in higher mortality.

As the biotope 'Polychaete/bivalve-dominated muddy sand shores (LS.LSa.MuSa)' occurs in sheltered, low energy areas, it can act as a sink for complex mixtures of pollutants. These pollutants can remain in the sediment for some time, and therefore recoverability will be low. Within this biotope, oil and other hydrocarbon pollution smothers the sediment, preventing oxygen exchanged and resulting in anoxic conditions. This leads to death of infaunal species associated with the biotope (Tyler-Walters and Marshall, 2006). Furthermore, some pollutants (such as PCBs and Hg) may also accumulate within the food chain associated with this biotope.

Overall, there is a lack of information available on the sensitivities of the representative biotopes to the contaminants mentioned, with the majority of available sources is now somewhat dated. This has resulted in no MarESA available for the relevant pressures for this impact for two out of the four biotopes. Therefore, based on the absence of information, and the potential intolerance of many benthic species to contamination (bivalves in particular), the sensitivity of these receptors will be assessed on a precautionary basis. Overall, the Mudflats and sandflats not covered by seawater at low tide IEF is deemed to be of high vulnerability, low recoverability, and international value. Therefore, the sensitivity of the receptor to this impact is, precautionarily, considered to be high.

Designated Sites

As detailed in Table 7.10, the sensitivities presented for the Mudflats and sandflats not covered by seawater at low tide IEF in the preceding section is applicable to the Dee Estuary/Aber Dyfrdwy SAC IEF. Thus, the Dee Estuary/Aber Dyfrdwy SAC IEF deemed to be of high vulnerability, low recoverability, and international value. Therefore, the sensitivity of the receptor to this impact is, precautionarily, considered to be high.

As detailed in Table 7.10, the area of the Fylde MCZ which overlaps with the Proposed Development has been assigned the biotope 'Sublittoral sands and muddy sands (SS.SSa)' (Envision Mapping, 2015), however has not been assigned more specific biotopes. As this area overlaps with the 'Subtidal sands and gravels' IEF identified during the site-specific survey within the Proposed Development, the representative biotopes identified for this IEF have also been used to characterise the Fylde MCZ IEF in the assessment. Therefore, the Fylde MCZ IEF is deemed to be of high vulnerability, low recoverability, and national value. Therefore, the sensitivity of these receptors to this impact is, precautionarily, considered to be high.

Table 7.39: Sensitivity Of The Benthic Subtidal And Intertidal Ecology IEFs To Accidental Pollution

IEF	Representative Biotopes Identified	Sensitivity to Defined MarESA Pressure			Overall Sensitivity (Based on Table 7.29)
		Transition Elements and Organo-metal Contamination	Hydrocarbon and PAH Contamination	Synthetic Compound Contamination	
Subtidal Habitats and Species					
Subtidal Sands and Gravels	*M. fragilis, Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel (SS.SCS.CCS.MedLumVen)	Not assessed	Not assessed	Not assessed	Could not be defined by the MarESA, refer to text for sensitivity assessment
	N. cirrosa and *Bathyporeia* spp. In infralittoral sand (SS.SSa.IFiSa.NcirBat)	Not assessed	Not assessed	Not assessed	Could not be defined by the MarESA, refer to text for sensitivity assessment
Mud Habitats in Deep Water	*A. filiformis, K. bidentata* and *A. nitida* in circalittoral sandy mud (SS.SMu.CSaMu.AfilKurAnit)	Not assessed	Not assessed	Not assessed	Could not be defined by the MarESA, refer to text for sensitivity assessment
Subtidal Mixed Muddy Sediment	*O. fragilis* and/or *O. nigra* brittlestar beds on sublittoral mixed sediment (SS.SMx.CMx.OphMx)	Not assessed	Not assessed	Not assessed	Could not be defined by the MarESA, refer to text for sensitivity assessment
Ross Worm *S. spinulosa*	-	Not assessed due to insufficient evidence	Not assessed due to insufficient evidence	Not Sensitive	Could not be defined by the MarESA, refer to text for sensitivity assessment
Intertidal Habitats and Species					
Mudflats and sandflats not covered by seawater at low tide	Talitrids on the upper shore and strand-line (LS.Lsa.St.Tal)	Not assessed	Not assessed	Not assessed	Could not be defined by the MarESA, refer to text for sensitivity assessment
	M. balthica and *A. marina* in littoral muddy sand (LS.LSa.MuSa.MacAre)	Medium	Medium	Medium	Medium
	Barren or amphipod-dominated mobile sand shores (LS.LSa.MoSa)	Not assessed	Not assessed	Not assessed	Could not be defined by the MarESA, refer to text for sensitivity assessment
	Polychaete/bivalve-dominated muddy sand shores (LS.LSa.MuSa)	High	High	High	High

Significance of Effect

Subtidal Habitats and Species

Overall, for the subtidal habitats and species IEFs, the magnitude of impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high. Therefore, the significance of effect of accidental pollution is **minor adverse,** which is **not significant** in EIA terms. In addition, the effects of this impact will be minimised by the EMP (including a MPCP), which is an embedded mitigation measure (Table 7.32). Under this mitigation, accidental pollution from ships will be minimised.

Intertidal Habitats and Species

Overall, for the Mudflats and sandflats not covered by seawater at low tide IEF, the magnitude of impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high. Therefore, the significance of effect of accidental pollution is **minor adverse,** which is **not significant** in EIA terms. In addition, the effects of this impact will be minimised by the EMP (including a MPCP), which is an embedded mitigation measure (Table 7.32). Under this mitigation, accidental pollution from ships will be minimised.

Designated Sites

Overall, for the Designated Sites IEFs, the magnitude of impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high. Therefore, the significance of effect of accidental pollution is **minor adverse,** which is **not significant** in EIA terms. In addition, the effects of this impact will be minimised by the EMP (including a MPCP), which is an embedded mitigation measure (Table 7.32). Under this mitigation, accidental pollution from ships will be minimised.

7.12.8.2 Operations and Maintenance Phase

There is a risk of pollution to water and sediment through accidental release of chemicals and pollutants from vessels, equipment, and machinery used during operation and maintenance activities.

Magnitude of Impact

The MDS for this impact assumes a total of 750 return trips by vessels over the 25-year duration of the operation and maintenance phase (Table 7.21). These include geophysical survey, maintenance, and support vessels (see Table 7.21 for all details). The risk of accidental pollution during this phase will be lower than that of the construction phase, due to the lack of drilling in the operation and maintenance phase. Thereby, the risk of accidental pollution through the release of drill cuttings, drilling mud, and cement products, will not apply in the operation and maintenance phase.

As stated in Table 7.32, embedded mitigation (e.g. an EMP) will reduce the likelihood of accidental pollution occurring. The development of and adherence to an EMP (including a MPCP) will include planning for accidental spills, address all potential contaminant releases, and include key emergency details. Measures will also be adopted to ensure that the potential for release of pollutants is reduced so far as reasonably practicable. These will likely include designated areas for refuelling where spillages can be easily contained, storage of chemicals in secure designated areas in line with appropriate regulations and guidelines, double skinning of pipes and tanks containing hazardous substances, and storage of these substances in impenetrable bunds. Finally, all vessels will be required to comply with the MARPOL regulations.

Therefore, for all subtidal habitats and species IEFs, this impact is predicted to be of local spatial extent, short-term duration, intermittent, and of high reversibility. It is predicted that this impact will affect the receptor directly. Due to the embedded mitigation measures, this impact will result in very minor loss or detrimental alteration to one or more characteristics, features, or elements. Therefore, as per Table 7.27, the magnitude of impact is concluded to be negligible.

Intertidal Habitats and Species

The MDS for this impact involves the use of any machinery required for cable maintenance within the intertidal zone (Table 7.21). Due to the lack of other vessel and equipment usage within the intertidal zone in comparison to the subtidal zone, the risk of accidental pollution is lower for the Mudflats and sandflats not covered by seawater at low tide IEF. Furthermore, the embedded mitigation described above for 'Subtidal Habitats and Species' is also relevant to the intertidal zone.

Therefore, for the 'Mudflats and sandflats not covered by seawater at low tide' IEF, this impact is predicted to be of local spatial extent, short-term duration, intermittent, and of high reversibility. It is predicted that this impact will affect the receptor directly. Due to the embedded mitigation measures and limited vessel and equipment usage within the intertidal zone, this impact will result in very minor loss or detrimental alteration to one or more characteristics, features, or elements. Therefore, as per Table 7.27, the magnitude of impact is concluded to be negligible.

Designated Sites

As above for the intertidal IEF (Mudflats and sandflats not covered by seawater at low tide), accidental pollution may arise in the Dee Estuary/Aber Dyfrdwy SAC due to the use of machinery for cable maintenance within the intertidal zone. Although the Fylde MCZ overlaps with the Proposed Development offshore, there is unlikely to be any disturbance to the Fylde MCZ as it is a minimum of 1.82 km from the area of project physical work (see Figure 7.4).

Overall, the impact on the designated site IEFs is predicted to be of local spatial extent, short-term duration, intermittent, and of high reversibility. It is predicted that this impact will affect the receptor directly. Due to the embedded mitigation measures, this impact will result in very minor loss or detrimental alteration to one or more characteristics, features, or elements. Therefore, as per Table 7.27, the magnitude of impact is concluded to be negligible.

Sensitivity of Receptor

All IEFs

The sensitivities of all the IEFs are considered to be as previously described for the construction phase (Table 7.39) and are considered to be high.

Significance of Effect

Subtidal Habitats and Species

Overall, for the subtidal habitats and species IEFs, the magnitude of impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high. Therefore, the significance of effect of accidental pollution is **minor adverse,** which is **not significant** in EIA terms. In addition, the effects of this impact will be minimised by the EMP (including a MPCP), which is an embedded mitigation measure (Table 7.32). Under this mitigation, accidental pollution from ships will be minimised.

Intertidal Habitats and Species

Overall, for the Mudflats and sandflats not covered by seawater at low tide IEF, the magnitude of impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high. Therefore, the significance of effect of accidental pollution is **minor adverse,** which is **not significant** in EIA terms. In addition, the effects of this impact will be minimised by the EMP (including a MPCP), which is an embedded mitigation measure (Table 7.32). Under this mitigation, accidental pollution from ships will be minimised.

Designated Sites

Overall, for the Designated Sites IEFs, the magnitude of impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high. Therefore, the significance of effect of accidental pollution is **minor adverse,** which is **not significant** in EIA terms. In addition, the effects of this impact will be minimised by the EMP (including a MPCP), which is an embedded mitigation measure (Table 7.32). Under this mitigation, accidental pollution from ships will be minimised.

7.12.8.3 Decommissioning Phase

There is a risk of pollution to water and sediment through accidental release of chemicals and pollutants from vessels, equipment, and machinery used during decommissioning activities.

Magnitude of Impact

The MDS for this impact involves the use of vessels, machinery, and equipment that will be used to remove infrastructure within the decommissioning phase (Table 7.21). This includes a total of 128 vessel round trips during the decommissioning phase. This is likely to be of a similar or lesser extent to that of the construction phase. The risk of accidental pollution during this phase will be lower than that of the construction phase, due to the lack of drilling in the decommissioning phase. Thereby, the risk of accidental pollution through the release of drill cuttings, drilling mud, and cement, will not apply in the decommissioning phase.

As stated in Table 7.32, embedded mitigation (e.g. an EMP) will reduce the likelihood of accidental pollution occurring. The of development and adherence to an EMP (including a MPCP) will include planning for accidental spills, address all potential contaminant releases, and include key emergency details. Measures will also be adopted to ensure that the potential for release of pollutants is reduced so far as reasonably practicable. These will likely include designated areas for refuelling where spillages can be easily contained, storage of chemicals in secure designated areas in line with appropriate regulations and guidelines, double skinning of pipes and tanks containing hazardous substances, and storage of these substances in impenetrable bunds. Finally, all vessels will be required to comply with the MARPOL regulations.

Therefore, for all subtidal habitats and species IEFs, this impact is predicted to be of local spatial extent, short-term duration, intermittent, and of high reversibility. It is predicted that this impact will affect the receptor directly. Due to the embedded mitigation measures, this impact will result in very minor loss or detrimental alteration to one or more characteristics, features, or elements. Therefore, as per Table 7.27, the magnitude of impact is concluded to be negligible.

Intertidal Habitats and Species

The MDS for this impact involves the use of any machinery required for cable removal within the intertidal zone (Table 7.21). Due to the lack of other vessel and equipment usage within the intertidal zone in comparison to the subtidal zone, the risk of accidental pollution is lower for the ‘Mudflats and sandflats not covered by seawater at low tide’ IEF. Furthermore, the embedded mitigation described above for ‘Subtidal Habitats and Species’ is also relevant to the intertidal zone.

Therefore, for the Mudflats and sandflats not covered by seawater at low tide IEF, this impact is predicted to be of local spatial extent, short-term duration, intermittent, and of high reversibility. It is predicted that this impact will affect the receptor directly. Due to the embedded mitigation measures and limited vessel and equipment usage within the intertidal zone, this impact will result in very minor loss or detrimental alteration to one or more characteristics, features, or elements. Therefore, as per Table 7.27, the magnitude of impact is concluded to be negligible.

Designated Sites

As above for the intertidal IEF (Mudflats and sandflats not covered by seawater at low tide), accidental pollution may arise in the Dee Estuary/Aber Dyfrdwy SAC due to the use of machinery for cable removal within the intertidal zone. Although the Fylde MCZ overlaps with the Proposed Development offshore, there is unlikely to be any disturbance to the Fylde MCZ as it is a minimum of 1.82 km from the area of project physical work (see Figure 7.4).

Overall, the impact on the designated site IEFs is predicted to be of local spatial extent, short-term duration, intermittent, and of high reversibility. It is predicted that this impact will affect the receptor directly. Due to the embedded mitigation measures, this impact will result in very minor loss or detrimental alteration to one or more characteristics, features, or elements. Therefore, as per Table 7.27, the magnitude of impact is concluded to be negligible.

Sensitivity of Receptor

All IEFs

The sensitivities of all the IEFs are considered to be as previously described for the construction phase (Table 7.39) and are considered to be high.

Significance of Effect

Subtidal Habitats and Species

Overall, for the subtidal habitats and species IEFs, the magnitude of impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high. Therefore, the significance of effect of accidental pollution is **minor adverse,** which is **not significant** in EIA terms. In addition, the effects of this impact will be minimised by the EMP (including a MPCP), which is an embedded mitigation measure (Table 7.32). Under this mitigation, accidental pollution from ships will be minimised.

Intertidal Habitats and Species

Overall, for the Mudflats and sandflats not covered by seawater at low tide IEF, the magnitude of impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high. Therefore, the significance of effect of accidental pollution is **minor adverse,** which is **not significant** in EIA terms. In addition, the effects of this impact will be minimised by the EMP (including a MPCP), which is an embedded mitigation measure (Table 7.32). Under this mitigation, accidental pollution from ships will be minimised.

Designated Sites

Overall, for the Designated Sites IEFs, the magnitude of impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high. Therefore, the significance of effect of accidental pollution is **minor adverse,** which is **not significant** in EIA terms. In addition, the effects of this impact will be minimised by the EMP (including a MPCP), which is an embedded mitigation measure (Table 7.32). Under this mitigation, accidental pollution from ships will be minimised.

Fish and Shellfish Ecology

7.12.9 Temporary Subtidal Habitat Loss and/or Disturbance

7.12.9.1 Construction Phase

There is potential for direct habitat and species loss in the Proposed Development due to site preparation activities and the installation of development infrastructure (such as subsea cable pipeline installation and jack-up vessel deployments).

Magnitude of Impact

All species

The installation of the new Douglas platform within the Proposed Development will lead to temporary habitat loss and/or disturbance. The MDS accounts for up to 1.91 km^2 of temporary habitat loss and/or disturbance during the construction phase (Table 7.22). This equates to approximately 0.32% of the area within the Proposed Development overall, although only a small proportion of this will be impacted at any one time. The magnitude of impact is as described above for benthic subtidal and intertidal ecology and is not repeated here (see section 7.12.1).

The impact on all fish and shellfish IEFs is predicted to be of local spatial extent (0.32% of the Proposed Development), short term duration (up to two years), intermittent (due to the construction schedule), and of high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore considered to be low.

Sensitivity of Receptor

Indirect effects of this impact on fish and shellfish also include loss of foraging habitat and reduced prey availability. For example, fish and shellfish species, such as forage fish, small benthic fish species, and smaller crustaceans, are considered important prey for larger fish and shellfish species, in addition to benthic invertebrates (which are discussed in section 7.12.1). However, since this impact is predicted to only affect a small proportion of seabed habitats in the regional fish and shellfish ecology study area at any one time, with similar habitats (and prey species) occurring throughout the whole regional fish and shellfish ecology study area, these indirect effects are likely to be limited and reversible. On the contrary, sediment disturbance associated with this impact will also dislodge infaunal prey species from the sediment (discussed in section 7.12.1), potentially offering foraging opportunities to some mobile opportunistic scavenging fish and shellfish species immediately after disturbance. The implications of changes in fish and shellfish prey species in the short-term are also discussed for marine mammals and birds in section 7.12.19 and volume 2, chapter 8. respectively.

Substrate type is the primary driver for recoverability and rate of recovery of an area after large scale seabed disturbance (Newell *et al.,* 1998; Desprez, 2000). Gravelly and sandy habitats, which are found throughout the regional fish and shellfish ecology study area, have been demonstrated to return to baseline species abundance approximately five to ten years after seabed disturbance due to aggregate extraction (Foden *et al.,* 2009). This is dependent on replenishment rates which are related to tidal stress, currents, and availability and transference of conspecifics from less impacted to more impacted environments (Foden *et al.,* 2009). Within the regional fish and shellfish ecology study area, in the eastern Irish Sea, the year one post-construction monitoring of the Walney Wind Farm Extension reported a degraded benthic and demersal fish and shellfish community in comparison to pre-construction levels within the Array Area, but no significant difference within transmission assets (CMACS, 2012). In the three-year post-construction survey, there was a smaller difference in community degradation compared to pre-construction levels, suggesting a that the area was recovering to baseline conditions, with relatively little overall impact (CMACS, 2014).

Shellfish

In general, shellfish are more vulnerable receptors than fish, due to their lower mobility. Of these, slow-recruiting shellfish species are likely to be the most highly impacted by temporary disturbance (Macdonald *et al.,* 1996). For example, a capture-mark-recapture study in Norway demonstrated that 84% of berried (e.g. egg bearing) European lobster remained within 500 m of their release site (Agnalt *et al.,* 2006).

A range of shellfish species are known to be present within the regional fish and shellfish ecology study area, including species of commercial importance (such as brown crab, European lobster, king and queen scallop, Norway lobster, and velvet swimming crab). Temporary habitat loss in the construction phase will represent a maximum of 1.91 km^2 in the Proposed Development. As stated above, this is likely due to cable laying operations and seabed preparation activities. While the total temporary habitat loss and/or disturbance footprint represents a relatively large proportion of the area within the Proposed Development (0.32%), only a small proportion of this area would be affected at any one time. Further, sediments have been demonstrated to recover relatively rapidly (RPS, 2019). In addition, associated benthic communities (see section 7.12.1), including shellfish populations, are expected to recover and species to move back into the affected areas.

King and queen scallop have been evaluated as IEFs of local importance within the regional fish and shellfish ecology study area (Table 7.13). They are predominantly sessile animals, however, can swim limited distances, typically as an escape response, by ejecting water around the hinge of their shells (Marshall and Wilson, 2008; Schalkhausser *et al.,* 2014). King scallop have been documented to swim up to 30 m, with a tagging study in western Scotland demonstrating that the majority of adults were within 30 m of their release point after 18 months (Howell and Fraser, 1984). As a result, king and queen scallop may have improved resilience to this impact, as they could potentially flee areas of disturbance. Scallop tend to occur in aggregations as their larval distribution is reliant on relatively unpredictable hydrographic features (Brand, 1991; Delargy *et al.,* 2019). For example, Le Pennec *et al.* (2003) report that king scallop larvae could travel up to 40 km in 18 days, while Sinclair *et al.* (1985) proposed that larvae can also undertake vertical migrations and retain self-sustaining populations. Nonetheless, king and queen scallop are expected to continue spawning outside the Proposed Development within unimpacted areas of the regional fish and shellfish ecology study area. As suitable settlement habitat will remain following cessation of construction, it is expected that scallop will continue to be recruited within the Proposed Development and within the wider regional fish and shellfish ecology study area, either through vertical or horizontal larval transport. Scallop are therefore likely to recover well from disturbance due to temporary habitat loss. This is supported by the MarESA (Marshall and Wilson, 2008) which concluded king scallop have a high recovery potential for substratum loss. At the time of writing, there is no MarESA available for queen scallop.

Norway lobster, European lobster, and other larger crustaceans are classed as equilibrium species, meaning that they can only recolonise an area once the original substrate has recovered to baseline conditions (Newell *et al.,* 1998). The sensitivity of these IEFs is therefore higher, as recovery of equilibrium species may take up to ten years in some areas of coarse sediments (Phua *et al.,* 2002). For example, Norway lobster is concluded to have a moderate recoverability and sensitivity to substratum loss according to the MarESA, however this assessment is not available for European lobster (Sabatini and Hill, 2008). However, it should be noted that the lowered predation rates in the absence of larger crustacean and flatfish species due to habitat disturbance can increase overall benthic abundance (Skold *et al*., 2018). This suggests resilience among smaller fish and shellfish species which could contribute to a minor short-term change in ecosystem function, which is likely to recover to the baseline in the long-term. Furthermore, construction activities, such as cable installation, within the regional fish and shellfish ecology study area may also impact Norway lobster spawning and nursery grounds, which are in proximity to the Proposed Development, in the eastern Irish Sea (Coull *et al.,* 1998). However, as there is no spatial overlap with the Proposed Development, impacts are likely to be limited. Larval settlement will also increase the rate of recovery of disturbed areas within the Proposed Development (Phua *et al.,* 2002) due to the proximity to spawning and nursery habitats.

In addition, a recent study of European lobster in a north-east England fishing ground found that the size and abundance of individuals increased following temporary closure of the area for construction of the Westermost Rough Offshore windfarm (Roach *et al.,* 2018). These findings indicate that the activities associated the construction, such are foundation and cable installation, did not adversely impact on resident European lobster populations, and actually allowed some population recovery due to suspended fishing activity (Roach *et al*., 2018).

Spiny lobster inhabits rocky substrates with crevices and holes to hide in. Juveniles often remain in algal or seagrass nursery areas until they are large enough to move into rocky crevices (Devon and Severn Inshore Fisheries and Conservation Authority, 2019). Populations in UK and Ireland collapsed due to overfishing in the 1970’s, with evidence of recovery in the 21st century (Hiscock *et al.,* 2011; Gibson-Hall *et al.,* 2020). This recovery appears to be very slow, as it has been over 40 years for a significant recruitment to be reported (Hiscock *et al.,* 2011). According to the MarESA, this species has medium resistance, low resilience, and medium sensitivity to abrasion and disturbance of the substratum or seabed surface. However, impacts such as penetration or disturbance of the substratum subsurface and removal of substratum are not relevant for this species, likely due to their preference for hard, rocky substrates (Gibson-Hall *et al.,* 2020). These habitats are not likely to be affected by this impact.

Overall, spiny lobster are deemed to be of medium vulnerability, low to medium recoverability, and of national importance. The sensitivity of the receptor is therefore considered to be medium. European lobster and Norway lobster are deemed to be of high vulnerability, medium to high recoverability and of local importance. The sensitivity of the receptor is therefore considered to be medium.

King and queen scallop are deemed to be of medium vulnerability, high recoverability, and of local importance. The sensitivity of the receptor is therefore considered to be low.

All other shellfish IEFs are deemed to be of medium vulnerability, medium recoverability, and of local importance. The sensitivity of the receptor is therefore considered to be medium.

Marine Fish

Fish and shellfish IEFs that spawn near or on the seabed are likely to be the most sensitive to temporary habitat loss and/or disturbance, due to reduced spawning habitat. These include herring, sandeel, and elasmobranchs, such as spotted ray and thornback ray. Conversely, pelagic spawning species and highly mobile elasmobranchs, such as basking shark, are unlikely to be sensitive to this impact. Spotted ray and thornback ray were evaluated as IEFs of regional importance and have low intensity spawning grounds in proximity to the Proposed Development (Ellis *et al.,* 2012) (Table 7.13). However, as these spawning grounds are only of low intensity, and that these species also have significant areas spawning grounds within the wider regional fish and shellfish ecology study area, these species are likely to be resilient to temporary habitat loss and/or disturbance within the Proposed Development.

Anglerfish and flatfish, such as lemon sole, sole, plaice, and others, were evaluated as IEFs of local to regional importance (Table 7.13) due to presence of nursery and spawning grounds within proximity to the Proposed Development. These species live in the demersal zone and could therefore potentially be affected by temporary habitat loss and/or disturbance to their habitat. However, neither beneficial nor adverse effects of construction and operation of the Block Island Wind Farm in the US were observed for a range of north American flatfish species (Wilber *et al.,* 2018), suggesting a degree of resilience to this impact in flatfish. It is unlikely that temporary habitat loss and/or disturbance would heavily impact these species, given that their spawning and nursery grounds extend throughout much of the regional fish and shellfish ecology study area.

Herring were evaluated as IEFs of national importance (Table 7.13) and have low and high intensity nursery and spawning grounds in the vicinity of the Proposed Development. Although a pelagic species, herring require suitable seabed habitat for spawning. They deposit thick matts of demersal eggs in areas of suitable sediment composition (Aneer *et al.,* 1983). Suitable spawning grounds are therefore vital for the resilience of herring stocks, although these habitats are often adversely impacted by environmental impacts, such as storms, and anthropogenic pressures (Thurstan and Roberts, 2010; Moll *et al.,* 2018). Herring stocks around the UK and Ireland have historically followed “boom and bust” cycles, with the mechanisms involving recolonisation of spawning grounds and subsequent population recovery not fully understood (Schmidt *et al.,* 2009; Dickey-Collas *et al.,* 2010; Trochta *et al.,* 2020). They are very particular in where they chose to spawn, however their plasticity in spawning ground utilisation can buffer against temporary changes to their environment, and increase population resilience (Schmidt *et al.,* 2009; Frost and Diele, 2022). Furthermore, the results of the PSA conducted on the sediment samples collected during the site-specific survey (Table 7.6) demonstrated that the Proposed Development is largely unsuitable spawning habitat for herring, with only one sampling site (1.3% of the total number of samples) classified as ‘suitable’ habitat under the Reach *et al.* (2013) methodology. There were four samples (5.3% of the total) classified as ‘sub-prime’ spawning habitat. In addition, there were no spawning grounds overlapping with the Proposed Development, with the closest identified around the Isle of Man, and with nationally significant spawning grounds located out with the regional fish and shellfish ecology study area entirely (Coull *et al.,* 1998). Overall, it is unlikely that herring populations will be largely affected by temporary habitat loss and/or disturbance in the construction phase.

Sandeel were evaluated as IEFs of regional importance, (Table 7.13) and have low and high intensity spawning habitats within the regional fish and shellfish ecology study area and overlapping with the Proposed Development. Therefore, any significant seabed disturbance activities carried out during spawning periods may result in mortality of eggs and reduced opportunity due to removal of suitable habitat. In addition, temporary habitat loss and/or disturbance may also lead to adult and juvenile sandeel mortality, as sandeel species spend significant amounts of time buried in the sediment. Adult sandeel spend the winter buried in the sediment, only emerging briefly to spawn. Mortality could therefore occur if individuals are unable to colonise viable sandy sediment habitats nearby, or in habitat patches that are at carrying capacity (Wright *et al*., 2000). Sandeel IEFs are therefore highly sensitive to this impact due to direct physical disturbance (Wright *et al*., 2000). Sandeel may also be particularly vulnerable during the winter, as they spend more time buried in the seabed and are less mobile.

The results of the PSA conducted on the sediment samples collected during the site-specific survey (Table 7.6) highlighted varying degrees of sandeel spawning habitat suitability throughout the Proposed Development with 43.4% of samples classified as 'unsuitable', 22.4% as 'sub-prime', 19.7% as 'suitable', and 14.4% as 'prime'. There was a patchy distribution in the 'prime' and 'sub-prime' samples throughout the Proposed Development, however they were mainly present along the pipeline connection towards the Point of Ayr. Overall, the Proposed Development was largely unsuitable and sub-prime, but temporary habitat loss and/or disturbance could still impact some sandeel spawning habitats the area. However, the proportion of these habitats affected is predicted to be relatively small, given the abundance of similar substrate types and the extensive nature of fish spawning grounds across the regional fish and shellfish ecology study area.

The rate of sediment recovery to suitable conditions for sandeel recolonisation will determine the recovery rate of sandeel populations. The effect of offshore windfarm construction and post-construction (i.e. operation and maintenance) activities on sandeel populations have been investigated through short- and long-term monitoring at the Horns Rev offshore wind farm in Denmark (Jensen *et al.,* 2004; van Deurs *et al.,* 2012). Due to the nature and scale of the Horns Rev offshore wind farm, these construction and post-construction activities involve similar, if not higher levels of temporary habitat loss and/or disturbance than expected for the Proposed Development. These monitoring studies demonstrated that the construction and post-construction activities did not result in significant adverse effects on sandeel populations and that sandeel recovered quickly following (Jensen *et al.,* 2004; van Deurs *et al.,* 2012). Sandeel recovery can also be inferred from the results of a fisheries study by Jensen *et al.* (2010), which found that sandeel populations mixed within fishing grounds by up to 28 km. This degree of mixing suggests that adult populations are likely to recover following construction activities, which would have similar effects on the sediments as fishing activities. Recovery of sandeel populations may also occur through larval dispersal into suitable sandy sediments during spring, following the winter and spring spawning period. Similarly, the results of post construction surveys at the Beatrice OWF and the Horns Rev 1 Offshore Wind Farm demonstrated that construction posed neither a benefit nor a threat to sandeel populations (Stenberg *et al.,* 2011; Beatrice Offshore Wind Farm Limited (OWL), 2021a). Construction activities resulting in temporary habitat loss and/or disturbance will not occur simultaneously within the Proposed Development, and once completed, sediments and communities are expected to recover. Based on the information presented in the preceding paragraphs, it is highly likely that sandeel will recolonise disturbed areas, and recovery will occur continuously throughout the construction phase.

Sandeel constitute important prey species for other fish and shellfish IEFs, such as cod, sea trout, and whiting. The effects of temporary habitat loss and/or disturbance on sandeel are predicted to be limited (particularly in the context of available habitats in the wider regional fish and shellfish ecology study area), temporary and reversible, with recovery of sandeel populations occurring during and post-construction. Therefore, larger fish and shellfish IEFs that prey on sandeel are also unlikely to be significantly affected. Changes in prey availability for higher trophic level receptors (i.e. marine mammals and birds) are also discussed in section 7.12.19 and volume 2, chapter 8.

Overall, most fish and shellfish ecology IEFs in the regional fish and shellfish ecology study area (such as pelagic spawners, elasmobranchs, and flatfish) are deemed to be of low vulnerability, high recoverability and local to national importance. The sensitivity of the receptor is therefore considered to be low.

Sandeel are deemed to be of high vulnerability, high recoverability and of regional importance. The sensitivity of sandeel is therefore considered to be medium.

Herring are deemed to be of high vulnerability, medium recoverability and of national importance, which would normally generate a medium to high sensitivity. However, the sensitivity of herring to this impact is considered to be low, due to the limited suitable spawning sediments within the Proposed Development and the core herring spawning ground being located well outside and to the north-east of the regional fish and shellfish ecology study area.

Diadromous Fish

By nature, diadromous fish species are highly mobile and thus generally able to avoid areas subject to temporary habitat loss. In addition, they are less reliant on seabed habitats than other fish and shellfish IEFs discussed, such as sandeel. Diadromous species are only likely to interact within the regional fish and shellfish ecology study area while migrating to and from rivers and freshwater habitats. Thus, temporary habitat loss and/or disturbance of seabed is unlikely to be of particular relevance for diadromous fish species as it will not affect migration.

Diadromous species may be indirectly affected due to impacted prey species. However as outlined in the preceding paragraphs, the majority of marine fish species would be able to avoid temporary habitat loss effects due to their greater mobility and would recover into the areas affected following cessation of construction. Sandeel (and other less mobile prey species) would be affected by temporary habitat loss, although recovery is expected to occur quickly as the sediments recover following activities such as cable installation (RPS, 2019) and adults recolonise, and larvae are recruited into the recovered habitats (RPS, 2019).

Overall, diadromous fish species are deemed to be of low vulnerability, high recoverability and national to international importance. However, the relatively low amount of construction required and short construction period for the Proposed Developments in comparison to other projects (such as offshore wind farm construction) likely highly reduces the probability of either spatial or temporal overlap with many migrating diadromous species. As such, the sensitivity of the receptor is therefore considered to be negligible. Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the sensitivity of the freshwater pearl mussel IEF is also considered to be negligible.

Significance of Effect

Shellfish

For king and queen scallop, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms

For European lobster, Norway lobster, and spiny lobster, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For all other shellfish IEFs, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

Marine Fish

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of most fish IEFs is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For sandeel, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For herring, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

Diadromous Fish

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be negligible. The effect will, therefore, be of **negligible adverse** significance, which is **not significant** in EIA terms. Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the significance of the effect on the freshwater pearl mussel IEF is also considered to be **negligible adverse.**

7.12.9.2 Operation and Maintenance Phase

Temporary habitat loss and/or disturbance may occur during operation and maintenance activities, such as cable and infrastructure repair and associated vessel anchoring.

Magnitude of Impact

All species

The MDS accounts for up to 72,000m^2 of temporary habitat loss and/or disturbance within this phase (Table 7.22). This equates to a small proportion (0.01%) of the total Proposed Development. It should also be noted that only a small proportion of the total temporary habitat loss and/or disturbance is likely to occur at any one time, with the MDS for this impact spread over the 25-year lifetime. Therefore, individual maintenance activities will be small scale and intermittent events. The magnitude of impact is as described above for benthic subtidal and intertidal ecology and is not repeated here (see section 7.12.1).

The spatial extent of this impact is small in relation to the whole regional fish and shellfish ecology study area, although there is the potential for repeat disturbance to the habitats in the immediate vicinity the infrastructure because of these activities. However, effects on seabed habitats and associated fish and shellfish communities are expected to be similar to the construction phase, but of a much lower magnitude.

Overall, this impact is predicted to be of local spatial extent (0.01% of the Proposed Development), short term duration, intermittent throughout the lifecycle of the Proposed Development, and high reversibility. It is predicted that the impact will affect fish and shellfish receptors directly. The magnitude is therefore, considered to be low.

Sensitivity of Receptor

All species

The sensitivities of all fish and shellfish IEFs (shellfish, marine fish, and demersal species) presented in the assessment of this impact in the construction phase equally apply in the operation and maintenance phase (negligible to medium).

Significance of Effect

Shellfish

For king and queen scallop, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms

For European lobster, Norway lobster, and spiny lobster, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For all other shellfish IEFs, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

Marine Fish

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of most fish IEFs is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For sandeel, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For herring, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

Diadromous Fish

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be negligible. The effect will, therefore, be of **negligible adverse** significance, which is **not significant** in EIA terms. Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the significance of the effect on the freshwater pearl mussel IEF is also considered to be **negligible adverse.**

7.12.9.3 Decommissioning Phase

Decommissioning activities within the Proposed Development will result in temporary habitat loss and/or disturbance in this phase.

Magnitude of Impact

All species

The MDS for the decommissioning phase assumes that all infrastructure will be removed (except some rock placement which may remain *in situ*) (Table 7.22). The extent of temporary habitat loss and/or disturbance during this phase will be significantly lower than that of the construction phase, as seabed preparation activities will not be required.

The spatial extent of this impact is small in relation to the whole regional fish and shellfish ecology study area and effects on seabed habitats and associated fish and shellfish communities are expected to be similar to the construction phase, but of a much lower magnitude.

Overall, this impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect fish and shellfish receptors directly. The magnitude is therefore, considered to be low.

Sensitivity of Receptor

All species

The sensitivities of all fish and shellfish IEFs (shellfish, marine fish, and demersal species) presented in the assessment of this impact in the construction phase equally apply in the decommissioning phase (negligible to medium).

Significance of Effect

Shellfish

For king and queen scallop, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms

For European lobster, Norway lobster, and spiny lobster, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For all other shellfish IEFs, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

Marine Fish

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of most fish IEFs is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For sandeel, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For herring, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

Diadromous Fish

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be negligible. The effect will, therefore, be of **negligible adverse** significance, which is **not significant** in EIA terms. Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the significance of the effect on the freshwater pearl mussel IEF is also considered to be **negligible adverse.**

7.12.10 Long-term Subtidal Habitat Loss

7.12.10.1 Construction and Operation and Maintenance Phases

Potentially, long-term subtidal habitat loss could occur as a result of cable crossing protection of the newly installed subsea power cables. Additionally, rock placement associated with the construction will also result in long-term subtidal habitat loss. The installation of the new Douglas platform within the Proposed Development will also lead to long-term subtidal habitat loss around its foundations. In this impact assessment, long-term subtidal habitat loss does not represent complete removal of habitat, but rather a physical change in a sedimentary habitat and replacement with a hard, artificial substrate. In the MarESA, this is defined as the physical change to another seabed type. The effects of long-term subtidal habitat loss are assessed in this section, however the potential for colonisation of hard substrates by benthic species have been assessed in section 7.12.4. The construction and operation and maintenance phases are assessed in combination as the impacts of long-term subtidal habitat loss from the construction phase will persist into the operation and maintenance phase and will be continuous over the 25-year lifetime of the Proposed Development.

Magnitude of Impact

The construction of infrastructure associated with the Proposed Development will result in long-term subtidal habitat loss. The MDS accounts for up to 64,169 m^2 of long-term subtidal habitat loss due to installation of foundations and cable crossing protection in the construction phase (Table 7.22), which equates to 0.01% of the total Proposed Development overall. This will include the installation of 58,800 m^2 of cable crossing protection (Table 7.22). The foundations of the new Douglas platform may account for up to 169 m^2 of long-term subtidal habitat loss.

Offshore cable crossing protection will be required at up to 32 crossings, with each crossing up to 0.8 m in height and 7 m wide. The design of the cable crossing protection will have tapered profiles to reduce the impacts upon physical processes and seabed morphology. Cable crossing protection is the only cable protection measure proposed for the project, as the nature of the seabed sediment within the Proposed Development accommodates cable burial to the required depth. Therefore, no protection is required for buried cables, which are not anticipated to become exposed and require additional protection throughout the operation and maintenance phase. For example, cable crossings include one between the PoA to new Douglas platform cable and the Burbo Bank Offshore Wind Farm Extension Export Cable. Where practicable, the requirements will be compliant with the MCA navigation guidance which includes that there will be no more than a 5% reduction in water depth (referenced to CD) at any point along the cable route (MCA, 2021), without prior written approval from the Licensing Authority in consultation with the MCA. In compliance with the MCA navigation guidance, the maximum height of the shallowest cable crossing would be restricted to 5% of the water depth and therefore exhibit no change in wave climate, however, given the majority of cable crossings fall in waters deeper than 25 m (CD) they will change water depths to a much lesser degree than the 5% limit. With most of the cable crossing protection installed in waters of approximately 25 m (CD), which equates to 28 m mid tide, the introduction of 0.8 m height cable crossing protection represents less than a 3% change in water depth and therefore likely < 3% change to tidal currents. This change is approximately a quarter of the size as exhibited in the natural variation between peak spring and peak neap tidal flows. Given the small scale of cable crossing protection to be installed, and further measures such as tapered profiles and compliance with the MCA navigation guidance, it is not expected that impacts from cable crossings would be sufficient to disrupt offshore bank morphological processes, experience significant secondary scour or destabilise coastal features.

Long-term subtidal habitat loss will occur during the construction phase and be continuous and irreversible throughout the 25-year operations and maintenance phase. Some long-term subtidal habitat loss will persist indefinitely after the operations and maintenance phase, such as that caused by rock placement which will be left *in situ* following the lifetime of the Proposed Development.

Overall, the MDS for this impact presents some measurable, minor loss of and alteration to the affected areas of the seabed within the Proposed Development. As per the terms set out for defining the magnitude of impact (Table 7.27), the impact of long-term subtidal habitat loss is predicted to be of local spatial extent, long-term duration, continuous, and irreversible during the construction and operation and maintenance phases. It is predicted that the impact will affect fish and shellfish receptors directly. Therefore, the magnitude of impact is considered to be low.

Sensitivity of Receptor

Marine Fish

Species that rely on the presence of suitable sediment and subtidal habitats for their survival are typically more vulnerable to change, depending on the availability of said habitats within the wider geographical region. The loss of subtidal seabed habitats caused by installation of infrastructure in the Proposed Development will reduce the area of suitable habitat and available food resources for the fish and shellfish communities associated with them. However, this area represents a low percentage of the extensive subtidal habitats present within the regional fish and shellfish ecology study area.

As detailed in the baseline characterisation, the fish and shellfish ecology study area coincides with spawning and nursery habitats for a range of fish and shellfish species, with many overlapping with the Proposed Development in Liverpool Bay. Species with spawning and/or nursery grounds overlapping or in close proximity to the Proposed Development include anglerfish, cod, haddock, herring, horse mackerel, lemon sole, ling, mackerel, Norway lobster, plaice, sandeel, sole, sprat, spotted ray, spurdog, thornback ray, tope, and whiting

(Coull *et al.,* 1998; Ellis *et al.,* 2012; Aires *et al.,* 2014; Campanella and van der Kooij, 2021). Reference should be made to section 7.8.2.7 and volume 3, RPS Group (2024a) for full details and illustrative figures.

Sandeel and herring are the most vulnerable to long-term subtidal habitat loss due to their specific spawning requirements. As stated in section 7.12.9 (for 'Temporary Habitat Loss and/or Disturbance'), these species are demersal spawners (i.e. they lay their eggs on the seabed) and require specific sediment composition in order to spawn successfully. Some elasmobranchs, such as spotted ray and thornback ray, are also demersal spawners, as they lay egg cases in shallow nearshore nurseries. Low intensity nursery grounds for these species were identified as overlapping with the Proposed Development and being present throughout the Liverpool Bay area (Ellis *et al.,* 2012). However, given that these habitats are low intensity, extensive throughout the regional fish and shellfish ecology study area, and that they are predominantly coastal, these species are unlikely to be significantly impacted by long-term subtidal habitat loss. Furthermore, elasmobranchs, such as tope shark and spurdog, are unlikely to be affected by long-term subtidal habitat loss in terms of spawning and nursery habitats as these species give birth to live young and do not lay eggs.

There are known high and low intensity herring spawning grounds within the regional fish and shellfish ecology study area (see section 7.12.9 ('Temporary Habitat Loss and/or Disturbance')). However, the results of the PSA conducted on the sediment samples collected during the site-specific survey (Table 7.6) demonstrated that the Proposed Development is largely unsuitable spawning habitat for herring, with only one sampling site (1.3% of the total number of samples) classified as 'suitable' habitat under the Reach *et al.* (2013) methodology. There were four samples (5.3% of the total) classified as 'sub-prime' spawning habitat. In addition, there were no spawning grounds overlapping with the Proposed Development, with the closest identified around the Isle of Man, and with nationally significant spawning grounds located out with the regional fish and shellfish ecology study area entirely (Coull *et al.,* 1998). Overall, it is unlikely that herring populations will be largely affected by long-term subtidal habitat loss.

Sandeel also have specific habitat requirements during their life cycle. For example, they spend a significant portion of their adult life buried in the sediment and require specific sediment types for spawning. Long-term subtidal habitat loss within the Proposed Development could therefore impact sandeel species. As detailed in section 7.12.9 ('Temporary Habitat Loss and/or Disturbance'), the results of the PSA indicate patchy distribution of 'prime' and 'suitable' spawning habitat throughout the Proposed Development under the Latto *et al.* (2013) methodology. High and low intensity spawning and nursery grounds were identified as overlapping with the Proposed Development, within Liverpool Bay and throughout the regional fish and shellfish ecology study area (Ellis *et al.,* 2012; Campanella and van der Kooij, 2021). Given the extent of sandeel spawning habitat and of suitable sandy substrates for burial throughout the regional fish and shellfish ecology study area, it is unlikely that long-term subtidal habitat loss within the Proposed Development will affect sandeel at a population level. Furthermore, monitoring as the Horns Rev I offshore wind farm in Danish waters has indicated that the presence of operational wind farm infrastructure has not caused significant adverse long-term effects on sandeel populations (Stenberg *et al.,* 2011; van Deurs *et al.,* 2012). Similarly, the initial results of post-construction monitoring at the Beatrice Offshore Wind Farm in the North Sea have demonstrated no adverse effects on sandeel populations (BOWL, 2021a). This additional evidence from the offshore wind sector helps bolster the assessment of this impact, as the infrastructure associated with the Proposed Development will be similar, or even less detrimental, in terms of long-term subtidal habitat loss than that at offshore wind farms.

Overall, sandeel are deemed to be of high vulnerability, high recoverability, and of regional importance. The sensitivity of sandeel is therefore considered to be medium.

Herring are deemed to be of high vulnerability, medium recoverability, and of national importance, which would normally give a medium to high sensitivity. However, the sensitivity of herring to this impact is considered to be low, due to the limited suitable spawning sediments overlapping with the Proposed Development and the core herring spawning grounds being located well outside and to the north-east.

Overall, most marine fish IEFs in the regional fish and shellfish ecology study area (with the exception of herring and sandeel) are deemed to be of low vulnerability, high recoverability and local to national importance. The sensitivity of the receptor is therefore considered to be low.

Shellfish

The Proposed Development and regional fish and shellfish ecology study area overlaps spawning and fishing grounds of king and queen scallop. Long-term subtidal habitat loss has the potential to impact these grounds, however a decrease in fishing pressure has been suggested to increase maturity of king scallop populations, with no significant changes in resilience (Raoux *et al.,* 2019). Long-term subtidal habitat loss directly around the infrastructure only represents a very small proportion of habitat within the regional fish and shellfish ecology study area, and so are unlikely to cause significant impacts on wider scallop populations. This is supported by the MarESA (Marshall and Wilson, 2008) which concluded king scallop have a high recovery potential for substratum loss. At the time of writing, there is no MarESA available for queen scallop.

As described in section 7.12.9, Norway lobster, European lobster, and other larger crustaceans are classed as equilibrium species. The sensitivity of these IEFs is therefore higher than non-equilibrium species, as long-term subtidal habitat loss will prevent the original substrate recovering to baseline conditions. Norway lobster spawning and nursery grounds of undetermined intensity are present within the wider Liverpool Bay and the regional fish and shellfish ecology study area, but do not overlap with the Proposed Development (Coull *et al.,* 1998). Long-term subtidal habitat loss within the Proposed Development is therefore unlikely to affect these habitats. Furthermore, Norway lobster is concluded to have a high intolerance, moderate recoverability and overall moderate sensitivity to substratum loss according to the MarESA (Sabatini and Hill, 2008).

As detailed in section 7.12.9 (‘Temporary Habitat Loss and/or Disturbance’), adult spiny lobster inhabit rocky substrates with crevices and holes in which they hide, and nearshore vegetated waters as juveniles. Although the availability of these habitats are widespread throughout the regional fish and shellfish ecology study area, the spiny lobster shows high site fidelity, limited movement, and minimal homing range of 7 m^2 (Follesa *et al.,* 2009; Groenenveld *et al.,* 2013). Furthermore, spiny lobster has no resistance, very low resilience, and high sensitivity to physical change to another seabed type, according to the MarESA (Gibson-Hall *et al.,* 2020). However, aspects of the construction phase, such as rock placement which will be left *in situ* throughout and after the lifetime of the Proposed Development, may actually provide suitable habitat for spiny lobster if it occurs within its homing range.

The spawning and nursery habitats of various other shellfish IEFs identified in this assessment, such as brown crab and velvet swimming crab, are not available in the datasets utilised in this assessment (Coull *et al.,* 1998; Ellis *et al.,* 2012; Aires *et al.,* 2014; Campanella and van der Kooij, 2021). Given the wide range of available habitat throughout the regional fish and shellfish ecology study area, it is not likely that this impact will significantly impact these species.

Spiny lobster are deemed to be of high vulnerability, low recoverability, and of regional importance. The sensitivity of spiny lobster is therefore considered to be high.

Norway lobster and European lobster are deemed to be of high vulnerability, medium to high recoverability and of local importance. The sensitivity of these fish and shellfish IEFs is therefore considered to be medium.

King and queen scallop are deemed to be of medium vulnerability, high recoverability, and of local importance. The sensitivity of the receptor is therefore considered to be low.

All other shellfish IEFs are deemed to be of medium vulnerability, high recoverability, and of local importance. The sensitivity of the receptor is therefore considered to be low.

Diadromous Fish

As diadromous species are highly mobile and not reliant on demersal subtidal habitats for spawning or breeding, they are generally less susceptible to the impact of long-term subtidal habitat loss. Diadromous species are only likely to interact within the regional fish and shellfish ecology study area while migrating to and from rivers and freshwater habitats. Thus long-term subtidal habitat loss is unlikely to be of particular relevance for diadromous fish species as it will not affect migration.

Diadromous species may be indirectly affected due to impacted prey species, such as sandeel. However as outlined in the preceding paragraphs, the majority of marine fish species would be able to avoid long-term subtidal habitat loss effects due to their greater mobility and widespread nursery and spawning grounds and suitable habitats throughout the regional fish and shellfish ecology study area. For prey species with limited mobility, such as sandeel, long-term subtidal habitat loss is not likely to cause population level effects due to the presence of spawning habitats throughout the regional fish and shellfish ecology study areas.

Overall, diadromous fish species are deemed to be of low vulnerability, high recoverability and national to international importance. However, the relatively low footprint of long-term subtidal habitat loss within the Proposed Development in comparison to other projects (such as offshore wind farm construction) is likely to highly reduces the probability of either spatial or temporal overlap with many migrating diadromous species. As such, the sensitivity of the receptor is therefore considered to be negligible. Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the sensitivity of the freshwater pearl mussel IEF is also considered to be negligible.

Significance of Effect

Marine Fish

Overall, the magnitude of impact is deemed to be low, and the sensitivity of most marine fish IEFs in the regional fish and shellfish ecology study area (with the exception of herring and sandeel) is considered to be low. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

For sandeel, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

For herring, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Shellfish

For spiny lobster, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be high. As per Table 7.31, this yields a minor or moderate significance. The effect will be of **minor adverse** significance (which is **not significant** in EIA terms) due to the small proportion of the regional fish and shellfish ecology study area that may be impacted by long-term subtidal habitat loss.

For Norway lobster and European lobster, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

For king and queen scallop, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

For all other shellfish IEFs, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Diadromous Fish

Overall, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be negligible. Therefore, the effect will be of **negligible adverse** significance, which is **not significant** in EIA terms. Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the significance of the effect on the freshwater pearl mussel IEF is also considered to be **negligible adverse.**

7.12.10.2 Decommissioning Phase

Magnitude of Impact

All infrastructure is proposed to be removed in the decommissioning phase, including that left in place for reservoir modelling. However, there may be some rock placement left *in situ* during the decommissioning phase (Table 7.22). The impact is predicted to be of local spatial extent, long-term duration, continuous, and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore, considered to be low.

Sensitivity of Receptor

All species

The sensitivities of all fish and shellfish IEFs (shellfish, marine species, and demersal species) presented in the assessment of this impact in the construction phase equally apply in the operation and maintenance and decommissioning phases (negligible to high).

Significance of Effect

Marine Fish

Overall, the magnitude of impact is deemed to be low, and the sensitivity of most marine fish IEFs in the regional fish and shellfish ecology study area (with the exception of herring and sandeel) is considered to be low. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

For sandeel, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

For herring, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Shellfish

For spiny lobster, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be high. As per Table 7.31, this yields a minor or moderate significance. The effect will be of **minor adverse** significance (which is **not significant** in EIA terms) due to the small proportion of the regional fish and shellfish ecology study area that may be impacted by long-term subtidal habitat loss.

For Norway lobster and European lobster, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

For king and queen scallop, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

For all other shellfish IEFs, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Diadromous Fish

Overall, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be negligible. Therefore, the effect will be of **negligible adverse** significance, which is **not significant** in EIA terms. Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the significance of the effect on the freshwater pearl mussel IEF is also considered to be **negligible adverse.**

7.12.11 Underwater Noise Impacting Fish and Shellfish Receptors

7.12.11.1 Construction Phase

There is potential for disturbance and/or displacement to sensitive fish and shellfish species as a direct result of underwater noise resulting from construction activities, such as piling, UXO clearance, and vessel noise.

Magnitude of Impact

Injury and Behavioural Disturbance

The installation of the new Douglas Platform within the Proposed Development may lead to injury and/or disturbance to fish and shellfish species due to underwater noise during pile driving. The MDS considers the greatest effect from underwater noise on fish and shellfish IEFs, considering the greatest hammer energy for pin piling installation (Table 7.22). A maximum hammer energy of up to 3,000 kJ for pin piles was modelled.

The pin piling activities are represented by the installation of up to 4 pin-piled jacket foundations with two piles per leg (up to 8 piles total), with each pile installed via impact piling. Pin pile installation will take place over a period of up to 100 minutes per pile, with piling of up to two adjacent piles on the same platform at one time (Table 7.22). Therefore, there will be up to 800 minutes of piling over the entire piling phase, which equates to just under 13.5 hours. Piling was modelled for pin pile installation within the Proposed Development, see volume 3, RPS Group and Seiche (2024).

UXO clearance (including detonation) also has the capability to cause injury and/or disturbance to fish and shellfish IEFs. Clearance will be completed prior to the construction phase (pre-construction). The precise details and locations of potential UXOs is unknown at this time. For the purposes of this assessment, it has been assumed that the MDS will be clearance of UXO with a NEQ of 1,000 kg, cleared by either low order or high order techniques. Low order techniques are not always possible and are dependent upon the individual situations surrounding each UXO. UXOs may also be left *in situ* and micro-sited around. Detonation of UXO would represent a short term (i.e. seconds) increase in underwater noise (i.e. Sound Pressure Levels (SPL) and particle motion (the vibration of the water molecules which results in the pressure wave)) which will be elevated to levels which may result in injury or behavioural effects on fish and shellfish species. To understand the magnitude of underwater noise emissions from piling and UXO clearance during the construction phase, modelling has been undertaken considering the key parameters summarised above. Full details of the modelling undertaken are presented in volume 3, RPS Group and Seiche (2024). Underwater noise modelling included the use of 'soft start' mitigation to reduce the potential for injury effects (as set out in section 7.11). The implications of the modelling for fish and shellfish injury and behaviour are outlined in the following sensitivity section.

All other noise sources including cable installation and drilling are non-percussive and will result in much lower noise levels and therefore much smaller injury ranges (in most cases no injury is predicted) than those predicted for piling operations. For further information on other noise sources see volume 3, RPS Group and Seiche (2024). The pre-construction geophysical surveys, using any of the available techniques outlined in section 7.9.1, are likely to be very short term and spatially limited at any one time, reducing the magnitude of their likely impact on fish and shellfish receptors. They will also operate largely outside of the hearing frequencies of most fish and shellfish IEFs, thereby significantly reducing the potential for behavioural impacts to low or negligible levels. Only the injury ranges due to VSP have been modelled, with mortality and recoverable injury ranges very low (a maximum of 54 m from the source; see Table 7.46).

Overall, this impact is predicted to be of regional spatial extent, short-term duration (e.g. a maximum of eight piles with up to 100 minutes of piling each), intermittent throughout the two-year construction phase, and high reversibility (due to TTS and recoverable injury). It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be low.

Sensitivity of Receptor
Injury

All Species

The following sections apply to the fish and shellfish IEFs defined within this assessment, with a summary for each of these receptor groups provided below.

Underwater noise can potentially have an adverse impact on fish species, such as behavioural effects, and physical injury and/or mortality. Auditory injury can occur either as a Temporary Threshold Shift (TTS), where an animal's auditory system can recover, or Permanent Threshold Shift (PTS), where there is no hearing recovery in the animal. Recent peer reviewed guidelines have been published by the Acoustical Society of America (ASA) and provide directions and recommendations for setting criteria (including injury and behavioural criteria) for fish. The Sound Exposure Guidelines for Fishes and Sea Turtles (Popper *et al.,* 2014) are considered the most relevant and best available guidelines for impacts of underwater noise on fish species (see volume 3, RPS Group and Seiche (2024)). The Popper *et al.* (2014) guidelines broadly group fish into the following categories according to the presence or absence of a swim bladder and on the potential for that swim bladder to improve the hearing sensitivity and range of hearing:

- **Group 1:** Fishes lacking swim bladders (e.g. elasmobranchs, sandeel, flatfish, lampreys). These species are only sensitive to particle motion, not sound pressure and show sensitivity to only a narrow band of frequencies.
- **Group 2:** Fishes with a swim bladder but the swim bladder does not play a role in hearing (e.g. salmonids and some Scombridae). These species are considered more sensitive to particle motion than sound pressure and show sensitivity to only a narrow band of frequencies.
- **Group 3:** Fishes with swim bladders that are close, but not connected, to the ear (e.g. gadoids and eels). These fishes are sensitive to both particle motion and sound pressure and show a more extended frequency range than Groups 1 and 2, extending to about 500 Hz.
- **Group 4:** Fishes that have special structures mechanically linking the swim bladder to the ear (e.g. clupeids such as herring, sprat and shad). These fishes are sensitive primarily to sound pressure, although they also detect particle motion. These species have a wider frequency range, extending to several kHz and generally show higher sensitivity to sound pressure than fishes in Groups 1, 2 and 3.

Little is known about the effects of anthropogenic underwater noise upon crustacean species, as relatively few studies have been conducted on them (Morley *et al*., 2013; Williams *et al.,* 2015; Hawkins and Popper, 2016). Therefore, there are no injury criteria that have been developed for shellfish, however, these are expected to be less sensitive than fish species and therefore injury ranges of fish could be considered conservative estimates for shellfish IEFs (risk of behavioural effects are discussed further below for shellfish).

An assessment of the potential for injury/mortality and behavioural effects to be experienced by fish and shellfish IEFs with reference to the sensitivity criteria described above is presented below.

Table 7.40 summarises the fish injury criteria recommended for pile driving based on the Popper *et al*. (2014) guidelines, noting that dual criteria are adopted in these guidelines to account for the uncertainties associated with effects of underwater noise on fish. The recoverable injury threshold for eggs and larvae is categorised in relative terms as "high", "moderate" or "low" at three distances from the source: "near" (i.e. in the tens of metres), "intermediate" (i.e. in the hundreds of metres) or "far" (i.e. in the thousands of metres), as shown in Table 7.40. It is important to note that these criteria are qualitative rather than quantitative. Consequently, a source of noise of a particular type (e.g. piling) would result in the same predicted impact, no matter the level of noise produced or the propagation characteristics.

Table 7.40: Criteria for Onset of Injury to Fish due to Impulsive Piling (Source: Popper *et al*., 2014)

Group	Type of Animal	Parameter	Mortality and Potential for Mortal Injury Threshold	Recoverable Injury Threshold
1	Fish: no swim bladder (particle motion detect)	Sound Exposure Level (SEL), dB re 1 µPa^{2}s	>219	>216
		Peak, dB re 1 µPa	>213	>213
2	Fish: where swim bladder is not involved in hearing (particle motion detection)	SEL, dB re 1 µPa^{2}s	210	203
		Peak, dB re 1 µPa	>207	>207
3 and 4	Fish: where swim bladder is involved in hearing (primarily pressure detection)	SEL, dB re 1 µPa^{2}s	207	203
		Peak, dB re 1 µPa	>207	>207
Eggs and larvae	Eggs and larvae	SEL, dB re 1 µPa^{2}s	>210	(Near) Moderate (Intermediate) Low (Far) Low
		Peak, dB re 1 µPa	>207	

The full results of the underwater noise modelling are presented in volume 3, RPS Group and Seiche (2024). To inform this assessment, Table 7.41 displays the predicted injury ranges associated with impact piling, for Peak Sound Pressure Levels (SPL_{pk}). For SPL_{pk} when piling energy is at its maximum (i.e. 3,000 kJ), mortality and recoverable injury to fish may occur within a minimum of 184 m of the piling activity (smaller ranges for Group 1 fish species, higher ranges for Group 4 species; Table 7.41). The potential for mortality or mortal injury to fish eggs would also occur at distances of up to 314 m (Table 7.41), with a low to moderate risk of recoverable injury to eggs and larvae within the range of hundreds of metres (see Table 7.40 for qualitative criteria). It should be noted that these ranges are for the maximum hammer energy, and it is unlikely that injury will occur in this range due to the embedded mitigation of soft starts during piling operations (Table 7.32), which will allow some fish species to move away from the areas of highest noise levels, before they reach a level that would cause an injury. It is noted that some fish will likely benefit from the implementation of soft starts whereas others may not; fish and shellfish are a very broad group of organisms and the reality of the reaction to sound likely falls somewhere between those remaining static and those moving away. Soft starts will be implemented as standard to mitigate the impacts of underwater noise to marine mammals; therefore, it is considered appropriate to model piling operations with soft starts to ensure a realistic scenario, whether or not the different fish hearing groups experience a benefit. Stationary or passive eggs will likely be protected through scheduling of operational timing to avoid peak egg densities where possible, based on the baseline knowledge available, however the impact ranges modelled for eggs and larvae indicate that mortality ranges are relatively small when put into a population context and as such the necessity for operational scheduling is considered unlikely. The initial injury ranges for soft start initiation will be smaller than the maximum hammer energy ranges presented (i.e. with a minimum of 77 m, depending on the fish species considered; see Table 7.41).

As described, recoverable injury is used in this case to refer to tissue or physical damage or physiological effects that are recoverable but may reduce individual fitness levels. Table 7.41 also includes the predicted ranges of effect for recoverable injury for all fish groups which may occur as a result of peak and initial hammer strike during piling. Recoverable injury was modelled to occur to a maximum range of 314 m from maximum hammer energy for all hearing groups except Group 1 fish. For Group 1 fish, it was modelled to occur at a range of 184 m during maximum hammer energy.

Table 7.41: Summary Of Peak Pressure Injury Ranges For Fish Due To The Phase Of Impact Piling Resulting In The SPL_{pk}, And Due To The First Hammer Strike

Hearing Group	Response	Threshold (SPL_{pk} dB re 1 µPa)	Range (m)	
			Max Peak Experience	First Hammer strike
Group 1 Fish: no swim bladder (particle motion detected)	Mortality	213	184	77
	Recoverable injury	213	184	77
Group 2 Fish: where swim bladder is not involved in hearing (particle motion detection)	Mortality	207	314	131
	Recoverable injury	207	314	131
Groups 3 and 4 Fish: where swim bladder is involved in hearing (primarily pressure detection)	Mortality	207	314	131
	Recoverable injury	207	314	131
Eggs and larvae	Mortality	207	314	131

The results of the noise modelling for fish hearing groups are shown in Table 7.42, based on the Cumulative Sound Exposure Level (SEL_{cum}) thresholds for fleeing and static fish. Two results are shown for fleeing Group 1 fish, one based on a swim speed of 0.5 m/s, and another (in square brackets) showing the range for basking shark using a higher swim speed of 1 m/s. The swimming speed for Groups 2 to 4 fish was also modelled at 0.5 m/s. Fish eggs and larvae have been assumed to be static, resulting in a different impact range to reach the same numerical SEL_{cum} criteria. Under these conditions, the threshold for mortality was 4 m for Group 3 and 4 fish and 387 m for eggs and larvae, and not exceeded for the other hearing groups. For fish modelled as static receptors, the threshold for mortality increased to 125 m for Group 1 fish, 387 m for Group 2, and 561 m for Groups 3 and 4 (Table 7.42).

As described, TTS is a temporary reduction in hearing sensitivity caused by exposure to intense sound. Normal hearing ability returns following cessation of the noise causing TTS, though the recovery period is variable, during which fish may have decreased fitness due to a reduced ability to communicate, detect predators or prey, and/or assess their environment. Table 7.42 also includes the predicted ranges of effect for TTS for all fish groups against the SEL_{cum} thresholds as both moving and static receptors. The TTS range for all fish hearing groups was modelled to occur at a maximum of 5,500 m for moving fish, and 3,820 m for moving basking shark. For all fish groups modelled as static receptors, the TTS range was 7,400 m (Table 7.42).

Table 7.42: Injury Ranges For Single Impact Pile Driving Based On The Cumulative SEL Metric for Fleeing and Static Fish (N/E = Threshold Not Exceeded)

Hearing Group	Response	Threshold (SEL_{cum} dB re 1 µPa²s)	Range: Fleeing Fish (m)	Range: Static Fish (m)
Group 1 Fish: no swim bladder (particle motion detected) – [basking shark ranges shown in square brackets]	Mortality	219	N/E [N/E]	125
	Recoverable injury	216	N/E [N/E]	183
	TTS	186	5,500 [3,820]	7,400
Group 2 Fish: where swim bladder is not involved in hearing (particle motion detection)	Mortality	210	N/E	387
	Recoverable injury	203	9	925
	TTS	186	5,500	7,400
	Mortality	207	4	561

Hearing Group	Response	Threshold (SEL_{cum} dB re 1 μPa²s)	Range: Fleeing Fish (m)	Range: Static Fish (m)
Groups 3 and 4 Fish: where swim bladder is involved in hearing (primarily pressure detection)	Recoverable injury	203	9	925
	TTS	186	5,500	7,400
Eggs and larvae	Mortality	210	387	

As per the MDS, there is a possibility that multiple pin piles will need to be installed in a single 24-hour period. The potential SEL_{cum} injury ranges for fish hearing groups due to impact piling of pin piles are modelled as following the same piling schedule, but with continuous installation for 24 hours, which is an overestimation as the piling vessel will need to reposition. It is assumed that the fish will swim away from the pile installation and not return to the area within the 24-hour period. As the piling schedule, and therefore the hammer energies, remain unchanged, the injury ranges due to the peak metric will be the same as those for the single pile case. The results for consecutive piling scenarios based on the SEL_{cum} threshold are shown in Table 7.43 for both moving and static fish. Under these conditions for moving fish, the threshold for mortality was 4 m for Group 3 and 4 fish and 625 m for eggs and larvae, and not exceeded for the other hearing groups. For fish modelled as static receptors, the mortality ranges increased to 204 m for Group 1 fish, 625 m for Group 2, and 910 m for Group 3 and 4 (Table 7.43).

Although it is highly unlikely that fish will remain static in the water column, consecutive pin pile installation based on the SEL_{cum} threshold for static fish represents the worst case scenario based on the piling parameters provided in the MDS. Figure 7.5 to Figure 7.7 present the noise contours for the four fish hearing groups modelled as static receptors. For Group 1 and 2 fish, the mortality, recoverable injury, and TTS ranges are small in the context of both the Proposed Development and the wider Irish Sea as a whole (Figure 7.5). Figure 7.6 and Figure 7.7 show the noise contours for Group 3 and 4 fish overlaid on the spawning and nursery grounds for herring and cod, respectively. As illustrated in Figure 7.6, there is no potential for overlap between any of the noise contours and the herring spawning grounds, which are situated around the Isle of Man. For cod, the mortality noise contour could overlap with up to 0.01% of the total area of defined high intensity spawning grounds (Ellis *et al.,* 2012) (Figure 7.7). The contours for recoverable injury and TTS could overlap with up to 0.04% and 3.52%, respectively, of the total high intensity cod spawning area. Therefore, even in the unlikely case that fish will remain static in the water column during consecutive pin piling, the ranges for mortality, recoverable injury, and TTS remain low for all hearing groups, and there will be no to minimal overlap with defined spawning grounds for cod and herring.

When consecutive piling is considered and modelled based upon the SEL_{cum} metric, the TTS ranges for fish modelled as fleeing receptors have a maximum range of 8,360 m (5,740 m for basking shark). These ranges are slightly higher than the impacts of the single piling (Table 7.42), however they are unlikely to significantly increase the level of impact given their reversible nature after cessation of the noise source. For fish modelled as static receptors, the TTS range was 11,640 m for all hearing groups (Table 7.43).

Table 7.43: Injury Ranges For Consecutive Pin Pile Installation Based On The Cumulative SEL Metric For Fleeing and Static Fish (N/E = Threshold Not Exceeded)

Hearing Group	Response	Threshold (SEL dB re 1 μPa²s)	Range: Fleeing Fish (m)	Range: Static Fish (m)
Group 1 Fish: no swim bladder (particle motion detected) – [basking shark ranges shown in square brackets]	Mortality	219	N/E [N/E]	204
	Recoverable injury	216	N/E [N/E]	294
	TTS	186	8,360 [5,740]	11,640
	Mortality	210	N/E	625

Hearing Group	Response	Threshold (SEL dB re 1 µPa^{2}s)	Range: Fleeing Fish (m)	Range: Static Fish (m)
Group 2 Fish: where swim bladder is not involved in hearing (particle motion detection)	Recoverable injury	203	10	1,490
	TTS	186	8,360	11,640
Groups 3 and 4 Fish: where swim bladder is involved in hearing (primarily pressure detection)	Mortality	207	4	910
	Recoverable injury	203	10	1,490
	TTS	186	8,360	11,640
Eggs and larvae (static)	Mortality	210	625	

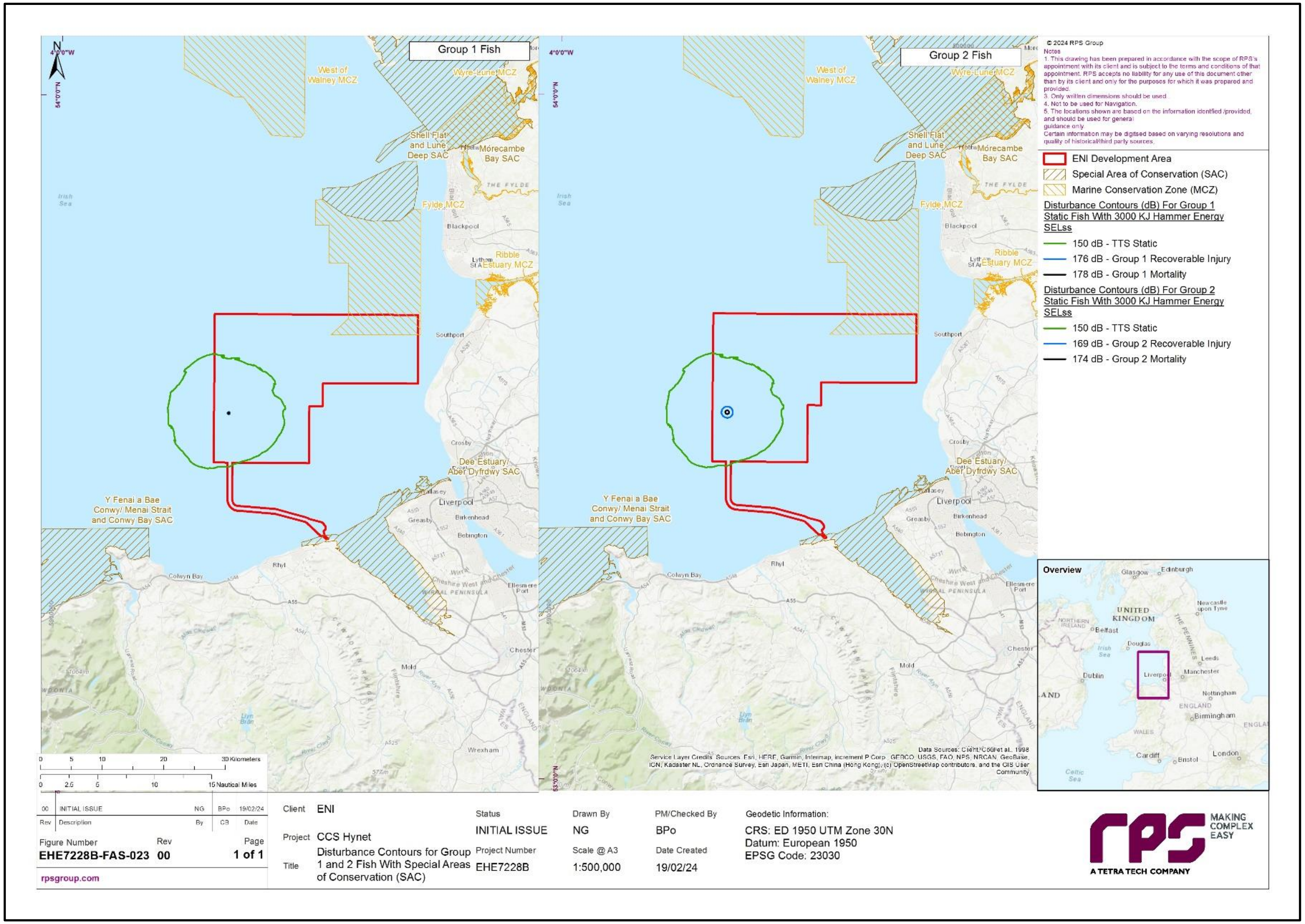

Figure 7.5: TTS, Recoverable Injury, and Mortality Noise Contours (dB) for Group 1 and 2 Fish Exposed to Consecutive Pin Pile Installation when Modelled as Static Receptors

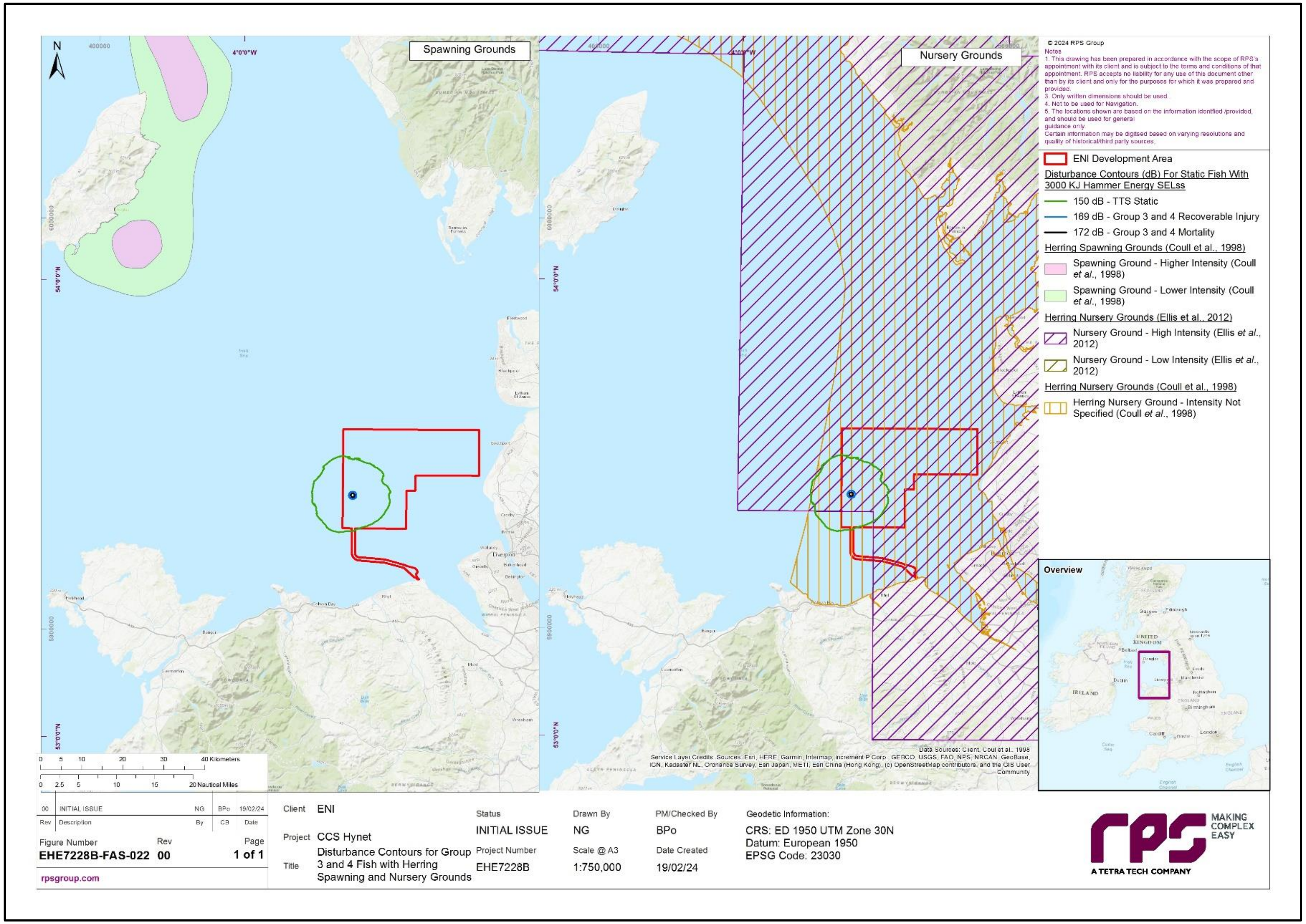

Figure 7.6: TTS, Recoverable Injury, and Mortality Noise Contours (dB) for Herring Exposed to Consecutive Pin Pile Installation when Modelled as Static Receptors

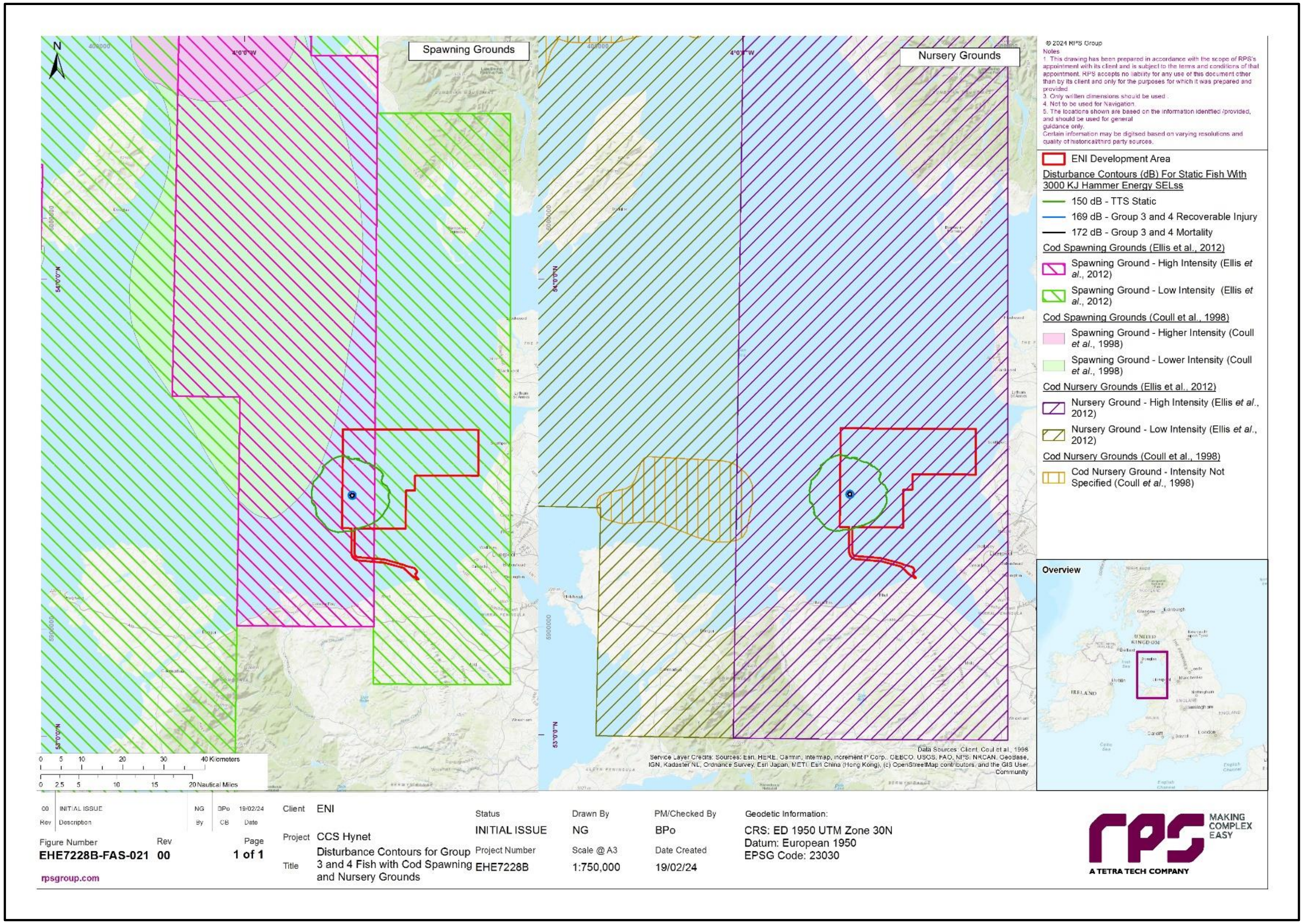

Figure 7.7: TTS, Recoverable Injury, and Mortality Noise Contours (dB) for Cod Exposed to Consecutive Pin Pile Installation when Modelled as Static Receptors

Underwater noise modelling has also been completed for UXO clearance and detonation. Modelling was undertaken for a range of orders of detonation, from a realistic worse case high order detonation to low order detonations (e.g. deflagration and clearance shots) to be used as mitigation to minimise noise levels. Table 7.44 details the injury ranges for fish of all groups in relation to various orders of detonation. For the purposes of this assessment, it has been assumed that the MDS will be clearance of UXO with a NEQ of 1,000 kg cleared by either low order or high order techniques. The maximum PTS ranges for UXO disposal were 985 m and 590 m for the high order detonation of a 907 kg UXO.

Table 7.44: Injury Ranges For All Fish Groups Relating To Various Orders Of UXO Detonation

Detonation Size (kg)	PTS Range SPL_{pk} (m)	
	Fish Lower Range*	Fish Higher Range*
0.08 kg low-order donor charge	44	27
0.5 kg clearing shot	81	49
2 x 0.75 kg low-yield charge	117	70
4 x 0.75 kg low-yield charge	147	88
1.2 kg donor charge for high-order disposal	108	65
3.5 km donor blast-fragmentation charge for high-order disposal	154	93
25 kg high order explosion	297	178
130 kg high order explosion	514	309
907 kg high order explosion	985	590

* The lower range and upper range refer to those provided within volume 3, RPS Group and Seiche (2024) of the ES, based upon the Popper et al. (2014) guidance for explosions, where thresholds are quoted as ranges. Values presented herein reflect those associated with the extremes of the ranges presented within volume 3, RPS Group and Seiche (2024).

Recoverable injury and TTS ranges were also modelled for Group 3 and 4 fish for various other underwater noise sources, such as cable trenching, cable laying, use of jack-up rigs, and vessels (Table 7.45). The threshold for recoverable injury and TTS was not exceeded for jack-up rigs, and low ranges were reported for the other activities. For example, the maximum range reported was a TTS range of 68 m for cable laying activities. Group 3 and 4 fish are the most sensitive to underwater noise, and as the modelled injury ranges were low, impacts to Group 1 and 2 fish are likely to be minimal. It should be noted that fish would need to be exposed within these impact ranges for a period of 48 hours continuously in the case of recoverable injury and 12 hours continuously in the case of TTS for the effect to occur. It is therefore considered that these ranges are highly precautionary, and injury is unlikely to occur in reality.

Table 7.45: Estimated Recoverable Injury And TTS Ranges For Group 3 And 4 Fish Due To Other Noise Sources (N/E = Threshold Not Exceeded)

Underwater Noise Source	Range (m)	
	Recoverable Injury 170 dB rms for 48 hrs	TTS 158 dB rms for 12 hrs
Cable trenching/cutting	<10	45
Cable laying	15	68
Jack-up rig	N/E	N/E
Anchor handling vessel	<10	19

Underwater Noise Source	Range (m)	
	Recoverable Injury 170 dB rms for 48 hrs	**TTS 158 dB rms for 12 hrs**
Main installation vessel, construction vessel	16	66

Finally, the mortality and recoverable injury ranges due to VSP are presented in Table 7.46, based on the impulsive noise thresholds set out in Popper *et al.* (2014). Both mortality and recoverable injury ranges were low for all hearing groups (i.e. <55 m).

Table 7.46: Summary Of Peak Pressure Injury Ranges For Fish Due To VSP

Hearing Group	Response	Threshold (SPL_{pk}, dB re 1 µPa)	Range (m)
Group 1 Fish: No swim bladder (particle motion detection)	Mortality	213	26
	Recoverable injury	213	26
Group 2 Fish: Swim bladder not involved in hearing (particle motion detection)	Mortality	207	54
	Recoverable injury	207	54
Group 3 and 4 Fish: Swim bladder involved in hearing (primarily pressure detection)	Mortality	207	54
	Recoverable injury	207	54
Fish eggs and larvae	Mortality	207	54

Behavioural Disturbance

Marine Species

Fish species responses to underwater noise related to construction activities include a wide variety of behaviours, including startle (C-turn) responses, strong avoidance behaviour, changes in swimming or schooling behaviour, and/or changes of position in the water column. The Popper *et al.* (2014) guidelines provide qualitative behavioural criteria for fish from a range of noise sources. These categorise the risks of effects in relative terms as “high”, “moderate” or “low” at three distances from the source: “near” (i.e. tens of metres), “intermediate” (i.e. hundreds of metres) or “far” (i.e. thousands of metres).

Any potential short-term noise effects on fish may not necessarily translate to population scale effect, with a relatively low amount of information available about *in situ* behavioural effects. A review by Carroll et *al.* (2017) showed that noise impact experiments can lead to highly variable results in caged fish. Therefore, many laboratory experiments may be more useful for providing evidence of potential physiological impacts than behavioural or population-level effects. Furthermore, there is no evidence base that is sufficiently robust to propose quantitative criteria for behavioural effects currently available, as the response between and within species to underwater noise is so variable (Popper *et al.,* 2014; Hawkins and Popper, 2016). As such the qualitative criteria for the four fish groups outlined in Table 7.47 are proposed, which propose risk ratings for behavioural effects and masking in the near field (i.e. tens of metres), intermediate field (hundreds of metres) and far field (thousands of metres).

Table 7.47: Potential Risk For The Onset Of Behavioural Effects In Fish (Source: Popper *et al.,* 2014)

Group	Type of Animal	Relative Risk of Behavioural Effects		
		Impulsive Piling	Explosives	Non-Impulsive Sound
1	Fish: no swim bladder (particle motion detect)	(Near) High (Intermediate) Moderate (Far) Low	(Near) High (Intermediate) Moderate (Far) Low	(Near) Moderate (Intermediate) Moderate (Far) Low
2	Fish: where swim bladder is not involved in hearing (particle motion detection)	(Near) High (Intermediate) Moderate (Far) Low	(Near) High (Intermediate) High (Far) Low	(Near) Moderate (Intermediate) Moderate (Far) Low
3 and 4	Fish: where swim bladder is involved in hearing (primarily pressure detection)	(Near) High (Intermediate) High (Far) Moderate	(Near) High (Intermediate) High (Far) Low	(Near) High (Intermediate) Moderate (Far) Low
Eggs and larvae	Eggs and larvae	(Near) Moderate (Intermediate) Low (Far) Low	(Near) High (Intermediate) Low (Far) Low	(Near) Moderate (Intermediate) Moderate (Far) Low

Group 1 fish (e.g. flatfish, elasmobranchs, sandeel, and lampreys), and Group 2 fish (e.g. salmonids) are less sensitive to sound pressure, with these species typically detecting sound in the environment through particle motion. However, sensitivity to particle motion in fish is also more likely to be important for behavioural responses rather than injury (Mueller-Blenkle *et al.,* 2010; Hawkins *et al*., 2014). Group 3 (including gadoids such as cod and whiting) and Group 4 fish (herring, sprat, and shad) are more sensitive to the sound pressure component of underwater noise and, as indicated in Table 7.47, the risk of behavioural effects in the intermediate and far fields are therefore greater for these species.

As discussed above, in terms of physical effects, injury up to and including mortality for many marine and diadromous fish species is to be expected for individuals within very close proximity to piling operations. However, this is unlikely to result in significant mortality due to soft start procedures allowing individuals in close proximity to flee the area, prior to maximum hammer energy levels which may cause injury to greater ranges.

Group 1 elasmobranch species do not possess a swim bladder, and thus will be most impacted by particle motion. There is evidence of startle and fleeing responses of elasmobranchs to piling (minimum of 20 to 30 dB re 1 µPa above background conditions) due to increased particle motion (Casper *et al.,* 2012). It is likely that the embedded soft start procedure will allow any individuals near the construction activities to flee the immediate area. This suggests a low vulnerability to this impact. In terms of recoverability, the construction activities will be temporary, and once they have ceased, elasmobranch species have been observed to gather at operational offshore built infrastructure (Stanley and Wilson, 1991). This indicates the potential for high recoverability after the end of the initial construction activities.

A number of studies have examined the behavioural effects of the sound pressure component of impulsive noise (including piling operations and seismic airgun surveys) on fish species. Mueller-Blenkle *et al.* (2010) measured behavioural responses of cod and sole to sounds representative of those produced during marine piling and recorded considerable variation across individuals. This variation occurred depending on the age, sex, and condition of the fish, as well as the possible effects of confinement in cages on the overall stress levels. The authors concluded that it was not possible to find an obvious relationship between the level of exposure and the extent of the behavioural response in these species, although an observable behavioural response was reported at 140 to 161 dB re 1 µPa (SPL_{pk}) for cod and 144 to 156 dB re 1 µPa (SPL_{pk}) for sole (Mueller-Blenkle *et al.,* 2010). However, these thresholds should not be interpreted as the level at which an avoidance reaction will be elicited, as the study was not able to show this. Recently, modelling on Group 3 cod has shown an expected decrease in population growth rates in response to loud piling noise due to a decrease in food intake and increase in energy expenditure (Soudijn *et al*., 2020). However, it is likely that cod fecundity is underestimated in this model, and this, combined with the short-term nature of the noise impact from piling (i.e. a maximum of eight piles with up to 100 minutes of piling each), suggests that long-term population-level effects are unlikely to occur within the regional fish and shellfish ecology study area.

Pearson *et al.* (1992) investigated the effects of geophysical survey noise on caged Group 2 rockfish *Sebastes* spp. The authors observed a startle (C-turn) response at peak pressure levels beginning around 200 dB re 1 µPa, although this was less common with larger-bodied individuals. Similarly, McCauley *et al*. (2000) exposed various fish species in large cages to seismic airgun noise and assessed behaviour, physiological and pathological changes. In general, they observed a behavioural response to move to the bottom of the cage during periods of high level exposure (greater than rms levels of around 156 to 161 dB re 1 µPa; approximately equivalent to SPL_{pk} levels of around 168 to 173 dB re 1 µPa). This was followed by a return to baseline behaviour within 30 minutes of cessation of airgun activities, with no significant long-term physiological impacts noted, except for likely reversible hearing hair cell damage at shore range (McCauley *et al.,* 2000). The behaviour of moving towards the bottom of the water column was also observed *in situ* by Fewtrell and McCauley (2012), who noted significant alarm responses in all investigated species at noise levels exceeding 147 to 151 dB re 1 µPa (SEL) in every case. These responses were also temporary and returned to baseline behavioural conditions shortly thereafter (Fewtrell and McCauley, 2012).

As outlined previously, the thresholds for behavioural effect proposed by Popper *et al*. (2014) are qualitative, however in order to provide a more quantitative estimation of the range at which behavioural effects may occur, noise modelling was undertaken for SPL (rms) within the Proposed Development. The disturbance range for fish was calculated as 150 dB re 1 µPa (rms) contour is 33 km for impact pile driving (volume 3, RPS Group and Seiche (2024)). Based on the studies summarised above, it can be expected that behavioural effects could be expected within the 150 dB contours, noting that this is likely to be conservative given McCauley *et al*. (2000) noted behavioural effects on a range of species at approximately 168 dB re 1 µPa. For Group 1 and Group 2 fish species this is likely to be highly precautionary as they are known to be less sensitive to underwater noise. Further, the noise contours are for the greatest hammer energy for impact piling, and therefore in most scenarios this hammer energy will not be used, and therefore smaller contours would be expected. These ranges and the results discussed below broadly align with qualitative thresholds for behavioural effects on fish as set out in Table 7.47, with moderate risk of behavioural effects in the range of hundreds of metres to thousands of metres from the piling activity, depending on the species.

For the sandeel IEF (Group 1), modelling has indicated a possible temporary reduction in sandeel populations in areas affected by piling noise (Serpetti *et al*., 2021). However, initial outputs of post-construction monitoring at the Beatrice OWF (BOWL, 2021a) concluded there was no evidence of long-term adverse effects on sandeel populations due to construction over the six-year period, demonstrating that any potential effect of piling on sandeel is temporary and reversible. Cod spawning behaviour was also monitored pre and post construction (which included piling operations) at the Beatrice OWF (BOWL, 2021b). Similarly, there was no change in the presence of cod spawning between pre and post construction (although spawning intensity was found to be low across both surveys). From these studies, it can be inferred that noise impacts associated with installation of an OWF development are temporary and that fish communities (specifically cod and sandeel in the case of Beatrice OWF) show a high degree of recoverability following construction. Given the nature of the Proposed Development, underwater noise levels generated during construction (particularly piling) are considerably lower than that an OWF development. Further, the short term and intermittent nature of piling activities associated with the Proposed Development, compared to the spawning period of cod (January-April, peaking in February and March), will likely limit the impact on cod spawning or populations significantly.

As a Group 4 species, herring are known to be particularly sensitive to underwater noise. Specifically, herring possess ancillary hearing structures which involve gas ducts extending into the skull, allowing detection of extremely high frequency sounds (Mann *et al.,* 2001). As they have specific benthic spawning habitat requirements, they are also more vulnerable to disturbance than most fish, which tend to be pelagic spawners. For herring, the core spawning grounds are located southeast and north-east of the Isle of Man, with seabed sediments within the Proposed Development shown to be largely unsuitable for herring spawning (see section 7.8.2.7 and volume 3, RPS Group and Seiche (2024)). Significant but reversible diving reactions have been noted for sounds up to 168 dB re 1 µPa (SPL) (Doksaeter *et al.,* 2012; based on sonar noise sources), which is above the 150 dB threshold suggested above.

Aside from the fish and shellfish IEFs mentioned above, other marine fish species utilise the regional fish and shellfish ecology study area for spawning or nursery purposes. However, the relative proportion of these habitats affected by piling operations at any one time will be small in the context of the wider habitat available, and, as outlined above, piling operations will be temporary and intermittent throughout the construction phase. It should also be noted that behavioural responses to underwater noise are highly dependent on a number of factors such as species, sex, age, condition, life history stage, as well as other stressors which it is or has been exposed to. Another important factor is the motivation for individuals to be in a particular area, such as spawning, migration, or foraging. For example, a study found a slight but **not significant** reduction in swimming speed among feeding herring schools exposed to impulsive seismic air gun surveys (Peña *et al*., 2013). This suggests that feeding herring were not displaying avoidance responses to seismic noise sources, even when the vessel came into close proximity to them. This indicated an awareness of and response to impulsive anthropogenic noise, which would be expected in response to piling, but not a significant response when fish were highly motivated (in this case during feeding). It may therefore be expected that increased tolerance (and decreased sensitivity) to underwater noise may occur for some fish and shellfish IEFs during key life history stages, such as spawning or migration.

Furthermore, potential effects on fish eggs and larvae are anticipated to be limited, with only low level of impacts which are limited in extent (relative to the wide-ranging nature of spawning nursery habitats) and high recoverability (Bolle *et al*., 2016). Fish larvae tend to have low sensitivity to impulsive piling noise up to 210 dB re 1 µPa (SPL) (Bolle *et al.,* 2016). Although there is evidence of underwater noise significantly interfering with demersal larval settlement (Stanley *et al.,* 2012), no significant mortality was observed for herring larvae compared to control groups after exposure to piling noise up to 216 dB re 1 µPa SEL_{cum} (Bolle *et al.,* 2014).

Overall, for the impact of underwater noise, most marine fish IEFs, including elasmobranchs are deemed to be of low vulnerability, high recoverability, and local to international importance. The sensitivity of these receptors is therefore, considered to be low.

Sprat (Group 4) are deemed to be of medium vulnerability, high recoverability, and regional importance. The sensitivity of these receptors is therefore, considered to be medium.

Cod (Group 3) and herring (Group 4) are deemed to be of high vulnerability, high recoverability, and national importance. The sensitivity of the receptor is therefore, considered to be high.

Diadromous Species

As discussed above for marine species, diadromous fish species may experience injury or mortality within close proximity to piling operations. However, due to the highly mobile nature of diadromous fish species and that they only tend to pass through the environment within the regional fish and shellfish ecology study area during migration, it is unlikely to result in significant mortality of diadromous species. The use of soft start piling procedures (see section 7.11), allowing individuals in close proximity to piling to flee the ensonified area, further reduces the likelihood of injury and mortality on diadromous species.

Similar to marine fish, diadromous species may experience behavioural effects in response to piling noise, such as a startle response, disruption of feeding, or avoidance of an area. These responses may occur within a range of hundreds of metres to several kilometres from piling operations, depending on the species and their relative sensitivities to underwater noise:

- **Group 1**: sea lamprey and river lamprey.
- **Group 2**: Atlantic salmon and sea trout.
- **Group 3**: European eel and smelt.
- **Group 4**: Allis shad and twaite shad.

Lampreys are known to have relatively simple ear structures (Popper and Hoxter, 1987). They have been recorded to demonstrate very few responses to auditory stimuli overall (Popper, 2005), except a slight increase in swim speed and decrease in resting behaviour when exposed to continuous low frequency sound of 50 to 200 Hz (Mickle *et al.,* 2019). This suggests that they have a low vulnerability to underwater noise impacts overall. The noise modelling outputs discussed in the previous section indicated that piling related underwater noise would result in behavioural responses (e.g. as indicated by the 150 dB re 1 µPa (rms) contours; which is likely to be highly precautionary for lamprey) in the vicinity of the Proposed Development. Further, the noise impacts will be short-term and intermittent in nature during the construction phase (i.e. a maximum of eight piles with up to 100 minutes of piling each). As such, there is negligible risk of disruption to migration of lamprey.

Smelt have the potential to be impacted by noise, possibly in terms of disruption to migration to their preferred spawning habitats, such as in the Ribble Estuary MCZ and Wyre Lune MCZ. Evidence from a port noise study indicates that smelt are able to habituate to repeated noise impacts with no significant loss of ecological function (Jarv *et al.,* 2015). As the piling noise has little overlap with these coastal habitats, and will be short term and intermittent, smelt are likely to have low vulnerability and high recoverability to this impact and are therefore at negligible risk to this impact.

Physiological or behavioural responses were not observed in Atlantic salmon when subjected to noise similar to that of piling (Harding *et al.,* 2016). However, the noise levels tested were estimated at <160 dB re 1 µPa (rms), below the level at which injury or behavioural disturbance would be expected for Atlantic salmon. Nedwell *et al.* (2006) found no significant behavioural response from piling activities in sea trout (slightly less sensitive than Atlantic salmon), with modelling suggesting a similar response in both species. Physical impacts on migrating salmonids have been noted from piling producing sounds of 218 dB re 1 µPa (Bagocius, 2015), although at these levels, avoidance reactions would be anticipating, thus avoiding injury effects. The underwater noise modelling outputs (including noise contours) indicate that piling related underwater noise would result in behavioural responses (e.g. as indicated by the 150 dB re 1 µPa (rms) contours; which is likely to be precautionary for Atlantic salmon and sea trout) in the vicinity of the Proposed Development. Further, the noise impacts will be short-term and intermittent in nature during the construction phase (i.e. a maximum of eight piles with up to 100 minutes of piling each). As such, there is negligible risk of disruption to migration of these species. The low risk of effects on migration of Atlantic salmon and sea trout extends to the freshwater pearl mussel, as part of its life stage is reliant on diadromous fish species including Atlantic salmon and sea trout.

European eel (Group 3) is known to have a wide hearing range (Jerko *et al*., 1989). Behavioural responses observed include startle responses (Sand *et al.,* 2000) and more than a doubling of short-term migration distances close to sources of infrasound deterrents (Piper *et al*., 2019). However, these impacts were noted on juveniles migrating towards the sea, with there being no significant impact expected on juveniles as a result. Eels are also known to be more vulnerable to predation due to difficulty in detecting predators compared to control groups when exposed to simulated underwater noise (Simpson *et al.,* 2014), with recovery noted when the noise source was removed. As noted above, the noise modelling outputs (including noise contours) discussed in the previous sections indicated that piling related underwater noise would result in behavioural responses (e.g. as indicated by the 150 dB re 1 µPa (rms) contours) in the vicinity of the Proposed Development. Further, given the short-term and intermittent nature of any construction activities (i.e. a maximum of eight piles with up to 100 minutes of piling each) alongside the relatively short migration window of eels through the affected zones of the regional fish and shellfish e ecology study area, it is predicted that any impact to European eel will be minor.

Allis and twaite shad, (Group 4 species, like herring), are known to be sensitive to underwater noise, particularly ultrasonic tones. They are able to detect ultrasonic tones of 171 dB re 1 µPa (SPL) at a distance of up to 187 m (Mann *et al*., 1998). In terms of behavioural responses to underwater noise, evasive behaviours were commonly seen in direct response to ultrasonic stimuli (Platcha and Popper, 2003). Due to this sensitivity and evasiveness, it is unlikely that shad species will remain in the vicinity of construction activities, which will utilise the soft-start procedure, for a long enough period to cause significant harm, with this representing a low vulnerability to this impact. With regard to disruption to migration, as noted above, noise modelling outputs (including noise contours) discussed in the previous sections indicated that piling related underwater noise would result in behavioural responses (e.g. as indicated by the 150 dB re 1 μPa (rms) contours) in the vicinity of the Proposed Development. It should also be noted that the ranges presented above are for the maximum hammer energy and all other scenarios (i.e. lower hammer energies) would result in considerably smaller noise impact ranges. Further, the noise impacts will be short-term and intermittent in nature during the construction phase (i.e. a maximum of eight piles with up to 100 minutes of piling each) and shad would only have the potential be affected if piling occurs during the migratory period for these species, which occurs over spring up until June, and peaks in April and May (Acolas *et al.,* 2004). As such, there is low risk of disruption to migration of these species.

Overall, to the impact of underwater noise, most diadromous fish species IEFs are deemed to be of low vulnerability, high recoverability and national to international importance. The sensitivity of these receptors is therefore, considered to be low.

As Group 4 species, Allis shad and twaite shad are deemed to be of high vulnerability, high recoverability, and national importance. The sensitivity of these receptors is therefore considered to be high.

Shellfish Species

As the impact of underwater noise on marine invertebrates is largely unknown, there are no standardised exposure criteria (Hawkins *et al.,* 2014). Studies on marine invertebrates have illustrated a general sensitivity to substrate borne vibration (Roberts *et al*., 2016). Aquatic decapod crustaceans have been shown to possess a number of receptor types potentially capable of responding to the particle motion component of underwater noise and ground borne vibration (Popper *et al.,* 2001). Noise is detected more as particle motion through stimulation of sensory setae within statoliths (Carroll *et al*., 2017), although other mechanoreceptor systems are present, which could be capable of detecting vibration. Generally, there is evidence of crustaceans being sensitive to sounds of frequency <1 kHz, however this is a broad statement for shellfish as a whole (Budelmann, 1992). It has also been reported that the sound wave signature of piling noise can travel considerable distances through sediments (Hawkins and Popper, 2016), with implications for demersal and sediment dwelling shellfish species (e.g. Norway lobster) in close proximity to piling activities.

A recent review by Scott *et al.* (2020) summaries the existing published literature on the influence of anthropogenic noise and vibration and on crustaceans, including some shellfish IEFs identified in this assessment. The authors concluded that some literature sources identified behavioural and physiology effects on crustaceans from anthropogenic noise, however, there were several that showed no effect. This review notes that no effect or influence of noise or vibrations has been reported on mortality rates or fisheries catch rates or yields so far for shellfish. In addition, no studies have indicated a direct effect of anthropogenic noise on mortality, whether that be immediate or delayed effects (Scott *et al.,* 2020).

Of the shellfish IEFs identified in this assessment, decapod crustaceans (e.g. brown crab, European lobster, Norway lobster, spiny lobster, velvet swimming crab) are believed to be physiologically resilient to noise as they lack gas filled spaces within their bodies (Popper *et al.,* 2001). Presently, there have been no lethal effects of underwater noise recorded for these IEFs, however a number of sub-lethal physiological effects have been reported among Norway lobster and related species, specifically a reduction in burying, bioregulation, and locomotion behaviour in response to simulative shipping and construction noise (Solan *et al.,* 2016). However, the authors noted that simulated shipping noise had no effect Norway lobster physiology (Solan *et al.,* 2016).

In snow crab *Chionoecetes opilio*, sub-lethal physiological effects due to impulsive noise sources included bruised hepatopancreas and ovaries after exposure to seismic survey noise emissions (at unspecified SPLs) (Department of Fisheries and Oceans Canada (DFO), 2004). Similarly, changes in serum biochemistry and hepatopancreatic cells were observed in American lobster *Homarus americanus* (Payne et al., 2007), increase in respiration in brown shrimp (Solan *et al.,* 2016), metabolic rate changes and reduced feeding behaviour in green shore crab (Wale *et al*., 2013), and evidence of oxidative stress in blue mussel (Wale *et al*., 2019) have also been identified as a result of underwater noise.

Another study found elevated SPL were correlated with increased incidences of cannibalism and significantly delayed growth in brown shrimp (Lagardère and Spérandio, 1981). The spiny lobster has been reported to have aspects of life history disrupted by anthropogenic noise (such as movement and anti-predation behaviour) in response to simulated shipping noise and offshore activities (Filiciotto *et al.,* 2016; Zhou *et al*., 2016). Such findings have implications regarding species fitness, stress, and compensatory foraging requirements, along with increased exposure to predators. These studies provide useful context for the sub-lethal effects from noise impacts which the spiny lobster IEF (and others, as a proxy) will likely similarly be exposed to.

Behavioural impacts have been noted in the giant scallop *Placopecten magellanicus*, with piling noise travelling through the seabed for up to 50 m and causing significant increases in valve closures with no acclimation to multiple piling exposures (Jezequel *et al.,* 2022). This could potentially have significant impacts on feeding success for the giant scallop. However, as this only occurred in very close proximity to the piling impact, and the giant scallop returned to baseline natural behaviour almost immediately following cessation of piling (Jezequel *et al.,* 2022). Therefore, it is unlikely that impact piling will cause any significant long-term impact on scallop populations within the Proposed Development, given the relatively small proportion of the overall scallop population in the regional fish and shellfish ecology study area potentially affected by this impact.

Shellfish will also likely be exposed to pre-construction seismic and geophysical surveys within the Proposed Development. Christian *et al.* (2013) found no significant difference between acute effects of seismic airgun exposure upon caged adult snow crabs, in comparison with those in control cages with no exposure to seismic pulses. Similarly, the link between seismic surveys and changes in commercial rock lobster *Panulirus cygnus* catch rates over a 26-year period was investigated by Parry and Garson (2006), who found no statistically significant correlative link. Comparison between laboratory and field studies is difficult due to differing sound properties in these controlled and uncontrolled environments (Carroll *et al*., 2017), therefore, setting standardised minimum injury and mortality thresholds proves difficult for this impact (Wright and Cosentino, 2015). Despite this difficulty, direct observation has shown that scallop species show no evidence of increased mortality within 10 months of seismic airgun exposure (Parry *et al.,* 2002), and lobsters show the same trend 8 months following exposure (Day *et al.,* 2016), suggesting a low vulnerability and high recoverability to this noise source.

There is no direct evidence to suggest that shellfish eggs and larvae are at risk of direct harm from high amplitude anthropogenic underwater noise sources, such as piling (Edmonds *et al.,* 2016). However, evidence exists of underwater noise significantly decreasing the capacity of benthic shellfish larvae to settle following their planktonic larval phase (Stanley *et al.,* 2012), potentially impacting long-term population recruitment. Of the few studies that have focused on the eggs and larvae of shellfish species, evidence of impaired embryonic development and mortality has been found to arise from playback of seismic survey noise among scallop, with up to 46% of affected larvae developing abnormalities compared to control groups (De Soto *et al.,* 2013). There is limited information on the effect of impulsive sound upon crustacean eggs, and no research has been conducted on commercially exploited decapod species in the UK, with all available studies focusing on seismic survey noise impacts. Like scallop larvae, exposure to sound from seismic source arrays could be implicated in delayed hatching of snow crab eggs, causing resultant larvae to be smaller than controls (DFO, 2004). However, Pearson *et al*. (1994) found no statistically significant difference between the mortality and development rates of stage II Dungeness crab *Metacarcinus magister* larvae exposed to single field-based discharges (231 dB re 1 μPa (zero-peak) @ 1 m) from a seismic airgun. This highlights the heterogeneity of results in this field, with further study required to refine this understanding. The existing evidence suggests a medium vulnerability of shellfish eggs and larvae to this impact, although recoverability of shellfish into spawning habitats is predicted to be high.

Monitoring of European lobster catch rates at the Westermost Rough OWF indicated that there were no significant adverse effects on shellfish species at a population level during and after construction compared to baseline conditions (Roach *et al.,* 2018). In fact, the respite from fishing activities due to construction exclusion zones potentially resulted in short term benefits for some populations (Roach *et al.,* 2018). While there may be some residual uncertainty with regard to behavioural effects while piling operations are ongoing, the evidence suggests that long term effects will not occur, and any effects will be reversible.

Overall, due to the impact of underwater noise all shellfish IEFs are deemed to be of low vulnerability, high recoverability and local to national importance. The sensitivity of these receptors is therefore, considered to be low.

Significance of Effect

Marine Species

Overall, for most marine IEFS (including elasmobranchs), the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For sprat (Group 4) the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be **minor adverse**, which is **not significant** in EIA terms.

For cod (Group 3) and herring (Group 4), the magnitude of impact is deemed to be low, and the sensitivity of the receptors is considered to be high. As per Table 7.31, this yields a 'minor or moderate' significance. Due to the limited piling (up to 800 total hours) required for the Proposed Development and the availability of suitable habitat elsewhere in the regional fish and shellfish ecology study area, the effect has been assessed as **minor adverse** significance, which is **not significant** in EIA terms.

Diadromous Species

Overall, for most diadromous IEFs, the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For Group 4 diadromous IEFs (Allis and twaite shad), the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be high. As per Table 7.31, this yields a 'minor or moderate' significance. Due to the limited piling (up to 800 total hours) required for the Proposed Development and the availability of suitable habitat elsewhere in the regional fish and shellfish ecology study area, the effect has been assessed as **minor adverse** significance, which is **not significant** in EIA terms.

Shellfish

Overall, for all shellfish IEFs, the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

7.12.12 Increased SSCs and Associated Deposition

7.12.12.1 Construction Phase

Construction activities, such as subsea pipeline refurbishment, cable installation and protection (including sand wave clearance), installation of the new Douglas platform, and release of drill cuttings may result in increased SSCs and associated deposition. This may potentially result in indirect impacts on fish and shellfish ecology, such as increased turbidity, smothering effects, and release of additional contaminants into the benthic environment. These impacts could affect the water quality in the surrounding area and habitat degradation affecting spawning and nursery grounds.

A full description of the physical processes baseline characterisation, including the numerical modelling used to assess increased SSCs and associated deposition, is provided in volume 3, RPS Group (2024c). The 2016 Cefas Climatology Report (Cefas, 2016) and associated dataset provides the spatial distribution of average non-algal SPM around the UK. Between 1998 and 2005, the greatest plumes are associated with large rivers such as those that discharge into the Thames Estuary, The Wash and Liverpool Bay, which show mean values of SPM above 30 mg/l. Based on the data provided within this study, the SPM associated with the Proposed Development has been estimated as approximately 0.9 to 3 mg/l over the 1998 to 2005 (Cefas, 2016).

Magnitude of Impact

All Species

Increases in SSCs and associated deposition due to construction activities has been assessed based on the MDS parameters in Table 7.22.

These parameters have been defined by a numerical modelling study was undertaken on the potential impacts of the Proposed Development on physical processes (see volume 3, RPS Group (2024c)). This included tidal current, wave climate, and sediment transport under both calm and storm conditions. Numerical modelling has been used to quantify the changes in physical processes, predominantly suspended sediment concentrations, due to seabed preparation activities, the drilling of new monitoring wells, and laying of cables. The following activities in the construction phase have been considered:

- seabed preparation (such as sand wave clearance);
- drill cuttings; and
- cable installation.

Details of the modelling and the parameters used are provided in full in for the impact of increased SSCs and associated deposition on benthic subtidal and intertidal ecology and are not repeated here (see section 7.12.2). Overall, the increased SSCs and associated deposition due to the construction activities described above are predicted to be of local spatial extent, short-term duration, intermittent throughout the construction phase, and of high reversibility. It is predicted that the impact will affect the receptor directly. Therefore, for all fish and shellfish IEFs, the magnitude of impact is predicted to be low.

Sensitivity of Receptor

In general, greater increases in SSCs and associated deposition result in greater impact on fish and shellfish receptors. The product of sediment concentration (in mg/l) and the duration of exposure is used to give an indication of effects (Newcombe and MacDonald, 1991).

Marine Fish

Typically, fish eggs and larvae are the most susceptible life stage to the impacts of increased SSCs and associated deposition. In general, SSCs have to be on the scale of mg/l to be lethal to eggs and larvae but on the scale of g/l to be lethal to juveniles and adults (Engell-Sørensen and Skyt, 2001). The development of fish eggs and larvae can be impacted by suspended sediments at concentrations of thousands of mg/l (Auld and Schubel, 1978; Appleby and Scarratt, 1989). Modelling undertaken of SSCs associated with the construction phase identified maximum concentrations of 30 mg/l during dredging at West Hoyle Bank. However, it should be noted that this value is equivalent to background levels. It is unlikely that these SSCs will affect the development of eggs and larvae and they are only expected to be present in the immediate vicinity of the release site with dispersion continuing over successive tides.

Eggs and larvae of species which deposit their eggs near or on the seabed are most likely to be affected by SSCs and associated deposition. This includes sandeel and herring. While sandeel spawning grounds were identified within the Proposed Development, sandeel and their eggs are likely to be tolerant to some level of sediment deposition due to the nature of re-suspension and deposition within their natural high energy preferred habitat and spawning environment within the Irish Sea (MarineSpace Ltd *et al.*, 2013). Sandeel prefer coarse to medium sands for spawning (Wright *et al.,* 2000), with 65% of the PSA samples collected within the Proposed Development being characterised as unsuitable or sub-prime for spawning using the Latto *et al.* (2013) methodology (see volume 3, RPS Group (2024a) for further information on this analysis). Sandeel are sensitive to changes in spawning habitat and show reduced selection or avoidance of gravel and fine sediment habitats (Holland *et al.,* 2005). Therefore, increased SSCs in areas of suitable or prime spawning habitat within the Proposed Development may cause avoidance behaviour until the fine sediments are dissipated by the current. However, modelled deposition levels for fine sediments are expected to be highly localised, with finer mud particles dispersed with residual currents. For example, modelling of sedimentation during drilling suggested that mean sedimentation was contained within a 500 m radius of the drill site and limited to <0.1 mm (see volume 3, RPS Group (2024c) for further information). Therefore, effects on sandeel spawning populations due to this impact are predicted to be limited.

Herring are a pelagic species, which lay matts of demersal eggs on the seabed (this is discussed in greater detail in section 7.12.9). They are known to prefer gravelly and coarse sand environments for this spawning, which includes areas around the southeast and north-east of the Isle of Man (Coull *et al*., 1998). Kiørboe *et al.* (1981) reported that embryonic development of herring eggs was unimpaired by SSCs of up to 300 mg/l for one day. The authors suggested that harmful effects of increased SSCs are most likely to occur when oxygen tension is reduced, which is often the case when organic matter and reducing agents are released from the sediments (Kiørboe *et al.,* 1981). Further, Messieh *et al.* (1981) demonstrated that although substantial egg mortality could occur due to a thin film of sediment encasing the eggs, no deleterious effect on hatching was observed in SSCs of up to 7,000 mg/l. Their results suggest that herring eggs may be tolerant to high SSC levels, although the size at hatching tended to be higher in lower SSCs (Messieh *et al.,* 1981). Detrimental effects may occur if eggs are smothered and the deposited sediment is not removed by the currents (Birklund and Wijsmam, 2005), however this would be expected to occur quickly in this case (i.e. within a couple of tidal cycles), given the low levels of deposition expected. Furthermore, the results of the PSA conducted on the sediment samples collected within the Proposed Development demonstrated that the area is largely unsuitable spawning habitat for herring. There was only one sampling site (1.3% of the total number of samples) classified as ‘suitable’ habitat under the Reach *et al.* (2013) methodology and there were four samples (5.3% of the total) classified as ‘sub-prime’ spawning habitat. In addition, there were no spawning grounds overlapping with the Proposed Development, with the closest identified around the Isle of Man, and with nationally significant spawning grounds located out with the regional fish and shellfish ecology study area entirely (Coull *et al.,* 1998). Overall, it is unlikely that herring populations will be largely affected by this impact.

Adult marine fish species are more mobile than many of the other fish and shellfish IEFs identified in this assessment, and therefore would be likely to show greater avoidance behaviour within areas affected by increased SSC (Emu, 2004). Avoidance of turbid water is a common response behaviour to elevated SSCs (Collin and Hart, 2015). For example, avoidance behaviour was observed in adult herring and cod exposed to sediment plumes as low as 2 mg/l (Westerberg *et al.,* 1996). It is proposed that this increased mobility makes these species less susceptible to physiological effects of this impact. Conversely, due to the reduced mobility and higher dependence on specific nursery habitats, juvenile fish are likely to be less able to avoid habitat disturbances due to increased SSCs and associated deposition. This has been well researched for juvenile salmonids (Bisson and Bilby, 1982; Berli *et al.,* 2014). Juvenile fish are likely to occur throughout the regional fish and shellfish ecology study area, with nursery habitats present inshore and offshore depending on species (a complete account of all species with spawning and nursery grounds overlapping the Proposed Development and within the regional fish and shellfish ecology study area is available in volume 3, RPS Group (2024a).

Temporary increases in SSCs occur regularly in the north Irish Sea, linked heavily to interannual changes in meteorological conditions and the frequency of spring storms (White *et al*., 2003). Seasonal variation in SSCs is also typical for the area, with an increase of up to a factor of 2.7 in winter compared to summer levels (Bowers *et al.,* 2010). Further, juvenile fish typically inhabit inshore areas, where SSCs are typically higher. As the fish and shellfish assemblage in proximity to the Proposed Development is characteristic of the regional fish and shellfish ecology study area, it is likely that juveniles are acclimatised to these natural fluctuations in SSCs. Therefore, it is proposed that most juvenile fish within the regional fish and shellfish ecology study area will be largely unaffected by the relatively low-level temporary increases in SSC resulting from the construction phase. These concentrations are likely to be within the range of natural variability (generally at background levels of 30 mg/l). Recoverability, in terms of fish returning to the affected area, is highly dependent on the recovery of the area to pre-disturbance conditions, the availability of alternative suitable habitat, and the ecological plasticity of that species (Wenger *et al.,* 2017). As a result, there will be little to no impact on mobile species, such as pelagic fish and elasmobranch IEFs.

Overall, all marine fish IEFs, except herring, are deemed to be of low vulnerability, high recoverability and local to national importance. The sensitivity of these IEFs is therefore considered to be low.

Based on the increase in sensitivity of herring eggs to the smothering effects of increased sediment deposition, herring is deemed to be of medium vulnerability, high recoverability and of national importance, and therefore the sensitivity of this receptor is considered to be medium. Despite the relatively large distance of the spawning grounds and primary habitat from the Proposed Development, the sensitivity of this receptor is still considered to be medium as a precautionary measure.

Shellfish

Many shellfish species have a high tolerance to increases in SSC and are reported to be insensitive to increases in turbidity (Wilber and Clarke, 2001). This includes shellfish IEFs, such as brown crab which has been assessed in the MarESA as being tolerant to increase in SSCs, smothering, and increase in turbidity, with very low, low, and no sensitivity to each of these impacts, respectively (Neal and Wilson, 2008). This is due to their mobility, allowing brown crab to escape from sediment deposition and avoid areas of increased SSCs, as they rely on good visibility to forage (Neal and Wilson, 2008). Non-mobile shellfish IEFs, such as common cockle, have also been assessed in the MarESA as being tolerant and not sensitive to increased SSCs and turbidity (Tyler-Walters, 2007). This is because this species naturally inhabits sedimentary and turbid environments and is therefore considered to be tolerant to these impacts (Navarro and Widdows, 1997; Tyler-Walters, 2007). The common cockle also has intermediate tolerance to smothering of up to 5 cm of deposited sediment, with a high recovery rate, and an overall low sensitivity to smothering (Tyler-Walters, 2007). For example, in laboratory and field conditions, individuals have been observed to burrow quickly to the surface if smothered by 2 to 5 cm of sediment (Jackson and James, 1979; Richardson *et al.,* 1993).

Historic common cockle beds are present within the Dee Estuary, which have been subject to previous closures and are not managed under the Dee Estuary Cockle Fishery Order (2008) Management Plan (NRW, 2024). Given the low sensitivities of common cockle to increased SSCs, turbidity, and smothering (Tyler-Walters, 2007), it is not likely that this impact will affect the cockle beds of the Dee Estuary.

Norway lobster, European lobster, and other larger crustaceans, such as spiny lobster, are classed as equilibrium species, meaning that they can only recolonise an area once the original substrate has recovered to baseline conditions (Newell *et al.,* 1998). Egg bearing (e.g. 'berried') Norway lobster and European lobster are potentially more vulnerable to increased SSCs as the eggs they carry attached to their bodies required regular aeration. However, the MarESA for Norway lobster states that this species is tolerant and not sensitive to increased SSCs, smothering, and increased turbidity (Sabatini and Hill, 2008). This is because they inhabit large burrows, which can penetrate 20 – 30 cm into the sediment and be over a metre long (Rice and Chapman, 1971), which would not be affected by this impact. Similarly, they are mobile species, thus are able to move to more suitable conditions if necessary, during periods of increased SSCs during the construction phase, which are not expected to be continuous and will only affect a small area at any one time (see 'magnitude of impact' above). Further, spawning and nursery grounds for Norway lobster are located to the north of the Proposed Development, but do not directly overlap, therefore are unlikely to be impacted by increased SSCs and associated deposition. There is no MarESA available for European lobster, however this species inhabits unsheltered seabeds, rocky crevices, and in excavated burrows (Dybern, 1973), and is also highly mobile. Therefore, it is likely that any impact to this species will be low.

Increased SSCs are unlikely to impact spiny lobster directly, as they prefer dens in shaded, sub-vertical substratum, which reduces siltation rate (Gristina *et al.,* 2009). Increased SSCs may indirectly affect spiny lobster due to reduced foraging success, however as they have been recorded remaining in shelters without food for up to a week (Groeneveld *et al.,* 2013), it is likely they are tolerant to reduced foraging ability until SSCs return to baseline conditions. The MarESA for this species is a medium resistance, and medium sensitivity to changes in suspended solids (Gibson-Hall, *et al.,* 2020). As spiny lobster are large and mobile species, light smothering (<5 cm) is unlikely to impact them, with high resistance and no sensitivity to this impact concluded in the MarESA (Gibson-Hall *et al.,* 2020). Heavier sediment deposition (>5 cm) could obstruct the entrance to their shelters or smother potential prey, with low resistance and high sensitivity to this impact concluded in the MarESA (Gibson-Hall *et al.,* 2020). However, modelled deposition levels for fine sediments are expected to be highly localised, with finer mud particles dispersed with residual currents. Thus heavier deposition is not likely to impact this species. Overall, it is likely that any impact to spiny lobster will be low.

Both king and queen scallop have the potential to be adversely impacted by burial during sediment deposition. Hendrick *et al.* (2016) demonstrated that queen scallop had some ability to emerge from burial of up to 2 cm, but mortality occurred after several days of burial and under sediments over 5 cm. The MDS modelling of sediment plume movement and deposition depths have shown this is unlikely to occur in this case (see 'magnitude of impact' above). King scallop appear to be more tolerant to burial than queen scallop, with high levels of emergence and low mortality recorded in coarse to medium grain sizes and depths of <3 cm (Szostek *et al.,* 2013). Emergence decreased and mortality increased in king scallops buried under fine sediment of increasing depths (up to 5 cm) (Szostek *et al.,* 2013). Within this study, king scallop also demonstrated increased clapping rate (a method of clearing unwanted particles by clapping their shell) at SSCs of <100 mg/l and up to 700 mg/l (Szostek *et al.,* 2013). King and queen scallop are both more mobile than many other shellfish species and are likely able to avoid active construction activities causing increases in SSC. It has been proposed that scallops may be able to visually detect the size and speed of moving particles to identify preferrable feeding conditions (Speiser and Johnsen, 2008), thus supporting the notion that they will display avoidance behaviour. Queen scallop are believed to be more mobile that king scallop, although this is yet to be quantified (Howarth and Stewart, 2014). King and queen scallop both have high intensity spawning grounds within the eastern Irish Sea and are important commercial species within the region. However, given the relatively low level of SSCs and deposition modelled (generally within background levels), their avoidance behaviour, and the large area available alternatively for spawning, this impact is unlikely to affect king and queen scallop populations in the short or long term. Similarly, king scallop has been assessed as having high tolerance, high recoverability, and low sensitivity to increased SSCs, smothering, and increase in turbidity in the MarESA (Marshall and Wilson, 2008), although no assessment is currently available for queen scallop.

Overall, all shellfish IEFs are deemed to be of low to medium vulnerability, high recoverability and local to national importance. The sensitivity of these IEFs is therefore considered to be low.

Diadromous Fish

The diadromous fish IEFs are expected to have some tolerance to naturally high SSCs, given their migration routes typically require them to travel through estuarine habitats, which have background SSCs that are considerably higher than in offshore areas. As the construction activities will only produce temporary and short-lived increases in SSC, with levels well below those experienced in estuarine environments, it is predicted that diadromous fish IEFs will only temporarily affected at most (if they are affected at all, based on the timing of the construction phase and their migratory seasons). Any adverse effects on these species are likely to be short term behavioural effects, such as temporary slightly erratic alarmed swimming behaviour (Chiasson, 2011), or avoidance behaviour, which has been recorded in diadromous species such as Coho salmon *Oncorhynchus kisutch*, Arctic grayling *Thymallus arcticus*, and rainbow trout *O. mykiss* (Newcombe and Jensen, 1996). While these species are not present within the regional fish and shellfish ecology study area, they share similar life histories and habitats to the diadromous fish IEFs identified as part of this assessment. Avoidance behaviour can occur at very low levels of suspended sediment (Wenger *et al.,* 2017), and studies on Coho salmon have illustrated that avoidance behaviour ceases post-disturbance or if the fish becomes acclimated (Berg, 1983; Berg and Northcote, 1985).

Overall, this impact is not expected to create any significant barrier to migration to rivers or estuaries used by these diadromous species within the regional fish and shellfish ecology study area. Diadromous fish IEFs in the regional fish and shellfish ecology study area are deemed to be of low vulnerability, high recoverability and national to international importance. The sensitivity of the receptors is therefore, considered to be low. Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the sensitivity of the freshwater pearl mussel IEF is also considered to be low.

Significance of Effect

Marine Fish

Overall, for all marine fish IEFs except herring, the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be low. The effect will, therefore, be of **negligible adverse** significance, which is **not significant** in EIA terms.

For herring, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

Shellfish

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be low. The effect will, therefore, be of **negligible adverse** significance, which is **not significant** in EIA terms.

Diadromous Fish

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be low. The effect will, therefore, be of **negligible adverse** significance, which is **not significant** in EIA terms. Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the significance of the effect upon the freshwater pearl mussel IEF is also considered to be **negligible adverse.**

7.12.12.2 Decommissioning Phase

Activities in the decommissioning phase, such as removal of foundations, cables, and cable crossing protection, may lead to increases in SSCs and associated sediment deposition.

Magnitude of Impact

All Species

Based on the MDS (Table 7.22), the removal of foundations, cables, and cable crossing protection would result in increased SSCs and associated deposition within the Proposed Development. It is assumed that the increases in SSCs and associated sediment deposition generated in the decommissioning phase would be of a lower extent than that of the construction phase. This is due to the absence of seabed preparation activities, drilling, and depositing of drill cuttings, which account for additional increases in SSCs and associated deposition in the construction phase.

The impact is predicted to be of local spatial extent, short term duration (for the individual decommissioning activities), intermittent, and of high reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Sensitivity of Receptor

All Species

The sensitivities of all fish and shellfish IEFs (marine fish, shellfish, and demersal species) presented in the assessment of this impact in the construction phase equally apply in the decommissioning phase (low to medium).

Significance of Effect

Marine Fish

Overall, for all marine fish IEFs except herring, the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be low. The effect will, therefore, be of **negligible adverse** significance, which is **not significant** in EIA terms.

For herring, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

Shellfish

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be low. The effect will, therefore, be of **negligible adverse** significance, which is **not significant** in EIA terms.

Diadromous Fish

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be low. The effect will, therefore, be of **negligible adverse** significance, which is **not significant** in EIA terms. Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the significance of the effect upon the freshwater pearl mussel IEF is also considered to be **negligible adverse.**

Marine Mammals and Marine Turtles

7.12.13 Underwater Noise and Marine Mammals and Marine Turtles

Elevated underwater noise generated during various activities in the construction, operation and maintenance, and decommissioning of the Proposed Development is a key impact for marine mammals and marine turtles and forms the majority of impacts assessed in this section. Therefore, a brief overview on underwater noise and marine mammals and marine turtles is provided in the following paragraphs.

7.12.13.1 General Overview

Marine mammals, particularly cetaceans, are able to generate and detect sound, and are dependent on sound for many aspects of their lives (Au, *et al.,* 1974; Bailey *et al.,* 2010). This includes foraging and prey identification, avoiding predators, navigation, and communication. Anthropogenic increases in underwater noise may consequently impact marine mammals (Parsons *et al.,* 2008; Bailey *et al.,* 2010).

Richardson *et al.* (1995), describes four zones of influence of underwater noise on marine mammals, which vary with the distance from the source. These include audibility (detection of the sound), masking (interference with detection of sounds and communication), responsiveness (behavioural or physiological response to the sound) and injury/hearing loss (tissue damage in the ear) (Richardson *et al.,* 1995). This assessment of impacts relating to underwater noise in this section consider the zones of auditory injury and disturbance (i.e. responsiveness). There is insufficient scientific evidence to properly evaluate masking and no relevant threshold criteria to enable a quantitative assessment. The relevant thresholds for onset of effects, and the evidence base from which they are derived, are given below.

While marine turtles are also capable of detecting sound, there is limited information on auditory criteria for them, and the effect of underwater noise is therefore inferred from documented effects to other vertebrates. Bone conducted hearing is the most likely mechanism for auditory reception in marine turtles and, since high frequencies are attenuated by bone, the range of hearing are limited to low frequencies only. For example, the hearing range of leatherback turtle has been recorded as between 50 Hz and 1,200 Hz with maximum sensitivity between 100 Hz and 400 Hz (Piniak, 2012).

7.12.13.2 Marine Mammals

Auditory Injury

As discussed for fish and shellfish in section 7.12.11 above, auditory injury in marine mammals can occur either as a TTS, where an animal's auditory system can recover, or PTS, where there is no hearing recovery in the animal. The 'onset' of TTS is deemed to be where there is a temporary elevation in the hearing threshold by 6dB and is "*the minimum threshold shift clearly larger than any day to day or session to session variation in a subject's normal hearing ability*", and which "*is typically the minimum amount of threshold shift that can be differentiated in most experimental conditions*" (Southall *et al*., 2007). Since it is considered unethical to conduct experiments measuring PTS in animals, the onset of PTS was extrapolated from early studies on TTS growth rates in chinchillas and is conservatively considered to occur where there is 40dB of TTS (Southall *et al.,* 2007).

Potential auditory injury is assessed in terms of PTS due to the irreversible nature of the effect, unlike TTS which is temporary and reversible. Animals (particularly highly mobile species) exposed to sound levels that could induce TTS are likely to respond by moving away from (fleeing) the ensonified area and therefore avoiding potential injury. It is considered there is a behavioural response (disturbance) that overlaps with potential TTS ranges. Since derived thresholds for the onset of TTS are based on the smallest measurable shift in hearing, TTS thresholds are likely to be very precautionary and could result in overestimates of TTS ranges.

Noise propagation models can be constructed to allow the received noise level at different distances from the source to be calculated. To determine the consequence of these received levels on any marine mammals which might experience such noise emissions, it is necessary to relate the levels to known or estimated impact thresholds. The injury criteria proposed by Southall *et al*. (2019) are based on a combination of linear (i.e. un-weighted) SPLs and mammal hearing weighted SELs. The hearing weighting function is designed to represent the bandwidth for each group within which acoustic exposures can have auditory effects. The categories include:

- Low Frequency (LF) cetaceans (minke whale);
- High Frequency (HF) cetaceans (bottlenose dolphin, common dolphin, Risso's dolphin);
- Very High Frequency (VHF) cetaceans (harbour porpoise); and
- Phocid Carnivores in Waters (PCW) (grey seal and harbour seal).
- these weightings have been used in this assessment, and are shown in Figure 7.8.

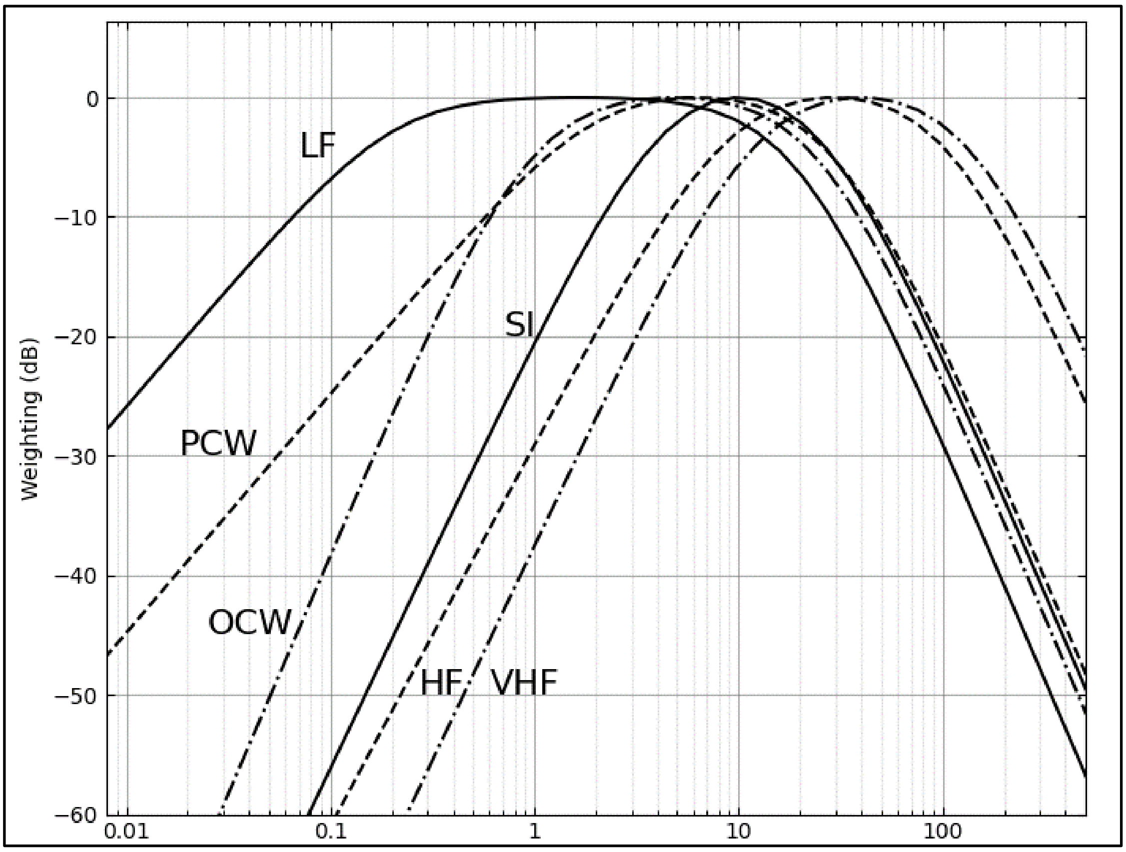

Figure 7.8: Hearing Weighting Functions For Marine Mammals (Source: Southall *et al.,* 2019) (SI = Sirenians, OCW = Other Marine Carnivores In Water)

Southall *et al.* (2019) also present injury criteria for two different types of underwater noise:

- **Impulsive sound**: which are typically transient, brief (less than 1 second), broadband, and consist of high peak sound pressure with rapid rise time and rapid decay (American National Standards Institute (ANSI) 1986; National Institute for Occupational Safety and Health (NIOSH) 1998; ANSI 2005). This category includes sound sources such as seismic surveys, impact piling and underwater explosions
- **Non-impulsive sound**: which can be broadband, narrowband or tonal, brief or prolonged, continuous or intermittent and typically do not have a high peak sound pressure with rapid rise/decay time that impulsive sounds do (ANSI 1995; NIOSH 1998). This category includes sound sources such as continuous running machinery, drilling, sonar and vessels.

The criteria for impulsive and non-impulsive sound have been adopted for this assessment, given the nature of the sound source used during construction activities. The relevant criteria for the onset of both PTS and TTS proposed by Southall *et al.* (2019) are summarised in Table 7.48. These injury thresholds are based on both SPLpk (i.e. un-weighted) and marine mammal hearing-weighted SEL as per the latest guidance (Southall *et al.,* 2019).

Table 7.48: Summary Of PTS And TTS Onset Thresholds For Marine Mammals (Source: Southall *et al.,* 2019)

Hearing Group	Parameter	PTS Onset Threshold		TTS Onset Threshold	
		Impulsive	Non-impulsive	Impulsive	Non-impulsive
LF	SPL_{pk}, unweighted	219	-	213	-
	SEL, LF weighted	183	199	168	179
HF	SPL_{pk}, unweighted	230	-	224	-
	SEL, HF weighted	185	198	170	178
VHF	SPL_{pk}, unweighted	202	-	196	-
	SEL, VHF weighted	155	173	140	153
PCW	SPL_{pk}, unweighted	218	-	212	-
	SEL, PCW weighted	185	201	170	181

To calculate distances using the SEL_{cum} metric, the underwater noise modelling assessment made a simplistic assumption that an animal would be exposed over the duration of the piling activity and that there would be no breaks in activity during this time. It was assumed that an animal would swim away from the sound source at the onset of activity at a constant rate and subsequently, conservative species-specific swim speeds were incorporated into the model. As a marine mammal swims away from the sound source, the noise it experiences will become progressively more attenuated; the cumulative SEL is derived by logarithmically adding the SEL to which the mammal is exposed as it travels away from the source. This calculation was used to estimate the approximate minimum start distance for a marine mammal in order for it to be exposed to sufficient sound energy to result in the onset of potential injury. It should be noted that the sound exposure calculations are based on the simplistic assumption that the animal will continue to swim away at a fairly constant relative speed. The real-world situation is more complex, and the animal is likely to move in a more complex manner.

The swim speeds of marine mammals used in this assessment are summarised in Table 7.49.

Table 7.49: Swim Speeds Assumed For Exposure Modelling

Species	Hearing Group	Swim Speed (m/s)	Reference
Harbour porpoise	VHF	1.5	Otani *et al.,* 2000
Bottlenose dolphin	HF	1.52	Bailey and Thompson, 2010
Common Dolphin	HF	1.52	
Risso’s dolphin	HF	1.52	
Minke whale	LF	2.3	Boisseau *et al.,* 2021
Grey seal	PCW	1.8	Thompson, 2015
Harbor seal	PCW	1.8	

In addition, the assumptions and limitations of underwater noise modelling (e.g. equal energy rule, reduced sound levels near the surface, conservative swim speeds, and use of impulsive sound thresholds at large ranges) also lead to an overestimation of ranges. Notably, Hastie *et al.* (2019) reported that during piling operations, there were range dependent changes in signal characteristics with received sound losing its impulsive characteristics at ranges of several kilometres, especially beyond 10 km. As such, TTS is not considered to be a useful predictor of the effects of underwater sound on marine mammals where ranges exceed more than 10 km and therefore, where this is the case (i.e. piling and UXO clearance), TTS is not included in the final assessment of significance for injury. Ranges for TTS were modelled for completeness for all noise-related impacts and are presented in this chapter and in volume 3, Underwater Noise Technical Report (RPS Group and Seiche, 2024).

Behavioural Disturbance

Beyond the area in which injury may occur, the effect on marine mammal behaviour is the most important measure of impact. Significant (i.e. non-trivial) disturbance may occur when there is a risk of animals incurring sustained or chronic disruption of behaviour or when animals are displaced from an area, with subsequent redistribution being significantly different from that occurring due to natural variation.

To consider the possibility of significant disturbance resulting from the Proposed Development, it is therefore necessary to consider the likelihood that the sound could cause non-trivial disturbance, the likelihood that the sensitive receptors will be exposed to that sound and whether the number of animals exposed are likely to be significant at the population level. Assessing this is however a very difficult task due to the complex and variable nature of sound propagation, the variability of documented animal responses to similar levels of sound, and the availability of population estimates, and regional density estimates for all marine mammal species.

Southall *et al.* (2007) recommended that the only currently feasible way to assess whether a specific sound could cause disturbance is to compare the circumstances of the situation with empirical studies. JNCC (2010a) guidance indicates that a score of five or more on the Southall *et al.* (2007) behavioural response severity scale could be significant. The more severe the response on the scale, the lower the amount of time that the animals will tolerate it before there could be significant adverse effects on life functions, which would constitute a disturbance. The US National Marine Fisheries Service (NMFS) (NMFS, 2005) define strong disturbance in all marine mammals as Level B harassment and suggest a threshold of 160 dB re 1 µPa (rms) for impulsive noise. This threshold meets the criteria defined by the JNCC (2010a) as a 'non-trivial' (i.e. significant) disturbance and is equivalent to the Southall *et al*. (2007) severity score of five or more on the behavioural response scale. Beyond this threshold the behavioural responses are likely to become less severe (e.g. minor changes in speed, direction and/or dive profile, modification of vocal behaviour and minor changes in respiratory rate (Southall *et al.,* 2007)). The NMFS guidelines suggest a precautionary level of 140 dB re 1 µPa (rms) to indicate the onset of low-level marine mammal disturbance effects for all mammal groups for impulsive sound, although this is not considered likely to lead to a 'significant' disturbance response (NMFS, 2005). For continuous noise, the NMFS (2005) guidance sets the marine mammal level B harassment of 120 dB re 1 µPa (rms). This value sits approximately mid-way between the range of values identified in Southall *et al.* (2007) for continuous sound but is lower than the value at which the majority of mammals responded at a response score of six (i.e. once the received rms sound pressure level is greater than 140 dB re 1 µPa). Considering the paucity and high-level variation of data relating to onset of behavioural effects due to continuous sound, it is recommended that any ranges predicted using this number are viewed as probabilistic and potentially over precautionary.

To demonstrate the variation in behavioural responses of marine mammals, Graham *et al.* (2017) used empirical evidence collected during piling at the Beatrice OWF (Moray Firth, Scotland) to demonstrate that the probability of occurrence of harbour porpoise (measured as porpoise positive minutes) increased exponentially moving further away from the source. The study showed a 100% probability of disturbance at an (un-weighted) SEL of 180 dB re 1 µPa^{2}s, 50% at 155 dB re 1 µPa^{2}s and dropping to approximately 0% at an SEL of 120 dB re 1 µPa^{2}s. The dose response thresholds tie in with the NMFS (2005) criteria since a mild behavioural response is suggested to occur at a threshold of 140 dB re 1 µPa (rms) which is equivalent of 130 dB 1 µPa^{2}s where a small response (approximately 10% of animals) would occur according to the dose response. In addition, Graham *et al.* (2019) demonstrated that the response of harbour porpoise to piling diminished over the piling phase. For a given received sound level or at a given distance from the source, there were more detections of animals at the last piling location compared to the first piling location (Graham *et al.,* 2019). Dose response is an accepted approach to understanding the behavioural effects from piling and has been applied at other UK offshore projects, such as Seagreen OWF (Seagreen Wind Energy Ltd, 2012) and Hornsea Project Three (GoBe, 2018).

Similarly, a telemetry study undertaken of tagged harbour seal during pile driving at the Lincs OWF (The Wash, England) found that there was a proportional response at different received sound levels (Russell *et al.,* 2016). Dividing the study area into a 25 km^2 grid, the authors modelled Single-strike Sound Exposure Levels (SELss) and matched these to corresponding densities of harbour seal in the same grids during non-piling versus piling periods. The authors reported a significant decrease in usage (abundance) during piling at predicted received SEL levels of between 142 dB and 151 dB re 1µPa^{2}s (Russell *et al.,* 2016). More recently, the effects of piling sounds on harbour seal was investigated using tracking data from 24 individuals (Whyte *et al.,* 2020). Predicted SEL_{cum} experienced by each seal were compared to different auditory weighting functions and thresholds for TTS and PTS. The study used predictions of seal density during pile driving made by Russell *et al.* (2016) compared to distance from the OWF and predicted SELss by multiple approaches. Predicted seal density significantly decreased within 25 km or SELss (averaged across depths and pile installations) above 145 dB re 1 Ipa^2 (Whyte *et al.,* 2020).

This assessment adopts a conservative approach and uses the NMFS (2005) Level B harassment threshold of 160 dB re 1 µPa (rms) for impulsive sound. This is defined as having the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioural patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild (NMFS, 2005). This is similar to the JNCC (2010a) description of non-trivial disturbance and has therefore been used as the basis for onset of behavioural change in this assessment. It is important to understand that exposure to sound levels in excess of the behavioural change threshold stated above does not necessarily imply that the sound will result in significant disturbance. As noted previously, it is also necessary to assess the likelihood that the sensitive receptors will be exposed to that sound and whether the numbers exposed are likely to be significant at the population level. For the assessment of disturbance to all marine mammals (except harbour porpoise), underwater noise effects were modelled using the NMFS (2005) criteria (Table 7.50).

Table 7.50:Disturbance Criteria For Marine Mammals Used In The Assessment (Source: NMFS, 2005)

Effect	Non-Impulsive Threshold	Impulsive Threshold (Other than Piling)
Mild disturbance (all marine mammals)	-	140 dB re 1µ Pa (rms)
Strong disturbance (all marine mammals)	120 dB re 1µ Pa (rms)	160 dB re 1µ Pa (rms)

A recent position statement from NRW (2023) presents a number of disturbance criteria specifically for assessing the impacts on harbour porpoise, which are summarised in Table 7.51 below. Given that the Proposed Development lies in Welsh waters, separate disturbance calculations have been undertaken for harbour porpoise based on the guidance summarised in Table 7.51.

Table 7.51:Disturbance Criteria For Harbour Porpoise From NRW (2023) Guidance

Source	Recommended Criteria
Piling	Dose-response curves, where available. Where these are not available, the recommended disturbance criteria for piling align with those for seismic surveys (see next row).
Seismic surveys	143 dB SEL_{ss} (Tougaard, 2021); 145 dB SEL_{ss} (Lucke *et al.* 2009); or 140 dB SEL_{ss} (ASCOBANS, 2014)
Geophysical surveys (SBP and sonar)	160 dB SPL_{rms} level B harassment (NMFS, 2005)

Source	Recommended Criteria
UXO	140 dB SEL (W_{vhf}) (Southall *et al.,* 2019)
Continuous noise	120 dB SPL_{rms} (NMFS 2005)

When applying these criteria, it is possible to provide quantification of the magnitude of effects with respect to the spatial extent of disturbance and subsequently the number of animals potentially disturbed (based on availably density information). Caution, however, should be taken when using this approach, as there are significant challenges for developing a comprehensive set of empirically derived criteria for such a diverse group of animals (Southall *et al.,* 2021). Extensive data gaps have been identified (such as measurements of the effects of elevated noise on baleen whales) which mean that extrapolation from other species has been necessary. Sounds that disturb one species may, however, be irrelevant or inaudible to other species since there are broad differences in hearing across the frequency spectrum for different marine mammal hearing groups. Variance in responses even within a species are well documented to be context and sound-type specific (Ellison *et al*., 2012). In addition, the potential interacting and additive effects of multiple stressors (e.g. reduction in prey, noise and disturbance, contamination, etc.) is likely to influence the severity of responses (Lacy *et al.,* 2017).

For these reasons, neither a threshold approach nor a dose-response function was provided in the original guidance (Southall *et al.,* 2007) and subsequently the recent recommendations by Southall *et al.* (2021) also steer away from a single overarching approach. Instead, Southall *et al.* (2021) propose a framework for developing probabilistic response functions for future studies. The authors suggest different contexts for characterising marine mammal responses for both free-ranging and captive animals with distinctions made by sound sources (i.e. active sonar, seismic surveys, continuous/industrial sound and pile driving). Three parallel categories have been proposed within which a severity score from an acute (discrete) exposure can be allocated:

- Survival – defence, resting, social interactions and navigation.
- Reproduction – mating and parenting behaviours.
- Foraging – search, pursuit, capture and consumption.

Even where responses to these categories could be assigned, based on acute exposure, there is still limited understanding of how longer term (chronic) exposure could create impacts at the population level. To explore this, Southall *et al.* (2021) reported observations from long term whale watching studies and suggested that there were differences in the ability of marine mammals to compensate for long term disturbance which related to their breeding strategy. Mysticetes (i.e. baleen whales, such as minke whale) and grey seal are capital breeders, accumulating energy in their feeding grounds and transferring this to calves in their breeding ground. Grey seal often make long foraging trips from haul-out sites. Other marine mammals, such as harbour seal, bottlenose dolphin, and harbour porpoise are income breeders, meaning that they balance the costs of pregnancy and lactation by increased food intake, rather than depending on fat stores. In contrast to grey seal, harbour seal feed throughout the pupping season, and make shorter foraging trips from haul-outs sites. These different reproductive strategies can impact the energetic consequences of disturbance, and cause variation in an individual's vulnerability to disturbance (Harwood *et al.,* 2020).

In addition, the ability to compensate for chronic noise exposure will also depend on a range of ecological factors. These include the relative importance of the disturbed area and prey availability within their wider home range, the distance to and quality of other suitable sites, the relative risk of predation or competition in other areas, individual exposure history, and the presence of concurrent disturbances in other areas of their range (Gill *et al.,* 2001). For example, animals may be able to compensate for short-term disturbances by feeding in other areas, which would reduce the risk of longer-term population consequences. For harbour porpoise, foraging behaviour (intensity) and diet (largely target prey size) inform their vulnerability to disturbance, and if animals can find suitable high energy-density prey they may be capable of recovering from some lost foraging opportunities due to disturbance (Booth, 2020). Christiansen and Lusseau (2015) studied the effect of whale watching on minke whale in Faxafoi Bay, Iceland and found no significant long-term effects on vital rates, although years with low sandeel density led to increased exposure to whale watching as whales were forced to move into disturbed areas to forage. However, odontocetes (i.e. toothed whales, such as dolphins and harbour porpoise), may be more vulnerable to whale watching compared to baleen whales due to their more localised, and often, coastal home ranges. For example, Bejder *et al.* (2006) documented a decrease in local abundance of bottlenose dolphin which was associated with an increase in whale watching in a tourist area compared to a control area. If, however, there is no suitable habitat nearby, animals may be forced to remain in an area despite the disturbance, regardless of whether or not it could affect survival or reproductive success (Gill *et al*., 2001).

The marine mammal species considered in this assessment vary biologically and therefore have different ecological requirements that may affect their sensitivity to disturbance. In summation, Southall *et al.* (2021) clearly highlight the caveats associated with simple, one-size-fits-all, threshold approaches that could lead to errors in disturbance assessments. Recognising this inherent uncertainty in the quantification of effects the assessment has adopted a precautionary approach at all stages of assessment including:

- Conservative assumptions in the marine mammal baseline (e.g. use of seasonal density peaks, offshore and inshore densities)
- Conservative assumptions in the MDS for the project parameters (Table 7.23)
- Conservative assumptions in the underwater noise modelling (see volume 3, Underwater Noise Technical Report (RPS Group and Seiche, 2024)).

Relevant assumptions have been described throughout this chapter and demonstrate that such layering of conservatism is likely to lead to a very precautionary assessment.

7.12.13.3 Marine Turtles

Auditory Injury

The relevant criteria for injury are considered those contained in the recent ‘Sound Exposure Guidelines for Fishes and Sea Turtles’, by Popper *et al.* (2014). These guidelines set out criteria for injury due to different sources of noise. Where insufficient data exist to determine a quantitative guideline value, the risk is categorised in relative terms as “high”, “moderate” or “low” at three distances from the source: “near” (i.e. in the tens of metres), “intermediate” (i.e. in the hundreds of metres) or “far” (i.e. in the thousands of metres). It should be noted that these qualitative criteria cannot differentiate between exposures to different noise levels and therefore all sources of noise, no matter how noisy, would theoretically elicit the same assessment result.

The injury criteria used in this noise assessment for impulsive piling are given in Table 7.52, where both peak and SEL criteria are unweighted. Physiological effects relating to injury comprise of the following (Popper *et al.,* 2014; Popper and Hawkins, 2016):

- **Mortality and potential mortal injury**: either immediate mortality or tissue and/or physiological damage that is sufficiently severe (e.g. a barotrauma) that death occurs sometime later due to decreased fitness. Mortality has a direct effect upon animal populations, especially if it affects individuals close to maturity.
- **Recoverable injury**: Tissue and other physical damage or physiological effects, that are recoverable but which may place animals at lower levels of fitness, may render them more open to predation, impaired feeding and growth, or lack of breeding success, until recovery takes place.
- **TTS**: Short term changes in hearing sensitivity may, or may not, reduce fitness and survival. Impairment of hearing may affect the ability of animals to capture prey and avoid predators, and also cause deterioration in communication between individuals; affecting growth, survival, and reproductive success. After termination of a sound that causes TTS, normal hearing ability returns over a period that is variable, depending on many factors, including the intensity and duration of sound exposure.

Table 7.52: Criteria For The Onset Of Injury To Marine Turtles Due To Impulsive And Non-Impulsive Sound Sources (Source: Popper *et al.,* 2014)

Sound Source	Parameter	Mortality and Potential Mortal Injury	Recoverable Injury	TTS
Impulsive Piling	SEL, dB re 1 μPa$_2$s	210	(Near) High (Intermediate) Low (Far) Low	(Near) High (Intermediate) Low (Far) Low
	Peak, dB re 1 μPa	>207		
Non-impulsive Sound	-	(Near) Low (Intermediate) Low (Far) Low	(Near) Low (Intermediate) Low (Far) Low	(Near) Moderate (Intermediate) Low (Far) Low
Explosives (e.g. UXO)	Peak, dB re 1 μPa	229 – 234	(Near) High (Intermediate) High (Far) Low	(Near) High (Intermediate) High (Far) Low

It should be noted that there are no thresholds in Popper *et al*. (2014) in relation to noise from high frequency sonar (>10 kHz). This is because the hearing range of marine turtle species falls well below the frequency range of high frequency sonar systems. Consequently, the effects of noise from high frequency sonar surveys on marine turtles has not been conducted as part of this study, due to the frequency of the source being beyond the range of hearing and also due to the lack of any suitable thresholds.

As above for marine mammals, it was assumed that marine turtles would swim away from the sound source at the onset of activity at a constant rate. Therefore, a conservative swim speed of 0.5 m/s (Popper *et al.,* 2014) was incorporated into the model.

Behavioural Disturbance

As above for injury, the most recent criteria for disturbance to marine turtles are considered to be those detailed in Popper *et al.* (2014). The risk of behavioural effects is categorised in relative terms as “high”, “moderate” or “low” at three distances from the source: “near” (i.e. in the tens of metres), “intermediate” (i.e. in the hundreds of metres) or “far” (i.e. in the thousands of metres), as shown in Table 7.53. It is important to note that these criteria are qualitative rather than quantitative. Consequently, a source of noise of a particular type (e.g. piling) would result in the same predicted impact, no matter the level of noise produced or the propagation characteristics.

Table 7.53: Criteria For The Onset Of Behavioural Effects In Marine Turtles For Various Sound Sources (Source: Popper *et al.,* 2014)

Sound Source	Relative Risk of Behavioural Effects
Impulsive Piling	(Near) High (Intermediate) Moderate (Far) Low
Explosives (e.g. UXO)	(Near) High (Intermediate) High (Far) Low
Non-impulsive Sound	(Near) High (Intermediate) Moderate (Far) Low

7.12.14 Injury, Disturbance, and Displacement from Underwater Noise Generated during Piling

7.12.14.1 Construction Phase

Magnitude of Impact

The MDS for this impact is based on the piling of up to four jacket foundations for the new Douglas platform with a maximum hammer energy of 3,000 kJ (Table 7.23). This will require a total of eight piles, with a maximum of 100 minutes of piling each. Therefore, there will be a total of 800 minutes of piling required, which equates to just under 13.5 hours. The magnitude of impact is based on the underwater noise modelling presented in volume 3, Underwater Noise Technical Report (RPS Group and Seiche, 2024). The piling injury ranges are based on a comparison to the relevant impulsive sound thresholds, and disturbance range are based on application of a dose-response curve, as described in section 7.12.13.

Auditory Injury

During impact piling the interaction with the seafloor and the water column is complex. In these cases, a combination of dispersion (i.e. where the waveform shape elongates), and multiple reflections from the sea surface and bottom and molecular absorption of high frequency energy, the sound will lose its impulsive shape after some distance (generally in order of several kilometres).

Southall (2021) discusses this aspect in detail, and notes that "…*when onset criteria levels were applied to relatively high-intensity impulsive sources (e.g. pile driving), TTS onset was predicted in some instances at ranges of tens of kilometres from the sources. In reality, acoustic propagation over such ranges transforms impulsive characteristics in time and frequency. Changes to received signals include less rapid signal onset, longer total duration, reduced crest factor, reduced kurtosis, and narrower bandwidth (reduced high-frequency content). A better means of accounting for these changes can avoid overly precautionary conclusions, although how to do so is proving vexing*". The point is reenforced later in the discussion which points out that "…*it should be recognized that the use of impulsive exposure criteria for receivers at greater ranges (tens of kilometres) is almost certainly an overly precautionary interpretation of existing criteria*".

Consequently, caution should be used when interpreting any results with predicted injury ranges in the order of tens of kilometres from the sources.

The marine mammal PTS injury ranges due to impact piling with and without the use of an ADD for 30 minutes prior to the commencement of piling are shown in Table 7.54. As stated in section 7.11, the use of an ADD is an embedded mitigation measure. With 30 minutes of ADD activation, the threshold for PTS was not exceeded for any marine mammal hearing group (Table 7.54). For marine turtles, the SEL_{cum} threshold for mortality due to impact pile driving was also not exceeded (Table 7.55).

Table 7.54: Auditory Injury Ranges Based On The Cumulative SEL Metric For Marine Mammals Due To Impact Pile Driving Of The Platform Jackets, With And Without The Use Of An ADD (N/E = Threshold Not Exceeded)

Hearing Group	Threshold (Weighted SEL)	Range (m)	
		Without ADD	**With 30 mins ADD**
LF	PTS – 183 dB re 1 µPa²s	1,000	N/E
	TTS – 168 dB re 1 µPa²s	35,300	31,400
HF	PTS – 185 dB re 1 µPa²s	N/E	N/E
	TTS – 170 dB re 1 µPa²s	N/E	N/E
VHF	PTS – 155 dB re 1 µPa²s	20	N/E
	TTS – 140 dB re 1 µPa²s	8,660	5,960

Hearing Group	Threshold (Weighted SEL)	Range (m)	
		Without ADD	**With 30 mins ADD**
PCW	PTS – 185 dB re 1 µPa²s	N/E	N/E
	TTS – 170 dB re 1 µPa²s	3,710	585

Table 7.55: Injury Ranges For Marine Turtles Based On The Cumulative SEL Metric Due To Impact Pile Driving Based On The Cumulative SEL Metric (N/E = Threshold Not Exceeded)

Hearing Group	Response	Threshold (SEL, dB re 1 µPa²s)	Range (m)
Marine turtles	Mortality	210	N/E

The injury ranges for marine mammals based on peak pressure are summarised in Table 7.56 for both the first strike the animal experiences, and the phase of piling with the maximum sound energy. These ranges represent the potential zone for instantaneous injury. The injury ranges are therefore highly dependent upon the hammer energy, but independent of piling duration. It is assumed that, although the piling phase with the highest sound energy has larger injury ranges, the animal would have moved out of the ranges at the time those hammer energies are used. It is important to understand that a pile is a large and distributed source and therefore reporting injury ranges that are smaller than the physical size of the pile based on a point source sound level assumption (i.e. assumption of an infinitesimally small source size) could result in an overestimation of injury range. Harbour porpoise (VHF group) had the largest PTS injury range of 490 m for the maximum SPL (Table 7.56).

Table 7.56: Summary Of Peak Pressure Injury Ranges For Marine Mammals And Marine Turtles Due To The Phase Of Impact Piling Resulting In The Maximum Peak Sound Pressure Level, And Due To The First Hammer Strike

Hearing Group	Threshold (Unweighted Peak)	Range (m)	
		Max Peak Experienced	**First Hammer Strike**
LF	PTS – 219 dB re 1 µPa (pk)	180	45
	TTS – 213 dB re 1 µPa (pk)	184	77
HF	PTS – 230 dB re 1 µPa (pk)	41	17
	TTS – 224 dB re 1 µPa (pk)	69	29
VHF	PTS – 202 dB re 1 µPa (pk)	490	204
	TTS – 196 dB re 1 µPa (pk)	836	349
PCW	PTS – 218 dB re 1 µPa (pk)	118	49
	TTS – 212 dB re 1 µPa (pk)	201	84
Marine turtles	Mortality – 207 dB re 1 µPa (pk)	314	131

There is a possibility that multiple pin piles will need to be installed in a single 24-hour period. The potential SEL_{cum} injury ranges for marine mammals due to impact pile driving of pin piles are modelled as following the same piling schedule, but with continuous installation for 24 hours (this is an overestimation as the vessel will need to reposition). For injury the MDS considers a maximum of two adjacent piles at the same platform (Table 7.23). It is assumed that the marine mammal or marine turtle will swim away from the pile installation and not return to the area within the 24-hour period. As the piling schedule, and therefore the hammer energies, remain unchanged, the injury ranges due to the peak metric will be the same as those for the single pile case (Table

7.56). The results for the consecutive piling are shown in Table 7.57 for marine mammals and Table 7.58 for marine turtles. The PTS threshold was not exceeded for any marine mammal hearing group after 30 minutes of ADD activation. The highest TTS threshold after 30 minutes of ADD activation was 42,800 m for the LF hearing group (minke whale). For marine turtles, the SEL_{cum} threshold for mortality due to consecutive piling was not exceeded.

Table 7.57: Marine Mammal Injury Ranges For Consecutive Pin Pile Installation Based On The Cumulative SEL Metric (N/E = Threshold Not Exceeded)

Hearing Group	Threshold (Weighted SEL)	Range (m)	
		Without ADD	**With 30 min ADD**
LF	PTS – 183 dB re 1 µPa²s	1,905	N/E
	TTS – 168 dB re 1 µPa²s	46,900	42,800
HF	PTS – 185 dB re 1 µPa²s	N/E	N/E
	TTS – 170 dB re 1 µPa²s	N/E	N/E
VHF	PTS – 155 dB re 1 µPa²s	22	N/E
	TTS – 140 dB re 1 µPa²s	11,700	8,960
PCW	PTS – 185 dB re 1 µPa²s	N/E	N/E
	TTS – 170 dB re 1 µPa²s	6,280	3,050

Table 7.58: Marine Turtle Ranges For Consecutive Pin Pile Installation Based On The Cumulative SEL Metric (N/E = Threshold Not Exceeded)

Hearing Group	Response	Threshold (SEL, dB re 1 µPa²s)	Range (m)
Marine turtles	Mortality	210	N/E

Overall, the embedded mitigation measure of ADD activation for 30 minutes resulted in no PTS injury thresholds being exceeded for marine mammals (Table 7.54 and Table 7.57). ADDs are commonly used to mitigate harm to marine mammals from offshore developments and are recommended by the JNCC (2010a) guidance for piling, particularly in periods of low visibility. There are a range of ADDs with different sound source characteristics available (McGarry *et al.,* 2020), and a suitable device will be consulted upon and decided post-submission of the ES. The selected device will be deployed from the piling vessel and activated for a determined duration to allow individuals sufficient time to flee from the source, whilst also minimising the addition sound introduced into the environment. Furthermore, the PTS injury ranges based on the SPL_{pk} thresholds are all within 500 m (Table 7.56). As per the JNCC (2010a) guidance, a standard 500 m mitigation zone will be applied as part of the MMMP, which is also an embedded mitigation measure (see Table 7.32).

Harbour Porpoise

Activation of an ADD for 30 minutes is an embedded mitigation measure for this impact (Table 7.32). As a VHF species, PTS ranges for single or consecutive pin piling were not exceeded with the activation of an ADD for 30 minutes (see Table 7.54 and Table 7.57). Further, PTS ranges for the first hammer strike (204 m) and maximum hammer energy (490 m) were within the standard mitigation zone of 500 m (Table 7.56). As stated in Table 7.32, a standard 500 m mitigation zone will be applied as part of the MMMP (JNCC, 2010a), which is an embedded mitigation measure applicable to this impact.

The population densities provided in Table 7.17 were used to assess the number of animals with the potential to be injured by the different piling scenarios modelled above. For harbour porpoise, the maximum injury range occurred for the maximum SPL_{pk} (490 m; Table 7.56). Only up to one harbour porpoise was assessed as potentially being impacted by this scenario, which corresponded to 0.0001% of the reference population for the Celtic and Irish Seas MU.

Harbour porpoise typically live between 12 years and 24 years and give birth once a year (Fisher and Harrison, 1970). The duration of the construction phase is up to two years, although only eight piles will be installed in this period (as defined in Table 7.23). Depending on the piling schedule, it could potentially overlap with a maximum of two breeding cycles. The duration of the effect in the context of the life cycle of harbour porpoise is classified as medium term, as the risk (albeit very small) is meaningful in the context of the lifespan of this species.

Overall, this impact is predicted to be of local spatial extent with respect to the ranges over which PTS could occur, medium term duration, intermittent throughout the construction phase and, although the impact itself is reversible (i.e. the elevation in underwater sound only occurs during piling), the effect of PTS is permanent. It is predicted that the impact will affect the receptor directly. PTS could affect a small number of animals leading to measurable changes at an individual level, but this is unlikely to affect the wider population. The magnitude is therefore considered to be low.

Bottlenose Dolphin, Common Dolphin, and Risso’s Dolphin

As HF species, PTS ranges for single or consecutive pin piling were not exceeded with or without the activation of an ADD for 30 minutes (see Table 7.54 and Table 7.57). Further, PTS ranges for the first hammer strike (17 m) and maximum hammer energy (41 m) were well within the standard mitigation zone of 500 m (Table 7.56) (JNCC, 2010a).

The population densities provided in Table 7.17 were used to assess the number of animals with the potential to be injured by the different piling scenarios modelled above. For the dolphin species, the maximum injury range occurred for the maximum SPL_{pk} (41 m; Table 7.56). For three species, only up to one animal was assessed as potentially being impacted by this scenario. For bottlenose dolphin, this corresponded to which corresponded to 0.00001% of the reference population for the Irish Sea MU. For common dolphin and Risso’s dolphin, this corresponded to 0.0000001% and 0.000001% of the reference population of the Celtic and Irish Seas MU, respectively.

Overall, this impact is predicted to be of local spatial extent with respect to the ranges over which PTS could occur, medium term duration, intermittent throughout the construction phase and, although the impact itself is reversible (i.e. the elevation in underwater sound only occurs during piling), the effect of PTS is permanent. It is predicted that the impact will affect the receptor directly. Since injury will be fully mitigated via the embedded mitigation there is no residual risk of injury. The magnitude of impact is therefore considered to be negligible.

Minke Whale

As LF species, PTS ranges for single or consecutive pin piling were not exceeded with the activation of an ADD for 30 minutes (see Table 7.54 and Table 7.57). Further, PTS ranges for the first hammer strike (45 m) and maximum hammer energy (180 m) were well within the standard mitigation zone of 500 m (Table 7.56) (JNCC, 2010a).

The population densities provided in Table 7.17 were used to assess the number of animals with the potential to be injured by the different piling scenarios modelled above. For minke whale, the maximum injury range occurred for consecutive piling without the use of an ADD (1,905 m; Table 7.57). Only up to one minke whale was assessed as potentially being impacted by this scenario, which corresponded to 0.001% of the reference population for the Celtic and Greater North Seas MU.

Minke whale typically live up to 60 years and have a gestation period of approximately ten months. Females may give birth to one calf every one to two years and calves are weaned over five to ten months. Therefore, the two-year construction phase could potentially overlap with key breeding/nursing cycles, although only eight piles will be installed. For an individual female, the risk (albeit small) could interrupt at least one key breeding period with additional risk to mother calf pairs during nursing. This is meaningful in the context of the lifetime of an individual and therefore is classed as medium term.

Overall, this impact is predicted to be of local spatial extent with respect to the ranges over which PTS could occur, medium term duration, intermittent throughout the construction phase and, although the impact itself is reversible (i.e. the elevation in underwater sound only occurs during piling), the effect of PTS is permanent. It is predicted that the impact will affect the receptor directly. PTS could affect a small number of animals leading to measurable changes at an individual level, but this is unlikely to affect the wider population. The magnitude of impact is therefore considered to be low.

Grey Seal and Harbour Seal

For grey seal and harbour seal (PCW hearing group), PTS ranges for single or consecutive pin piling were not exceeded with or without the activation of an ADD for 30 minutes (see Table 7.54 and Table 7.57). Further, PTS ranges for the first hammer strike (49 m) and maximum hammer energy (118 m) were well within the standard mitigation zone of 500 m (Table 7.56) (JNCC, 2010a).

The population densities provided in Table 7.17 were used to assess the number of animals with the potential to be injured by the different piling scenarios modelled above. For both species, the maximum injury range occurred for the maximum SPL_{pk} (118 m; Table 7.56). Only up to one grey seal or harbour seal was assessed as potentially being impacted by this scenario. For grey seal, this corresponded to 0.0002% of the reference populations at the relevant Mus (see Table 7.17) and 0.0000003% of the OSPAR Region III population. For harbour seal, this corresponded to 0.00002% of the reference populations at the relevant Mus (Wales, NW England, and Northern Ireland).

Both seal species typically live between 20 years to 30 years with gestation lasting between ten months to 11 months (SCOS, 2021), thus the duration of piling (albeit intermittent over the two-year construction phase) could potentially overlap with up to two breeding cycles. Considering the above, the duration of the effect in the context of life cycle of harbour seal and grey seal is classified as medium term.

Overall, this impact is predicted to be of local spatial extent, medium term duration, intermittent throughout the construction phase and, although the impact itself is reversible (i.e. the elevation in underwater sound only occurs during piling), the effect of PTS is permanent. It is predicted that the impact will affect the receptor directly. Since injury will be fully mitigated via the embedded mitigation there is no residual risk of injury. The magnitude of impact is therefore considered to be negligible.

Marine Turtles

Use of an ADD is not applicable to marine turtles, and therefore, was not modelled. However, the threshold for mortality for single and consecutive piling was not exceeded for (Table 7.55 and Table 7.58). Further, mortality ranges for the first hammer strike (131 m) and maximum hammer energy (314 m) were well within the standard mitigation zone of 500 m (Table 7.56) (JNCC, 2010a).

Injury ranges to marine turtles due to piling activities were not presented in the underwater noise modelling assessment (volume 3, Underwater Noise Technical Report (RPS Group and Seiche, 2024)). As per the criteria by Popper *et al.* (2014) (Table 7.52), insufficient data exist to determine a quantitative guideline value for PTS. Instead, the available criteria for recoverably injury and TTS provide relative terms as “high”, “moderate” or “low” at three distances from the source: “near” (i.e. in the tens of metres), “intermediate” (i.e. in the hundreds of metres) or “far” (i.e. in the thousands of metres). As such, only an assessment on the mortality threshold of marine turtles could be conducted (Table 7.55 and Table 7.58). However, the marine turtle populations within the regional marine mammal and marine turtle study area are likely to be lower than those of the marine mammal IEFs, and this study area does not represent important habitat for reproduction and nesting. Therefore, the two-year construction phase will not overlap with key reproductive events in their life cycles. Considering this, the duration of the effect in the context of life cycle of marine turtles is classified as short term.

Overall, this impact is predicted to be of local spatial extent, short term duration, intermittent throughout the construction phase and, although the impact itself is reversible (i.e. the elevation in underwater sound only occurs during piling), mortality is permanent. It is predicted that the impact will affect the receptor directly. Since the mortality thresholds for single and consecutive piling were not exceeded, the magnitude of impact is **negligible.**

Behavioural Disturbance

<u>All Species</u>

For the assessment of behavioural disturbance as a result of piling at the new Douglas platform, a dose-response approach has been applied for all species.

Empirical evidence from monitoring at OWFs during construction suggests that pile driving is unlikely to lead to 100% avoidance of all individuals exposed, and that there will be a proportional decrease in avoidance at greater distances from the pile driving source (Brandt *et al.,* 2011). This was demonstrated at Horns Rev OWF, where 100% avoidance occurred in harbour porpoise at up to 4.8 km from the piles, whilst at greater distances (10 km plus) the proportion of animals displaced reduced to <50% (Brandt *et al.,* 2011). Similarly, Graham *et al*. (2019) used empirical evidence collected during piling at the Beatrice OWF to demonstrate that the probability of occurrence of harbour porpoise (measured as porpoise positive minutes) increased exponentially moving further away from the sound source. For harbour porpoise, in line with current guidance for assessing behavioural disturbance to this species (NRW, 2023), the dose-response curve was applied as shown by Graham *et al*. (2017) where the probability of response approaches zero at approximately 120 dB SEL_{ss}. In the absence of species-specific data for other cetacean species the same dose response curve was assumed to apply to all cetacean IEFs in this assessment (Figure 7.9).

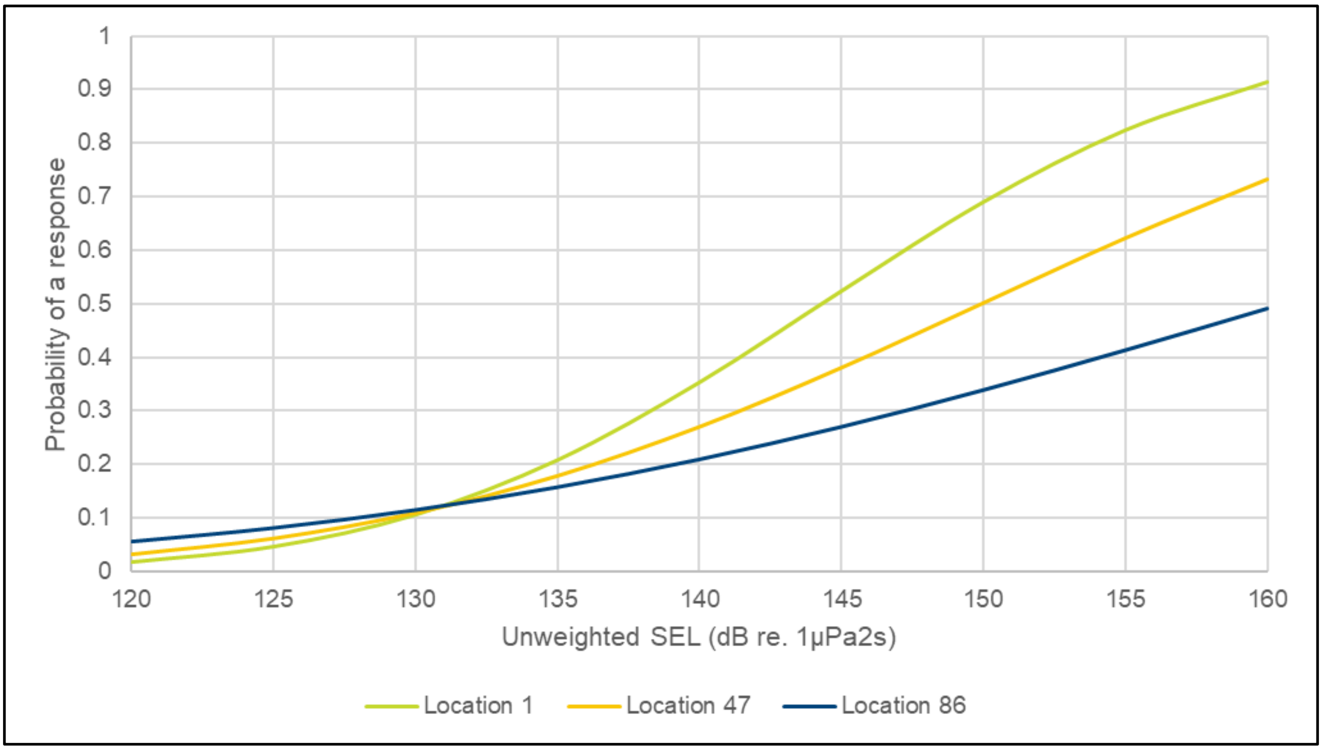

Figure 7.9: The Probability Of A Harbour Porpoise Response (24 hr) In Relation To The Partial Contribution Of Unweighted Received SEL_{ss} For The First Location Piled (Green), The Middle Location (yellow) And The Final Location (blue); Reproduced From Graham *et al*. (2019)

Similarly, a telemetry study undertaken by Russell *et al*. (2016) investigating the behaviour of tagged harbour seal during pile driving at the Lincs Offshore Wind Farm (The Wash) found that there was a proportional response at different received sound levels. Dividing the study area into a 5 km x 5 km grid, the authors modelled SEL_{ss} levels and matched these to corresponding densities of harbour seal in the same grids during non-piling versus piling periods to show change in usage. The study found that there was a significant decrease in usage (abundance) during piling at predicted received SEL levels of between 142 dB and 151 dB re 1µPa^{2}s.

More recently, a study by Whyte *et al. (*2020) used tracking data from 24 harbour seal to estimate the effects of pile driving sounds on this species. Predicted SEL_{cum} experienced by each seal were compared to different auditory weighting functions and thresholds for TTS and PTS. The study used predictions of seal density during pile driving made by Russel*l et al*. (2016) compared to distance from the wind farm and predicted SEL_{ss} by multiple approaches. Predicted seal density significantly decreased within 25 km or SEL_{ss} (averaged across depths and pile installations) above 145 dB re 1 lPa^2. Predictions of seal density, and changes in seal density, during piling were provided in Whyte *et al.* (2020), averaged across all water depths and piling events. A dose response curve derived from this study (Figure 7.10) was therefore applied to the seal assessment to determine the number of animals that may potentially respond behaviourally to received sound levels during piling. Unweighted SEL_{ss} contours were plotted in 5 dB isopleths in decreasing increments from 180 dB to 120 dB re. 1 µPa^{2}s using the highest modelled received sound level.

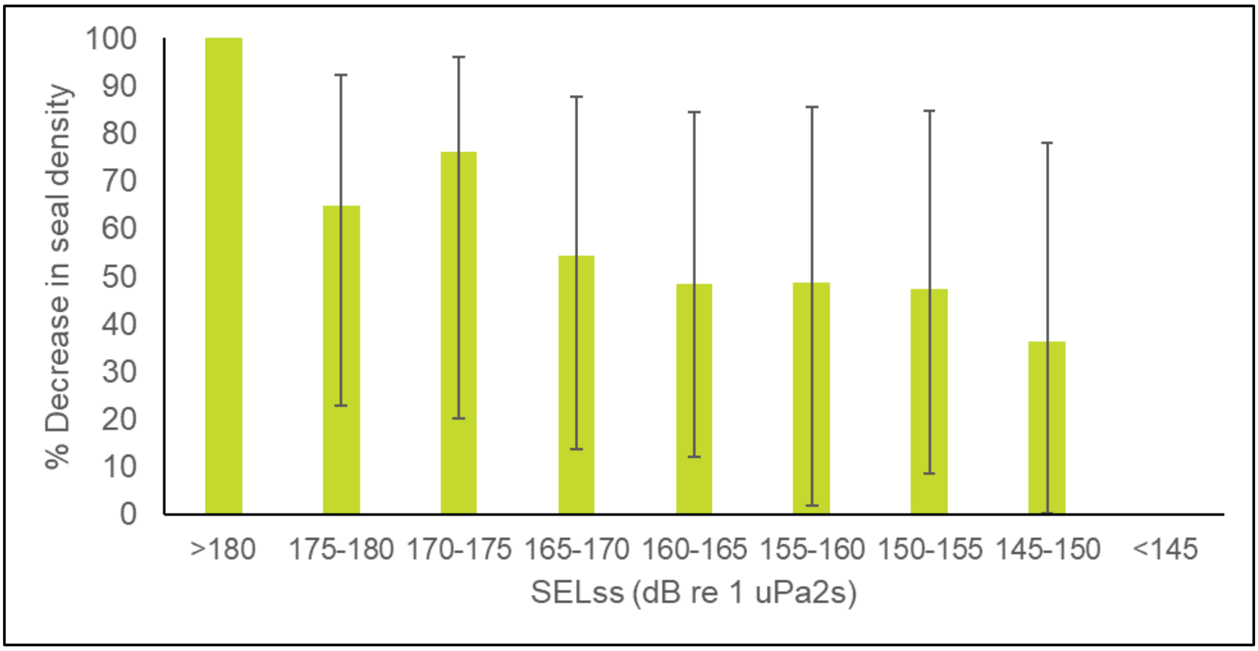

Figure 7.10: Predicted Decrease In Seal Density As A Function Of Estimated Sound Exposure Level, (Error Bars Show 95% CI) (From Whyte *et al.,* 2020)

To adopt the most precautionary approach, the dose-response contours were plotted in Geographical Information System (GIS) for the modelled piling location (Figure 7.11). The areas within each 5 dB isopleth were calculated from the spatial GIS map and a proportional expected response, derived from the dose response curve for each isopleth area, was used to calculate the number of animals potentially disturbed. These numbers were subsequently summed across all isopleths to estimate the total number of animals disturbed during piling. The number of animals predicted to respond was based on species-specific densities as agreed with statutory consultees (Table 7.17).

Using the dose-response approach as per NRW guidance (NRW, 2023) for harbour porpoise based on the SCANS-III Block F density estimate of 0.086 animals per km^2, 158 animals have the potential to be disturbed, representing 0.25% of the reference population of the Celtic and Irish Sea MU (Table 7.59). When this is based upon the recent SCANS-IV Block CS-E density estimate (0.5153 animals per km^2), this is equivalent to 945 animals or 1.51% of the reference population. The large increase in harbour porpoise density between SCANS-III Block F (0.086 animals per km^2) and SCANS-IV Block CS-E (0.5153 animals per km^2) is unlikely to represent a long-term increase, given the short timeframe over which the increase has occurred and the 'snap-shot' nature of the SCANS surveys. For these reasons, these two density estimates have been considered as the lower and upper limits, with actual density likely sitting within this range.

For bottlenose dolphin, 20 animals (6.51% of the Irish Sea MU population) were predicted to be disturbed. However, this increased to 65 animals (21.91%) for the density estimates for Cardigan Bay (0.035 animals per km^2) derived from Lohrengel *et al.* (2018). It should be noted that the densities derived from Lohrengel *et al.* (2018) are more precautionary, and the prediction of 20 bottlenose dolphin is more realistic. Similarly, for grey seal, 125 animals were predicted to be disturbed using the average densities from Carter *et al.* (2022) overlaid on the Proposed Development marine mammal and marine turtle study area. In contrast, if the maximum densities were used, this value increased to 1,084 animals. It should be noted that the value of 125 grey seal is more realistic. A similar trend was also observed for harbour seal (Table 7.59).

For all other marine mammal IEFs, the number of animals with the potential to be disturbed was predicted to be <100 and represented <0.5% of their respective reference populations (Table 7.59).

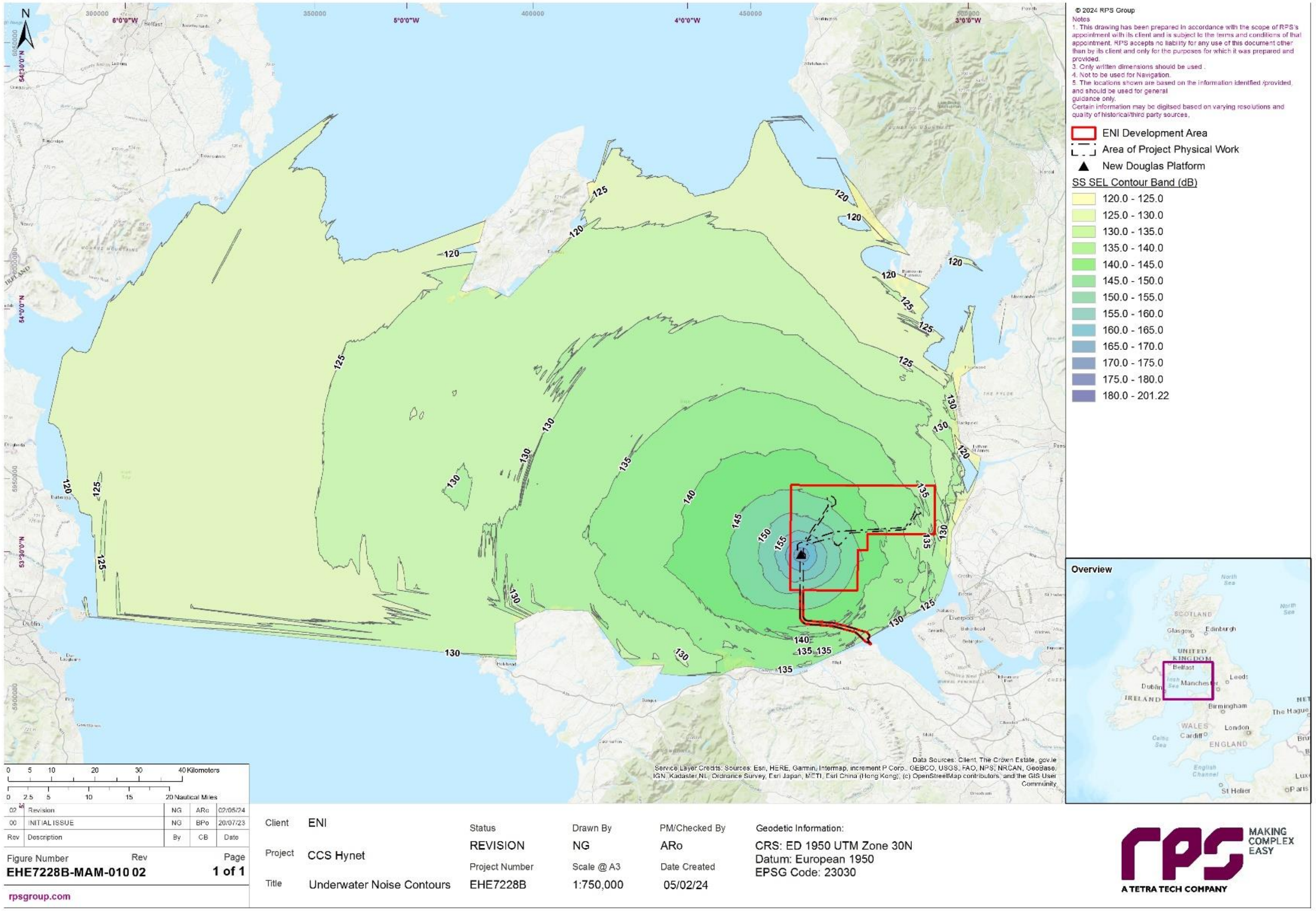

Figure 7.11: Maximum Adverse Piling Scenario At The Greatest Spatial Extent, Showing SEL_{ss} Noise Contours In 5 dB Isopleths

Table 7.59: Potential Number Of Animals Predicted To Be Disturbed Within Weighted SEL_{ss} Noise Contours As A Result Of Piling. Densities Derived From The Sources Presented In Table 7.17

Species	Density (animals per km^2)	New Douglas Platform Pile Installation		
		Number of Animals (based on dose-response)	% Reference Population (MU)	% OSPAR III Region
Harbour porpoise	0.086	158	0.25	N/A
	0.515	945	1.51	N/A
Bottlenose dolphin	0.010	20	6.51	N/A
	0.035	65	21.91	N/A
Common dolphin	0.027	50	0.05	N/A
Risso's dolphin	0.0313	58	0.47	N/A
Minke whale	0.009	17	0.08	N/A
Grey seal	0.467	125	0.92	0.21
	4.06	1,084	7.99	1.78
Harbour seal	0.0049	2	0.09	N/A
	0.593	159	11.1	

As only eight piles will be installed throughout the 2-year construction phase with an expected maximum total piling duration of 800 minutes (approximately 3.5 hours), behavioural disturbance will be short term and intermittent over the construction phase. As animals are expected to recover quickly after disturbance, only a minor alteration to the distribution of individuals within the regional marine mammal and marine turtle study area is possible. Regardless of the small scale of the response, behavioural disturbance associated with piling will be reduced by tertiary mitigation summarised in Table 7.32 and described in volume 4: Marine Mammal Mitigation Plan. Similarly, primary measures employed to mitigate injury (Table 7.32) are also expected to reduce disturbance due to piling. Overall, the impact of piling leading to behavioural effects is predicted to be of local spatial extent, short term duration, and intermittent over the construction phase. Further, the effect of behavioural disturbance is of high reversibility (with animals returning to baseline levels soon after surveys have ceased). It is predicted that the impact will affect the receptor directly. Therefore, for all marine mammal IEFs, the magnitude of impact is considered to be low.

As there are no population densities available for marine turtles (Table 7.17), a qualitative assessment was not possible. However, the marine turtle populations within the regional marine mammal and marine turtle study area are likely to be lower than those of the marine mammal IEFs, and this study area does not represent important habitat for reproduction and nesting. As marine turtles are not as sensitive to underwater noise as marine mammals, the magnitude of impact is not likely to be higher than that presented for the marine mammal IEFs. Therefore, a low magnitude of impact can be extrapolated from that presented above for the marine mammal IEFs.

Sensitivity of Receptor

Auditory Injury

<u>Harbour Porpoise</u>

It has been reported that hearing impairment due to exposure to piling noise is likely to occur where the source frequencies overlap the range of peak sensitivity for the receptor species rather than across the whole frequency hearing spectrum (Kastelein *et al*., 2013). This study demonstrated that harbour porpoise hearing around 125 kHz (the key frequency for echolocation) was not affected by simulated piling sound (broadband spectrum). Rather, a measurable threshold shift in hearing was induced between frequencies of 4 kHz to 8 kHz, although the magnitude of the shift was relatively small (2.3 dB to 3.6 dB at 4 kHz to 8 kHz). This relatively small shift was due to most of the energy from the simulated piling occurring in lower frequencies, which generate lower received SELs (Kastelein *et al.,* 2013). More recently, the authors confirmed that sensitivity declined sharply above 125 kHz (Kastelein *et al.,* 2017), providing further information to confirm the hearing range and sensitivities of harbour porpoise.

In addition to sound frequency, the duty cycle of fatiguing sounds is also likely to affect the magnitude of a hearing shift in harbour porpoise. For example, it has been suggested that hearing may recover to some extent during inter-pulse intervals, and that fatiguing sound is an important parameter in determining the magnitude of TTS (Kastelein *et al*., 2014). Similarly, Finneran (2015) highlights that whilst a threshold shift can accumulate across multiple exposures, the resulting shift will be less than the shift from a single, continuous exposure with the same total SEL. Again, this suggests that the ranges predicted by the underwater noise model using the SEL_{cum} metric are likely to be overestimates.

When assessing sensitivity to injury, a clear distinction between PTS and TTS must be made. TTS is temporary and reversible hearing damage, and therefore it is anticipated that any animals experiencing TTS would recover after they are no longer exposed to elevated noise levels (i.e. they may have moved beyond the injury zone or piling has ceased). The implication of animals experiencing TTS, leading to potential displacement, is not fully understood, but it is likely that aversive responses to anthropogenic noise could temporarily affect life functions, such as communication, foraging, mating, and predator detection. However, acute effects are less likely due to the reversibility of TTS. Further, in order to minimise exposure to sound, some cetaceans are able to undertake some self-mitigation measures, such as changing the orientation of the head to reduce sound levels reaching the ears. They may also be able to suppress hearing sensitivity by one or more neurophysiological auditory response control mechanisms in the middle ear, inner ear, and/or central nervous system. Self-mitigation has been reported for harbour porpoise by Nachtigall *et al.* (2017), who demonstrated a change in hearing levels when exposed to a loud warning sound. Kastelein *et al.* (2020) highlighted the lack of reproducibility of TTS in a harbour porpoise after exposure to repeated airgun sounds, suggesting that these discrepancies may be due to self-mitigation. The characteristics of the sound that the animal is exposed and the shift in hearing experienced will influence the degree and speed of hearing recovery. Following exposure to a sound source of 75 db re 1 µPa (SEL) over 120 minutes found that harbour porpoise recovery to the pre-exposure threshold was estimated to be complete within 48 minutes after exposure (e.g. the higher the hearing threshold shift, the longer the recovery) (Sea Mammal Research Company (SEAMARCO), 2011). Scientific understanding of this is limited to the results of controlled exposure studies on small numbers of captive animals (reviewed in Finneran, 2015). Therefore, extrapolating these results to the natural environment should be treated with caution as it is not possible to exactly replicate natural environmental conditions in captive studies. Furthermore, the small number of test subjects would not account for intraspecific differences (i.e. differences between individuals) or interspecific differences (i.e. extrapolating to other species) in response. Overall, since TTS is reversible, harbour porpoise is assessed as having high tolerance, medium vulnerability, high recoverability, and international value. The sensitivity of harbour porpoise to TTS is therefore considered to be low.

On the contrary, PTS is permanent and irreversible hearing damage. Thus, it is expected that harbour porpoise is sensitive to PTS as it would affect key life functions (e.g. communication, predator detection, foraging, mating, and maternal fitness) and could lead to a chronic and/or acute health problems (Erbe *et al.,* 2018). Due to a lack of empirical data, it is challenging to equate onset of PTS with biologically significant responses, however a potential consequence is a deterioration in health, which could potentially lead to reduced birth rate in females and mortality of individuals (Costa, 2012). The assessment of sensitivity takes into account the uncertainty surrounding the effects of PTS on survival and reproduction and the importance of sound for echolocation, foraging and communication. Although a threshold shift may occur outside of the most sensitive hearing range, the occurrence of PTS in harbour porpoise, due to the species reliance on hearing, could be detrimental to an individual's capacity for survival and reproduction. Since PTS is irreversible, harbour porpoise is assessed as high vulnerability, low recoverability, low tolerance, and international value. The sensitivity of harbour porpoise to PTS is therefore considered to be high.

Bottlenose Dolphin, Common Dolphin, and Risso's Dolphin

PTS would induce a biological effect that could impact the health and vital rates of these dolphin species (Erbe *et al*., 2018), which are all classed as HF cetaceans (Southall *et al*., 2019). As described for harbour porpoise above, there are frequency-specific differences in the onset and growth of a sound-induced threshold shift in relation to the characteristics of the sound source and hearing sensitivity of the receiving species. For example, Finneran and Schlundt (2013) demonstrated that exposure of two captive bottlenose dolphin to an impulsive sound source between 3 kHz and 80 kHz increased susceptibility to auditory fatigue between frequencies of 10 kHz. to 30 kHz. The SEL_{cum} threshold incorporates hearing sensitivities of marine mammals and the magnitude of effects for HF species are considerably smaller compared to the VHF species (e.g. harbour porpoise) and LF species (e.g. minke whale). This highlights that species such as bottlenose dolphin, common dolphin and Risso's dolphin are less sensitive to the frequency components of the piling sound signal. Self-mitigation has also been reported for bottlenose dolphin by Nachtigall *et al.* (2017), who demonstrated that a change in hearing levels when exposed to a loud warning sound. The assessment of sensitivity considered the irreversibility of the effects (as noted for harbour porpoise above) and importance of sound for echolocation, foraging and communication in small, toothed cetaceans.

Although there are no species-specific recovery rates for these dolphin species to TTS available, there is no evidence to suggest that recovery rates will be significantly different to those for harbour porpoise. Therefore, the hearing of these dolphin species will recover once they are no longer exposed to elevated noise levels (i.e. they may have moved beyond the injury zone or piling has ceased). Given that bottlenose dolphin, common dolphin, and Risso's dolphin would be able to tolerate TTS without any impact on reproduction or survival rates and would be able to return to previous behavioural states or activities once the impacts had ceased, these species are of medium vulnerability, high tolerance, high recoverability and international value. The sensitivity of these receptors to TTS is therefore considered to be low.

The assessment of sensitivity provided below takes into account the uncertainty surrounding the effects of PTS on survival and reproduction and the importance of sound for echolocation, foraging and communication. Bottlenose dolphin, short-beaked dolphin and Risso's dolphin are deemed to have low tolerance to PTS, low recoverability, high vulnerability, and international value. Therefore, the sensitivity of these receptors to PTS is considered to be high.

Minke Whale

Unlike dolphins and harbour porpoise, minke whale do not echolocate. However, they can produce and hear sounds, via a skull vibration enabled bone conduction mechanism and are likely to do so for communication (Cranford and Krysl, 2015). Although empirical evidence on minke whale hearing is limited, however it has been indicated that their hearing is likely to operate at similar frequencies to those of anthropogenic noise sources (Tubelli, *et al.,* 2012). Minke whale are baleen whales, which have an estimated functional hearing range between 17 Hz and 35 kHz, and it is likely that they rely on LF hearing (Ketten and Mountain, 2009). More recently, a best frequency range of between 30 Hz to 7.5 kHz or between 100 Hz to 25 kHz (depending on stimulation location) was predicted for the middle ear transfer function in minke whale (i.e. a measure of the transmission of acoustic energy from the external ear to the cochlea) (Tubelli, *et al.,* 2012). Similarly, a strong reaction to a 15 kHz ADD was recorded in a controlled exposure study on free-ranging minke whale in Iceland, suggesting that this frequency is the likely upper limit of their hearing sensitivity (Boisseau *et al.,* 2021). As described for harbour porpoise above, there are likely to be frequency-specific differences in the onset and growth of a sound-induced threshold shift in relation to the characteristics of the sound source and hearing sensitivity of the receiving species.

The assessment of sensitivity provided below considers the uncertainty surrounding the effects of PTS on minke whale survival and reproduction and the importance of sound for communication. Given that any effects of PTS will be irreversible (i.e. as noted for harbour porpoise above), minke whale are deemed to be of high vulnerability, low recoverability, low tolerance, and of international value. Therefore, the sensitivity of minke whale to PTS is considered to be high.

Although there are no species-specific recovery rates for minke whale to TTS available, there is no evidence to suggest that recovery rates will be significantly different to those for harbour porpoise. Furthermore, minke whale exhibit a temporal distribution in UK and Irish waters, with most sightings in continental shelf waters occurring between May and September. SCANS III surveys were carried out during summer months, and therefore density values, and subsequent predicted numbers to be affected for minke whale will be overly conservative for piling activities occurring during winter months. Given that minke whale would be able to tolerate the effect of TTS without any impact on reproduction or survival rates and would be able to return to previous behavioural states or activities once the impacts had ceased, minke whale are considered to be of medium vulnerability, high tolerance, high recoverability and of international value. Therefore, the sensitivity of minke whale to TTS is considered to be low.

Grey Seal and Harbour Seal

Seals are less reliant on hearing for foraging than cetacean species but may rely on sound for communication and predator avoidance (Deecke *et al*., 2002). They use their vibrissae (i.e. whiskers) to detect swimming fish (Schulte-Pelkum *et al.,* 2007), however, in certain conditions, they may also listen to sounds produced by fish in order to forage. Therefore, a reduction in fitness, reproductive output and longevity are potential ecological consequences of a sound induced threshold shift (Kastelein *et al.,* 2018a). Based on calculations of SEL of tagged harbour seal during the construction of the Lincs OWF (Greater Wash, England), at least half of the tagged seals would have received sound levels from pile driving that exceeded auditory injury thresholds (e.g. PTS) for pinnipeds (Hastie, *et al.,* 2015). However, as population estimates indicated that the relevant population trend is increasing and therefore, these predicted levels of PTS were not sufficient to cause a decrease in the population trajectory (although it should be noted that there are many other ecological factors that will influence the population health) (Hastie *et al.,* 2015). The authors noted that due to lack of data on effects of sound on seal hearing, the exposure criteria used are intentionally conservative and therefore predicted numbers of individuals likely to be affected by PTS would also have been highly conservative (Hastie *et al.,* 2015). However, despite the uncertainty surrounding PTS in seals, they rely on hearing much less than cetaceans and therefore would likely exhibit some tolerance (i.e. the effect is unlikely to cause a change in either reproduction or survival rates). In addition, it has been proposed that seals may be able to self-mitigate (i.e. reduce their hearing sensitivity in the presence of loud sounds) (Kastelein *et al.,* 2018a), as has been observed in odontocetes (Nachtigall *et al.,* 2018). However, it is not clear how long odontocetes can self-mitigate, or if seals can do this as well (Kastelein, *et al.,* 2018a). Seals may also be able to reduce their exposure to underwater noise by swimming near the water's surface, where SPLs are often lower (Kastelein *et al.,* 2018b).

Recently, Reichmuth *et al.* (2019) reported the first confirmed case of PTS following a known acoustic exposure event in a seal. The study included evaluation of the underwater hearing sensitivity of a trained harbour seal before and immediately following exposure to 4.1 kHz tonal fatiguing stimulus, and rather than the expected pattern of TTS onset and growth, an abrupt threshold shift of >47 dB was observed half an octave above the exposure frequency (Reichmuth *et al.*, 2019). Hearing at 4.1 kHz recovered within 48 hours, however, there was a PTS of at least 8 dB at 5.8 kHz, and hearing loss was evident for more than ten years (Reichmuth *et al.*, 2019).

Although the evidence from Hastie *et al.* (2015) suggests a lower sensitivity of pinnipeds to PTS, based on uncertainties and the results of Reichmuth *et al.* (2019), a precautionary approach has been taken in the assessment of sensitivity to PTS. Harbour seal and grey seal are deemed to have a low tolerance to PTS, low recoverability, high vulnerability, and of international value. Therefore, the sensitivity of these receptors to PTS is considered to be high.

A study measuring recovery rates of harbour seal following exposure to a sound source of 193 dB re 1 $\mu Pa^2 s$ (SEL_{cum}) over 360 minutes found that recovery from TTS to the pre-exposure baseline was estimated to be complete within 72 minutes following exposure (Kastelein *et al.,* 2018a). This is similar to recovery rates found in SEAMARCO (2011), which showed that for small TTS values, recovery in seals was very fast (around 30 mins); the higher the hearing threshold shift, the longer the recovery. Therefore, in most cases, reduced hearing for such a short time probably has little effect on the total foraging period of a seal. However, if hearing is impaired for longer periods (hours or days) the impact is likely to be ecologically significant (SEAMARCO, 2011). These results indicate that harbour seal (and therefore grey seal, using harbour seal as a proxy) are less vulnerable to TTS than harbour porpoise for the noise bands tested. It is also expected that seals would move beyond the injury range prior to the onset of TTS. Thus, grey seal and harbour seal are likely to be able to tolerate the effect of TTS without any impact on both reproduction and survival rates and would be able to return to previous behavioural states or activities once the impacts had ceased. Grey seal and harbour seal are considered to be of medium vulnerability, high tolerance, high recoverability and international value. Therefore, the sensitivity of these receptors to TTS is considered to be low.

Marine Turtles

Marine turtles are known to migrate through and feed within the regional marine mammal study area during the summer months. Therefore, they have the potential to be within the range of underwater noise impacts due to piling and would be sensitive to these impacts during that time of the year.

Marine turtles are able to detect LF sound (Ridgeway *et al.,* 1969; Bartol and Ketten, 2006; Lavender *et al.,* 2012; Martin *et al.,* 2012; Piniak *et al.,* 2012, 2016). Elevated underwater noise generated during piling has the potential to cause tissue damage and mortality in marine turtles (Nelms *et al.,* 2016). Studies have shown that marine turtles display avoidance and startle responses when exposed to impulse sounds (Lenhardt, 1994; McCauley *et al.,* 2000). These responses include increased swim speeds and altered dive durations, although the effects of these responses are largely unknown for marine turtles (reviewed in Nelms *et al.,* 2016). These responses may lead to physical injury and mortality as a result of decompression sickness and strandings, as is observed for marine mammals (Gordon *et al.,* 2003; Wright *et al.,* 2007; Mann *et al.,* 2010; Jepson *et al.,* 2013). Furthermore, García-Párraga *et al.* (2014) recorded decompression sickness in loggerhead sea turtles, although the study was not in relation to impacts of underwater noise. Although marine turtles use sound for predator avoidance (Piniak *et al.,* 2016), reliance on hearing for survival and reproduction is expected to be lower than in cetaceans and therefore animals would exhibit some tolerance (i.e. the effect is unlikely to cause a change in either reproduction or survival rates).

Overall, marine turtles are deemed to be of low tolerance to PTS, medium vulnerability, low recoverability, and international value. Therefore, the sensitivity of marine turtles to PTS has been considered, conservatively, to be high.

Whilst recovery rates from recoverable injury and TTS for marine turtles are unknown, it is expected that individuals would move beyond the injury range prior to the onset of impairment. Given that marine turtles likely to be able to tolerate the effect without any impact on reproduction or survival rates and would be able to return to previous behavioural states or activities once the impacts had ceased, they are deemed to be of medium tolerance, medium vulnerability, high recoverability, and international value. Therefore, the sensitivity of marine turtles to recoverable injury and TTS is considered to be low.

Behavioural Disturbance

Harbour Porpoise

As a small cetacean species, harbour porpoise has a high metabolic requirement and is vulnerable to heat loss through radiation and conduction. They must forage frequently to build sufficient fat reserves for insulation. For example, a study on six non-lactating harbour porpoise and found that they require between 4% and 9.5% of their body weight in fish per day (Kastelein *et al.*, 1997). Wild harbour porpoise have been reported to forage almost continuously day and night to achieve their required calorific intake (Wisniewska *et al.*, 2016) and therefore they are vulnerable to starvation if their foraging is interrupted. Although there were no site-specific marine mammal surveys conducted for the Proposed Development, harbour porpoise were sighted year round in site-specific surveys of OWFs that overlap with the Proposed Development (Gwynt y Môr OWF and Awel y

Môr OWF) (CMACS, 2005b; Goddard *et al.,* 2017; 2018; Goulding *et al.,* 2019; Sinclair *et al.,* 2021), and could therefore be vulnerable to piling throughout the year.

The variance in behavioural responses to increased underwater noise is well documented and is context specific. Factors such as the activity state of the receiving animal, the nature and novelty of the sound (i.e. previous exposure history), and the spatial relation between sound source and receiving animal are important in determining the likelihood of a behavioural response and therefore their sensitivity (Ellison *et al*., 2012).

Recently, Kastelein *et al.* (2022) studied the effects of six piling sounds (average in the pool of up to 135 dB re 1 μPa^{2}s) on one harbour porpoise under experimental conditions. The harbour porpoise was subjected to test periods of 15 minutes, where it was exposed to piling sounds. Behaviours was observed to return to normal immediately after each test period in which the harbour porpoise responded to the sound by behavioural reaction (e.g. changing her respiration rate, moving away from the sound source) (Kastelein *et al.,* 2022). At-sea measurements reported by Brandt *et al.* (2012) observed reduced porpoise acoustic activity within a 2.6 km range from a piling site 24 hours to 72 hours after sounds stopped, although shorter return times were recorded after application of sound abatement methods such as air bubble screens (for approximately six hours). The discrepancy between times required for harbour porpoise to return to the affected area in the pool (Kastelein *et al.,* 2022) versus at sea (Brandt *et al.,* 2012) are likely to relate to the SEL experienced by the animal, which depends on their distance from the piling location at sea (Kastelein *et al.,* 2022). The frequency content of sounds is an important factor determining the response of harbour porpoise to piling, and the high-frequency part of the spectrum of impulsive pile driving has a relatively large effect on their behaviour (Kastelein *et al.,* 2022).

Empirical evidence from monitoring at OWFs during construction suggests that pile driving is unlikely to lead to 100% avoidance of all individuals exposed, and that there will be a proportional decrease in avoidance at greater distances from the pile driving source (Brandt *et al*., 2011). This was demonstrated at Horns Rev OWF, where 100% avoidance occurred in harbour porpoises at up to 4.8 km from the piles, whilst at greater distances (10 km plus) the proportion of animals displaced reduced to <50% (Brandt *et al.,* 2011). Furthermore, recent results from the Beatrice OWF suggest that harbour porpoise may adapt to increased noise disturbance over the course of the piling phase, thereby showing a degree of tolerance and behavioural adaptation (Graham *et al.,* 2019). The authors also demonstrated that the probability of occurrence of harbour porpoise (measured as porpoise positive minutes) increased exponentially moving further away from the noise source. Similarly, a study of seven OWFs constructed in the German Bight also showed that harbour porpoise detections declined several hours before the start of pling within the vicinity of the construction site (up to 2 km) and were reduced for about one to two hours post-piling, whilst at the maximum effect distances (from 17 km out to approximately 33 km) avoidance only occurred during the hours of piling (Brandt *et al*., 2018). Harbour porpoise detections during piling were found at sound levels exceeding 143 dB re 1 μPa^{2}s and at lower received levels (i.e. at greater distances from the source) there was little evident decline in porpoise detections (Brandt *et al.,* 2018). These studies demonstrate the dose-response relationship between received noise levels and declines in porpoise detections although noting that the extent to which responses could occur will be context-specific such that, particularly at lower received levels (i.e. 130 dB -140 dB re 1 μPa2s), detectable responses may not be apparent from region to region.

As presented in section 7.12.13, Southall *et al.* (2021) build on the earlier work presented in Southall et al. (2007) and the expanding literature in this area to introduce a concept of a behavioural response severity spectrum. This spectrum has a progressive severity of possible responses within three response categories: survival, feeding, and reproduction. For example, between seven and nine on the spectrum, where sensitivity is highest, displacement is likely to occur resulting in movement of animals to areas with an increased risk of predation and/or with sub-optimal feeding grounds (Southall *et al.,* 2021). A failure of vocal mechanisms to compensate for sound can result in interruption of key reproductive behaviour including mating and socialising, causing a reduction in an individual's fitness leading to potential breeding failure and impact on survival rates.

There are limitations of the single step-threshold approach for strong disturbance and mild disturbance as it does not account for inter- or intra-specific variance or context-based variance. Acknowledging these limitations, harbour porpoise within an area modelled as 'strong disturbance' would be most sensitive to behavioural effects and therefore may have a response score of seven or above according to Southall *et al*. (2021). The potential severity of effects reduces towards the lower end of the spectrum, where there may be some detectable responses that could result in effects on the short-term health of animals. However, these are less likely to impact an animals' survival rate. For example, mild disturbance (score four to six on the spectrum) could lead to effects such as changes in swimming speed and direction, minor disruptions in communication, interruptions in foraging, or disruption of parental attendance/nursing behaviour (Southall *et al.,* 2021).

Although harbour porpoise may be able to avoid the disturbed area and forage elsewhere, the reproductive success of some individuals could potentially be affected. As mentioned above, it is anticipated that there would be some adaptability to the elevated sound levels from piling and therefore survival rates are not likely to be affected. Due to uncertainties associated with the effects of behavioural disturbance on vital rates of harbour porpoise, the assessment is highly conservative as it assumes the same level of sensitivity for both strong and mild disturbance, noting that for the latter the sensitivity is likely to be lower.

Harbour porpoise is deemed to have some tolerance to behavioural disturbance, medium vulnerability, high recoverability, and international value. Therefore, the sensitivity of harbour porpoise to behavioural disturbance is considered to be medium.

Bottlenose Dolphin, Common Dolphin, and Risso's Dolphin

Bottlenose dolphin, common dolphin and Risso's dolphin have larger body sizes and lower metabolic rates than harbour porpoise. Therefore, they have a lower necessity to forage frequently and are thought to be less vulnerable to disturbance than harbour porpoise. Common dolphin exhibit seasonal shifts around the UK and Ireland. Individuals move onto continental waters in the summer (coinciding with the mating/calving period) and come back to inshore waters during winter. As they tend to move towards the Celtic Shelf and into the western English Channel and St. George's Channel, probability of presence within Proposed Development is low. There were no site-specific marine mammal surveys undertaken for the Proposed Development, but these dolphin species were recorded sporadically in results of site-specific surveys of OWFs that overlap with the Proposed Development (Gwynt y Môr OWF and Awel y Môr OWF) (CMACS, 2005b; Goddard et al., 2017; 2018; Goulding et al., 2019; Sinclair et al., 2021). Bottlenose dolphin is largely coastally distributed in relation to the regional marine mammal study area and are more abundant during summer and autumn compared to late winter and early spring months (Baines and Evans, 2012). Risso's dolphin are mostly common in Manx territorial waters and there is a potential for these species to be present in the vicinity of the Proposed Development in the summer months (for more details see volume 3, RPS Group (2024a)). Overall, due to their distribution and seasonality these species are unlikely to be disturbed year-round as a result of piling. Additionally, these is no indication that waters within the Proposed Development are important for foraging or breeding for these species.

There is limited information regarding the specific sensitivities of HF cetaceans to disturbance from piling sound as most studies focus on harbour porpoise. A study of the response of bottlenose dolphin to piling sound during harbour construction works at the Nigg Energy Park (north-east Scotland) found that there was a weak but measurable response to impact and vibration piling with animals reducing the amount of time they spent in the vicinity of the construction works (Graham *et al.,* 2017). Fernandez-Betelu *et al.* (2021) investigated dolphin detections during impact piling at the Beatrice OWF and Moray OWF and found surprising results at small temporal scales. The reported an increase in dolphin detections on the southern Moray coast on days with impulsive sound compared to days without with predicted maximum received levels in coastal areas of 128 dB re 1μPa^{2}s and 141 dB re 1μPa^{2}s, respectively. The authors warned that caution must be exercised in interpreting these results as increased click changes do not necessarily equate to larger group sizes but may be due to a modification in behaviour (e.g. an increase in vocalisations during piling) (Fernandez-Betelu *et al*., 2021). The results of this study suggest that impulsive sound generated during piling at the OWFs did not cause any displacement of bottlenose dolphin from their population range.

Due to the low abundance of these three dolphin species in the vicinity of the Proposed Development, they may be able to avoid the disturbed area. Whilst there may some impacts on reproduction in closer proximity to the source (i.e. within the area of 'strong disturbance'), these are unlikely to impact on survival rates as some tolerance is expected to build up over the course of the piling. It is anticipated that animals would return to previous activities once the impact had ceased.

As above for harbour porpoise, the severity spectrum presented by Southall *et al*. (2021) applies across all marine mammals considered in this assessment. Therefore, it is expected that, as described for harbour porpoise, strong disturbance in the near field could result in displacement whilst mild disturbance over greater ranges would result in other, less severe behavioural responses.

Overall, bottlenose dolphin, common dolphin, and Risso's dolphin are deemed to have some tolerance to behavioural disturbance, low vulnerability, high recoverability and international value. Therefore, the sensitivity of these receptors to behavioural disturbance is considered to be medium.

Minke Whale

Minke whale have a seasonal occurrence within the Proposed Development marine mammal study area. Although sandeel are thought to be the key prey resource for minke whale within the North Sea, the distribution of minke whale seems to mirror the distribution of herring in Manx and Irish waters (Howe, 2018b). Disturbance from areas that are important for herring could have implications on the health and survival of disturbed minke whales, due to their reliance on herring in the area. Herring habitat in the vicinity of the Proposed Development is described in volume 3, RPS Group (2024a). The majority of the Proposed Development was considered as unsuitable sediment for herring spawning, although significant spawning areas were identified around the Isle of Man. The displacement of minke whale could lead to reduced foraging for disturbed individuals particularly since minke whale maximise their energy storage whilst on feeding grounds by exploiting prey herded by other species (Christiansen *et al*., 2013a). The presence of whale watching boats within an important feeding ground for minke whale in Iceland has been demonstrated to lead to a reduction in foraging activity (Christiansen *et al.,* 2013b). As a capital breeder, such a reduction could lead to reduced reproductive success since female body condition is known to affect foetal growth (Christiansen *et al.,* 2014). However, it is worth noting that the study was conducted in Faxafloi Bay (Iceland) where baseline noise levels are lower in comparison to the eastern Irish Sea. In addition, a subsequent study conducted by Christiansen and Lusseau (2015) in the same study area found no significant long-term effects of disturbance from whale watching on vital rates since whales moved into disturbed areas when sandeel numbers were lower across their wider foraging area.

As expected for all marine mammal species in this assessment, strong disturbances in the nearfield could result in displacement whilst mild disturbance over larger ranges would result in other, less severe behavioural responses (Southall *et al.,* 2021). The Proposed Development is situated in region of relatively high levels of existing sound disturbance due to shipping, fishing, and other vessel activity. Therefore, minke whale that occur within the Proposed Development are subject to underwater noise from existing activities and may be desensitised (to some extent) to increased noise levels, particularly in the far field where mild disturbance could occur.

Overall, minke whale is deemed to have some tolerance to behavioural disturbance, low vulnerability, high recoverability, and international value. The sensitivity of minke whale to behavioural disturbance is therefore, considered to be medium.

Grey Seal and Harbour Seal

Seals could potentially experience mild disturbance; however this constitutes only slight changes in behaviour (such as changes in swimming speed or direction), and is unlikely to result in population-level effects. Although there are likely to be alternative foraging sites for both seal species, barrier effects as a result of installation of the new Douglas platform could either prevent seals from travelling to forage from haul-out sites or force seals to travel greater distances than usual during periods of piling. Strong disturbance could result in displacement of seals from an area.

Hastie *et al.* (2021) measured the relative influence of perceived risk of different sound sources (e.g. silence, pile driving, and a tidal turbine) and prey patch quality (low density versus high density), in grey seal in an experimental pool environment. Their results showed that foraging success was highest under silence, but under tidal turbine and pile driving treatments success was similar at the high-density prey patch but significantly reduced under the low-density prey patch. Therefore, avoidance rates were dependent on the quality of the prey patch as well as the perceived risk from the anthropogenic sound and therefore it can be anticipated such decisions are consistent with a risk/profit balancing approach (Hastie *et al.,* 2021).

There are several empirical studies on seal behaviour during installation of OWFs, which can be extrapolated for this assessment. For example, Russell *et al.* (2016) studied movements of tagged harbour seal during piling at the Lincs OWF (Greater Wash, England) and reported significant avoidance of the OWF. Seal abundance significantly reduced up to 25 km from the piling activity and there was a 19% to 23% decrease in usage within this range (Russell *et al.,* 2016). However, the displacement was limited to pile driving activity only, with harbour seal returning rapidly to baseline levels of activity within two hours of cessation of the piling (Russell *et al.,* 2016). Aarts *et al*. (2018) tracked grey seal during construction of the Luchterduinen OWF and Gemini OWF (The Netherlands) and reported diverse reactions to piling, ranging from altered surfacing and diving behaviour, changes in swimming direction, or coming to a halt. In some cases, however, no apparent changes in diving behaviour or movement were observed (Aarts *et al*., 2018). Similar to the conclusions drawn by Hastie *et al.* (2021) the study at the Luchterduinen and Gemini OWFs suggested grey seal were balancing risk with profit. Whilst approximately half of the tracked grey seal were absent from the pile-driving area altogether, this may be because animals were drawn to other more profitable areas as opposed to active avoidance of the sound, although a small sample size (n=36 animals) means that no firm conclusions could be reached (Aarts *et al.,* 2018). It was notable that, in some cases, grey seal exposed to pile-driving at distances shorter than 30 km returned to the same area on subsequent trips. This suggests that the incentive to go to the area was stronger than potential deterrence effect of underwater noise from pile driving in some seals.

Behavioural changes and subsequent barrier effects could impact the ability of grey and harbour seals to accumulate the energy reserves required for both reproduction and lactation (Sparling *et al.,* 2006). To maximise energy for reproduction, female seals exhibit clear increases in foraging effort (including increased diving) in the run up to the breeding season. Further, during the third trimester of pregnancy, grey seal accumulates reserves of subcutaneous blubber which they use for milk production during lactation (Hall *et al*., 2001). Therefore, grey seal forging at sea may be most vulnerable during this period, as this energy storage is extremely important for offspring survival and female fitness (Mellish *et al.,* 1999; Hall *et al.,* 2001). Consequently, reproduction rates and probability of survival could be impacted by any potential exclusion from foraging grounds during this time.

Seals may also be vulnerable to disturbance during the lactation period, however the extent of which this may occur will depend on their breeding strategy. In particular, behavioural changes could impact harbour seal during lactating periods between June and August, when females spend much of their time in the water with their pups, and foraging is more restricted than during other periods (Bowen *et al.,* 1999). Effects of behavioural disturbance may include reduced fecundity, reduced fitness, and reduced reproductive success. Although harbour seal may be able to avoid the disturbed area to forage elsewhere, there may carry an energetic cost by having to move greater distances to forage, and therefore there may be a potential effect on reproductive success of some individuals. Conversely, the lactation period for grey seal (a capital breeder) is shorter (lasting around 17 days; Sparling *et al.,* 2006). During this time, females fast and remain mostly on shore. Furthermore, as female grey seal do not forage often during this lactation period, it is expected that they may exhibit some tolerance to disturbance as they would not spend as much time in sea, where they can be affected by underwater noise. It should be noted, however, that female grey seal return to the water post-lactation and must forage extensively to build up lost energy reserves.

Overall, grey seal and harbour seal are deemed to have some tolerance to behavioural disturbance, medium vulnerability, high recoverability, and international value. The sensitivity of these receptors to behavioural disturbance is therefore, considered to be medium.

Marine Turtles

Very limited data exists on sea turtle behavioural responses to noise (Nelms *et al.,* 2016), therefore the data which exist for fish have been used as a proxy. Various studies have examined the effect of the sound pressure component of impulsive noise (including piling operations and seismic airgun surveys) on the behaviour of different fish species. For example, an observable behavioural response was recorded for cod between SPL_{pk} 140 to 161 dB re 1 µPa and between SPL_{pk} 144 dB to 156 dB re 1 µPa for sole (Mueller-Blenkle *et al.,* 2010). In rockfish, a startle or 'C-turn' behavioural response was recorded at peak pressure levels, starting at around 200 dB re 1 µPa, although this was less common with larger-bodied individuals (Pearson *et al.,* 1992). McCauley *et al.* (2000) reported a that fish generally moved to the bottom of the cage during periods of high-level exposure in laboratory experiments (greater than rms levels of around 156 to 161 dB re 1 µPa; approximately equivalent to SPL_{pk} levels of around 168 to 173 dB re 1 µPa). These studies align with the criteria for onset of behavioural effects in marine turtles, which state that at 'far' distances from the sound source (thousands of metres) there is likely a low risk of onset of behavioural effects from impulsive piling and at 'intermediate' distances there is likely a moderate risk of onset of behavioural effects from impulsive piling (Table 7.53).

Marine turtles are known to migrate through and feed within the regional marine mammal study area during the summer, which is, therefore, considered to be the most sensitive time of year. However, piling activities are unlikely to result in barrier effects to migration for these species, as the disturbance ranges stated above in the 'Magnitude of Impact' section will likely constitute a small area in the context of the wider available habitat in the Irish Sea. Furthermore, marine turtles do not nest on beaches within the UK and Ireland, therefore their sensitivity to disturbance in this respect will be low. Offshore waters of the Irish Sea could potentially host important feeding grounds for marine turtles (NPWS, 2019), but as previously stated, the area disturbed during piling will likely constitute a very small proportion of available habitat in the context of the wider region. Thus, it is anticipated that marine turtles could tolerate the effects of disturbance without any impact on reproduction and survival rates and would return to previous activities once the impact had ceased.

Overall, marine turtles are deemed to be of low vulnerability, high tolerance, high recoverability, and international value. The sensitivity of marine turtles to behavioural disturbance is therefore, considered to be low.

Significance of Effect

Auditory Injury

Harbour Porpoise

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be high. As per Table 7.31, this results in a 'minor or moderate' significance of effect. Whilst there may be some residual effect with a small number of animals potentially exposed to sound levels that could elicit PTS this is unlikely to affect the international value of the species. Only a very minor loss or detrimental alteration to the harbour porpoise populations will occur due to this impact (see Table 7.27). Therefore, it has been concluded that the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Bottlenose Dolphin, Common Dolphin, and Risso's Dolphin

Overall, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Minke Whale

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be high. As per Table 7.31, this results in a 'minor or moderate' significance of effect. Whilst there may be some residual effect with a small number of animals potentially exposed to sound levels that could elicit PTS this is unlikely to affect the international value of the species. Only a very minor loss or detrimental alteration to the minke whale populations will occur due to this impact (see Table 7.27). Therefore, it has been concluded that the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Grey Seal and Harbour Seal

Overall, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Marine Turtles

Overall, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Behavioural Disturbance

All Marine Mammal IEFs

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Marine Turtles

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. As per Table 7.31, this results in a 'negligible or minor' significance of effect. Given that the effects of this impact are reversible and are not predicted to affect marine turtle reproductive cycles or a population, only a very minor loss or detrimental alteration to these species at a population level is possible (Table 7.27). Therefore, it has been concluded that the effect will be of **negligible adverse** significance, which is **not significant** in EIA terms.

7.12.15 Injury, Disturbance, and Displacement from Underwater Noise Generated during UXO Clearance

7.12.15.1 Construction Phase

UXO clearance prior to the construction of the Proposed Development may result in detonation (high order) of a UXO. This activity has the potential to generate some of the highest peak sound pressures of all anthropogenic underwater noise sources (von Benda-Beckman *et al.,* 2015), and are considered a high energy, impulsive sound source. The potential effects of UXO clearance will depend on sound source characteristics, the receptor species, distance from the sound source, and sound attenuation within the environment.

Further detail on underwater noise modelling of UXO clearance is provided in volume 3, Underwater Noise Technical Report (RPS Group and Seiche, 2024). For UXO detonation, underwater noise modelling was undertaken following the methodology described in Soloway and Dahl (2014), which provides a simple relationship between distance from an explosion and the weight of the charge but does not account for bottom topography or sediment characteristics. Since the charge is assumed to be freely standing in mid-water, unlike a UXO which would be resting on the seabed and could potentially be buried, degraded or subject to other significant attenuation, this estimation of the source level can be considered conservative. Additionally, the explosive material is likely to have deteriorated over time, so maximum sound levels are likely to be over-estimates of true sound levels. In order to compare to the marine mammal hearing weighted thresholds, it is necessary to apply the frequency dependent weighting functions at each distance from the source. This was accomplished by determining a transfer function between unweighted and weighted SEL values at various distances based on an assumed spectrum shape and taking into account molecular absorption at various ranges.

Recent controlled experiments showed low-order deflagration to result in a substantial reduction in acoustic output over traditional high order methods, with SPL_{pk} and SEL_{cum} being typically significantly lower for the deflagration of the same size munition, and with the acoustic output being proportional to the size of the shaped charge, rather than the size of the UXO itself (Robinson *et al.,* 2020).

Magnitude of Impact

Potential effects of high order UXO clearance include mortality, physical injury, or auditory injury. As the duration of impact (elevated sound) for each UXO detonation is very short (seconds), behavioural effects are considered to be negligible in this context. TTS is presented as a temporary auditory injury but also represents a threshold for the onset of a moving away response. Specific underwater noise modelling for the Proposed Development was undertaken using published and peer-reviewed criteria to determine PTS and TTS ranges. As an embedded mitigation measure, a MMMP will be developed in order to reduce the potential to experience injury.

The MDS assumes a maximum UXO size is of be 907 kg, with a maximum of one detonation in 24 hours (Table 7.23) A low order clearance donor charge of 0.08 kg is assumed whilst low-yield donor charges are multiples of 0.75 kg (up to four required for the largest UXO size of 907 kg). For donor charges for high-order clearance activities, charge weights of 1.2 kg (the most common) and 3.5 kg (single barracuda blast charge) have been included.

The clearance activities will be tide- and weather-dependent, with full details of the UXO clearance timeline not available at this stage. There is an assumption of up to 500 g NEQ clearance shot for neutralisation of residual explosive material at each location (Table 7.23).

Auditory Injury (PTS)

<u>All Species</u>

PTS ranges for low order and low yield UXO clearance activities are presented in Table 7.60, donor charges used in high order UXO clearance presented in Table 7.61, and high order clearance of UXO presented in Table 7.62. The number of animals predicted to experience PTS due to low order disposal is presented in Table 7.63, donor charges in Table 7.64, and high order clearance in Table 7.65.

There is a small risk that a low order clearance could result in high order detonation of UXO, and, as such, the underwater noise modelling considered both high order and low order techniques. As previously described in section 7.12.13, underwater noise is unlikely to be impulsive in character once it has propagated more than a few kilometres. The NMFS (2018) guidance suggested an estimate of 3 km for transition from impulsive to continuous (although this was not subsequently presented in the later guidance (Southall *et al.,* 2019)). Hastie *et al.* (2019) suggested that some measures of impulsiveness (for seismic airguns and pile-driving) change markedly within approximately 10 km of the source. Therefore, caution should be used when interpreting any results with predicted injury ranges in the order of tens of kilometres as the PTS ranges are likely to be significantly lower than what has been predicted.

A high order explosion of the maximum UXO size (907 kg) yielded the largest PTS ranges for all species, with the greatest injury range (15.37 km; SPL_{pk}) seen for the VHF hearing group (i.e. harbour porpoise) (Table 7.62). However, this injury range is reduced to 8.05 km for more common 130 kg charge in harbour porpoise (SPL_{pk}). Conservatively, the number of harbour porpoise that could be potentially injured, based on the densities provided in Table 7.17, was estimated as 64 animals for high order explosion of a 907 kg UXO (Table 7.65), based on the SCANS-III Block F density estimate, equating to 0.10% of the Celtic and Irish Seas MU. For the SCANS-IV Block CS-E density estimate, this would be expected to affect up to 383 animals (Approximately 0.61% of the Celtic and Irish Seas MU). Predicted numbers were much smaller for the 130 kg and 25 kg UXOs with up to 18 and six animals potentially experiencing PTS respectively, based on the SCANS-III Block F density estimate (Table 7.65). For the SCANS-IV Block CS-E density estimate, the corresponding numbers of animals affected would be 105 (130 kg) and 35 (25 kg). For low order techniques, the largest range of 2,290 m was predicted from the 4 x 0.75 kg low-yield charges (Table 7.60), which could injure up to two harbour porpoise based on the SCANS-III Block F density estimate, or up to nine animals based on the SCANS-IV Block CS-E estimate (Table 7.63).

The maximum PTS range estimated for bottlenose dolphin, common dolphin and Risso's dolphin (HF hearing group) using the SPL_{pk} metric was 890 m for the high order detonation of a 907 kg UXO (Table 7.62). This was reduced to 464 m for 130 kg and 268 m for 25 kg. Using the population densities provided in Table 7.17, it was calculated that up to one animal could potentially be injured by any of the three high order detonation sizes (Table 7.65). With reference to the wider populations of these species, this equated to very small proportions of the relevant Mus (<0.00007% for bottlenose dolphin, 0.0000004% for short-beaked common dolphin and 0.000006% for Risso's dolphin). For low order techniques, the injury ranges were considerably lower with a maximum of 133 m estimated (Table 7.60) with no more than one animal of any species likely to be present within this range (Table 7.63).

The maximum PTS range estimated for minke whale using the SEL_{cum} metric was 4.22 km for the detonation of a charge size of 907kg, but this was reduced to 1.71 km for 130 kg and 775 m for 25 kg (Table 7.62). Conservatively, the number of minke whale that could be potentially injured, based on the densities provided in Table 7.17, was estimated as up to one animal for high order explosion of a 907 kg UXO (Table 7.65) equating to 0.000005% of the population of the Celtic and Greater North Seas MU. For low order techniques, the maximum range predicted was up to 406 m (Table 7.60) with no more than one animal of any species likely to be present within this range (Table 7.63).

The maximum PTS range estimated for grey seal and harbour seal using the SPL_{pk} metric was 3.02 km for the detonation of charge size of 907 kg, but this was reduced to 1.58 km for 130 kg and 910 m for 25 kg (Table 7.62). Conservatively, the number of grey seal that could potentially be injured, based on the densities provided in Table 7.17, was estimated as up to 115 animals for high order explosion of a 907 kg UXO, 32 animals for 130 kg, and up to one animal for 25 kg (Table 7.65). For the 907 kg UXO, this equates to 0.001% of the population of the relevant MUs for grey seal within the regional marine mammal and marine turtle study area. This also equates to 0.02% of the population of grey seal within OSPAR Region III. Although the modelled PTS ranges were the same for both grey seal and harbour seal, up to two harbour seal could potentially be injured during a high order explosion of a 907 kg UXO, using the densities provided in Table 7.17. This equates to 0.0001% of the harbour seal population within the relevant Mus in the regional marine mammal and marine turtle study area. For low order techniques, the maximum range predicted was up to 449 m (Table 7.60) and there would be up to three grey seal and one harbour seal potentially injured within this range (Table 7.63).

Table 7.60: Potential PTS Ranges For Low Order And Low Yield UXO Clearance Activities

Charge Size (kg)	Hearing Group	PTS Range (m)	
		SPL_{pk}	SEL_{cum}
0.08 kg low order donor charge	LF	122	47
	HF	40	2
	VHF	685	190
	PCW	135	9
0.5 kg clearance shot	LF	223	115
	HF	73	4
	VHF	1,265	421
	PCW	247	22
2 x 0.75 kg low-yield charge	LF	322	196
	HF	105	7
	VHF	1,820	650

Charge Size (kg)	Hearing Group	PTS Range (m)	
		SPL_{pk}	SEL_{cum}
	PCW	357	38
4 x 0.75 kg low-yield charge	LF	406	275
	HF	133	10
	VHF	2,290	840
	PCW	449	53

Table 7.61: Potential PTS Ranges For Donor Charges Used In High Order UXO Clearance Activities

Charge Size (kg)	Hearing Group	PTS Range (m)	
		SPL_{pk}	SEL_{cum}
1.2 kg donor charge for high order UXO disposal	LF	299	176
	HF	98	6
	VHF	1,690	596
	PCW	331	34
3.5kg donor blast-fragmentation charge for high order UXO disposal	LF	427	297
	HF	140	10
	VHF	2,415	885
	PCW	473	57

Table 7.62: Potential PTS Ranges For High Order Clearance Of UXOs

Charge Size (kg)	Hearing Group	PTS Range (m)	
		SPL_{pk}	SEL_{cum}
25 kg UXO – high order explosion	LF	825	775
	HF	268	27
	VHF	4,645	1,645
	PCW	910	147
130 kg UXO – high order explosion	LF	1,425	1,705
	HF	464	61
	VHF	8,045	2,520
	PCW	1,580	323
907 kg UXO – high order explosion	LF	2,720	4,215
	HF	890	151
	VHF	15,370	3,820
	PCW	3,015	800

Table 7.63:Number Of Animals With The Potential To Experience PTS Due To Low Order And Low Yield UXO Clearance Activities

Threshold	Estimated Number of Animals with the Potential to be Affected						
	Harbour porpoise	Bottlenose dolphin	Common dolphin	Risso's dolphin	Minke whale	Grey seal	Harbour seal
0.08kg low-order donor charge							
SPL_{pk}	<1	<1	<1	<1	<1	<1	<1
SEL	<1	<1	<1	<1	<1	<1	<1
0.5kg clearing shot							
SPL_{pk}	<1 to 3	<1	<1	<1	<1	<1	<1
SEL	<1	<1	<1	<1	<1	<1	<1
2 x 0.75kg low-yield charge							
SPL_{pk}	<1 to 6	<1	<1	<1	<1	2	<1
SEL	<1	<1	<1	<1	<1	<1	<1
4 x 0.75kg low-yield charge							
SPLpk	2 to 9	<1	<1	<1	<1	3	<1
SEL	<1 to 2	<1	<1	<1	<1	<1	<1

Table 7.64: Number Of Animals With The Potential To Experience PTS Due To High Order UXO Clearance Activities

Threshold	Estimated Number of Animals with the Potential to be Affected						
	Harbour porpoise	Bottlenose dolphin	Common dolphin	Risso's dolphin	Minke whale	Grey seal	Harbour seal
1.2kg donor charge for high-order UXO disposal							
SPL_{pk}	<1 to 5	<1	<1	<1	<1	2	<1
SEL	<1	<1	<1	<1	<1	<1	<1
3.5kg donor blast-fragmentation charge for high-order UXO disposal							
SPL_{pk}	2 to 10	<1	<1	<1	<1	3	<1
SEL	<1 to 2	<1	<1	<1	<1	<1	<1

Table 7.65: Number Of Animals With The Potential To Experience PTS Due To High Order Clearance Of UXOs

Threshold	Estimated Number of Animals with the Potential to be Affected						
	Harbour porpoise	Bottlenose dolphin	Common dolphin	Risso's dolphin	Minke whale	Grey seal	Harbour seal
25kg UXO – high order explosion							
SPL_{pk}	6 to 35	<1	<1	<1	<1	<1	<1
SEL	<1 to 5	<1	<1	<1	<1	<1	<1
130kg UXO – high order explosion							
SPL_{pk}	18 to 105	<1	<1	<1	<1	32	<1
SEL	2 to 11	<1	<1	<1	<1	2	<1
907kg UXO – high order explosion							

Threshold	Estimated Number of Animals with the Potential to be Affected						
	Harbour porpoise	Bottlenose dolphin	Common dolphin	Risso's dolphin	Minke whale	Grey seal	Harbour seal
SPL_{pk}	64 to 383	<1	<1	<1	<1	115	2
SEL	4 to 24	<1	<1	<1	< 1	9	<1

For the purposes of this assessment, the MDS assumes clearance of a maximum UXO size of 907 kg by either low order or high order techniques. However, clearance of 130 kg UXOs is considered more likely. Embedded mitigation, such as using low order techniques where possible (primary mitigation) will reduce the risk of injury (Table 7.32). It must be noted, however, that low order techniques are not always possible and are dependent upon the individual situations surrounding each UXO.

With primary measures in place the assessment found that there would be a residual risk of injury over a range of 2.29 km that would require further mitigation (Table 7.60). Where low order/low yield measures are not possible there is a maximum risk of injury (predicted for harbour porpoise) out to 15 km for a 907 kg UXO and 8.05 km for a 130 kg UXO (Table 7.62). Therefore, adopting standard industry practice (JNCC, 2010b), tertiary mitigation will be applied as part of a MMMP (Table 7.32).

The harbour porpoise injury ranges (for both low order and high order clearance) are considerably larger than the standard 1,000 m mitigation zone recommended for UXO clearance (JNCC, 2010b) and there are often difficulties in detecting marine mammals (particularly harbour porpoise) over such large ranges (McGarry *et al.,* 2017, 2020). The MMMP will also include the use of ADDs to deter animals from the ZoI. The efficacy of such deterrence will depend upon the device selected and reported ranges of effective deterrence vary. In addition to the ADD, deterrence can also be achieved through soft start charges, the application of which will be discussed and agreed with consultees post-submission of the ES, once more information on the size and type of UXOs are known. Details of appropriate tertiary mitigation as set out in the draft MMMP will be discussed and agreed with consultees post-consent when further details of the size and type of potential UXOs are understood.

Adopting a precautionary approach, and assuming application of mitigation, the assessment considered the magnitude for a high order detonation. The magnitude of impact is predicted to be of local to regional spatial extent (depending on species), very short-term duration (for each UXO detonation), and intermittent throughout the construction phase. Although the impact itself is reversible (i.e. the elevation in underwater noise only occurs during the UXO detonation activity), the effect of PTS on sensitive receptors is permanent. It is predicted that the impact will affect the receptor directly. With tertiary mitigation applied (i.e. MMMP), it is anticipated that for most species, individuals would be deterred from the ZoI and therefore the risk of PTS would be reduced. For all marine mammal IEFs except harbour porpoise, the magnitude of impact is therefore considered to be negligible.

For harbour porpoise, as the ranges of effect are large, there is considered to be a residual risk of PTS to a small number of individuals. Therefore, the magnitude of impact is considered to be low. Whilst it is difficult to quantify this residual risk (due to uncertainties over the predicted ranges of effect and the potential ranges over which deterrence measures are effective), it is anticipated that there would be some measurable changes at an individual level but that this would not manifest to population-level effects due to the small proportion of the Celtic and Irish Sea MU potentially affected (0.01%).

Injury ranges to marine turtles due to UXO clearance activities were not presented in the underwater noise modelling assessment (volume 3, Underwater Noise Technical Report (RPS Group and Seiche, 2024)). As per the criteria by Popper *et al.* (2014) (Table 7.52), insufficient data exist to determine a quantitative guideline value for PTS as a result of UXO clearance activities. Instead, the available criteria provide relative terms as "high", "moderate" or "low" at three distances from the source: "near" (i.e. in the tens of metres), "intermediate" (i.e. in the hundreds of metres) or "far" (i.e. in the thousands of metres). As such, no assessment of the impact of UXO clearance on the marine turtles IEF could be conducted. However, the marine turtle populations within the regional marine mammal and marine turtle study area are likely to be lower than those of the marine mammal IEFs, and this study area does not represent important habitat for reproduction and nesting. As marine turtles are not as sensitive to underwater noise as harbour porpoise, a negligible magnitude of impact can be extrapolated from that presented for all marine mammal IEFs except harbour porpoise.

Behavioural Disturbance (TTS as a Proxy)

<u>All Species</u>

A second threshold assessed in the underwater noise modelling was the onset of TTS, whereby the resulting effect would be a potential temporary loss in hearing. Whilst similar ecological functions would be inhibited in the short term due to TTS, these are reversible on recovery of the animal's hearing and therefore not considered likely to lead to any long-term effects on the individual. The onset of TTS also corresponds to a moving away or 'fleeing response' as this is the threshold at which animals are likely to move away from the ensonified area. Thus, the onset of TTS also reflects the threshold at which behavioural displacement could occur.

As previously described in section 7.12.13, underwater noise is unlikely to be impulsive in character once it has propagated more than a few kilometres. It is particularly important when interpreting results for TTS with ranges of up to 34.37 km as these are likely to be significantly lower than predicted (34.37 km was the maximum TTS value modelled for any marine mammal hearing group; see Table 7.68).

As above for PTS, the assessment of TTS considered low order and low yield UXO clearance activities (Table 7.66), donor charges for high order UXO disposal (Table 7.67) and high order explosions (Table 7.68). The largest ranges using SPL_{pk} were predicted for clearance of the 907 kg UXO with potential TTS/moving away response over a maximum distance of 28.32 km for the VHF hearing group (i.e. harbour porpoise) (Table 7.68). However, a larger range of 34.36 km was predicted for the LF hearing group (i.e. minke whale) using the SEL_{cum} threshold (Table 7.68).

Table 7.66: Potential TTS Ranges For Low Order And Low Yield UXO Clearance Activities

Charge Size (kg)	Hearing Group	TTS Range (m)	
		SPL_{pk}	SEL_{cum}
0.08 kg low order donor charge	LF	224	655
	HF	73	23
	VHF	1,265	1,500
	PCW	247	124
0.5 kg clearance shot	LF	411	1,585
	HF	134	56
	VHF	2,325	2,435
	PCW	455	301
2 x 0.75 kg low-yield charge	LF	593	2,665
	HF	194	95
	VHF	3,350	3,120
	PCW	660	504
4 x 0.75 kg low-yield charge	LF	750	3,670
	HF	244	131
	VHF	4,220	3,600

Charge Size (kg)	Hearing Group	TTS Range (m)	
		SPL_{pk}	SEL_{cum}
	PCW	830	695

Table 7.67: Potential TTS Ranges For Donor Charges Used In High Order UXO Clearance Activities

Charge Size (kg)	Hearing Group	TTS Range (m)	
		SPL_{pk}	SEL_{cum}
1.2 kg donor charge for high-order UXO disposal	LF	551	2,400
	HF	180	85
	VHF	3,110	2,975
	PCW	610	454
3.5kg donor blast-fragmentation charge for high-order UXO disposal	LF	790	3,940
	HF	257	141
	VHF	4,445	3,715
	PCW	875	745

Table 7.68: Potential TTS Ranges For High Order Clearance Of UXOs

Charge Size (kg)	Hearing Group	TTS Range (m)	
		SPL_{pk}	SEL_{cum}
25 kg UXO – high order explosion	LF	1,515	9,325
	HF	494	343
	VHF	8,555	5,290
	PCW	1,680	1,760
130 kg UXO – high order explosion	LF	2,625	17,755
	HF	855	680
	VHF	14,825	6,830
	PCW	2,905	3,360
907 kg UXO – high order explosion	LF	5,015	34,365
	HF	1,635	1,380
	VHF	28,320	8,925
	PCW	5,550	6,470

The number of animals that would potentially experience TTS/fleeing due to low order and low yield UXO clearance activities is presented in Table 7.69, donor charges for high order UXO disposal in Table 7.70, and high order explosions in Table 7.71. The highest number of animals affected, based on high order detonation of a 907 kg UXO, was found for grey seal where up to 534 animals could experience TTS (Table 7.71). This equated to 0.45% of the relevant MU populations and 0.1% of the OSPAR Region III population (based on SEL_{cum}). For harbour porpoise, between 217 animals and 1,299 animals could potentially be affected by the high order detonation of a 907 kg UXO (based on SPL_{pk} with lower densities from SCANS-III and higher densities from SCANS-IV). This equated to 0.35% to 2.08% of the population of the Celtic and Irish Seas MU. For minke whale and harbour seal, up to 34 and eight individuals, respectively, could potentially experience TTS/fleeing due to the high order detonation of a 907 kg UXO (both based on SEL_{cum}) (Table 7.71). This equated to 0.17% and 0.05% of the populations of the relevant minke whale and harbour seal MUs, respectively.

For the three dolphin species, the number of animals predicted to experience TTS/fleeing was very small with no more than one animal for all UXO clearance activities (Table 7.69 to Table 7.71). For all species, behavioural disturbance associated with UXO clearance will be reduced by tertiary mitigation summarised in Table 7.32 and described in volume 4: Marine Mammal Mitigation Plan. Similarly, primary measures employed to mitigate injury, including the use of low-order detonation where appropriate (Table 7.32) are also expected to reduce disturbance due to UXO clearance.

Table 7.69: Number Of Animals With The Potential To Experience TTS Due To Low Order And Low Yield UXO Clearance Activities

Threshold	Estimated Number of Animals with the Potential to be Affected						
	Harbour porpoise	Bottlenose dolphin	Common dolphin	Risso's dolphin	Minke whale	Grey seal	Harbour seal
0.08kg low-order donor charge							
SPL_{pk}	<1 to 3	<1	<1	<1	<1	<1	<1
SEL	<1 to 4	<1	<1	<1	<1	<1	<1
0.5kg clearing shot							
SPL_{pk}	2 to 9	<1	<1	<1	<1	3	<1
SEL	2 to 10	<1	<1	<1	<1	2	<1
2 x 0.75kg low-yield charge							
SPL_{pk}	4 to 19	<1	<1	<1	<1	6	<1
SEL	3 to 16	<1	<1	<1	<1	4	<1
4 x 0.75kg low-yield charge							
SPL_{pk}	5 to 29	<1	<1	<1	<1	4	<1
SEL	4 to 21	<1	<1	<1	<1	7	<1

Table 7.70: Number Of Animals With The Potential To Experience TTS Due To High Order UXO Clearance Activities

Threshold	Estimated Number of Animals with the Potential to be Affected						
	Harbour porpoise	Bottlenose dolphin	Common dolphin	Risso's dolphin	Minke whale	Grey seal	Harbour seal
1.2kg donor charge for high-order UXO disposal							
SPL_{pk}	3 to 16	<1	<1	<1	<1	5	<1
SEL	3 to 15	<1	<1	<1	<1	3	<1
3.5kg donor blast-fragmentation charge for high-order UXO disposal							
SPL_{pk}	6 to 32	<1	<1	<1	<1	10	<1
SEL	4 to 23	<1	<1	<1	<1	7	<1

Table 7.71: Number Of Animals With The Potential To Experience TTS Due To High Order Clearance Of UXOs

Threshold	Estimated Number of Animals with the Potential to be Affected						
	Harbour porpoise	Bottlenose dolphin	Common Dolphin	Risso's dolphin	Minke whale	Grey seal	Harbour seal
25kg UXO – high order explosion							
SPL_{pk}	20 to 119	<1	<1	<1	<1	36	<1
SEL	8 to 46	<1	<1	<1	3	40	<1
130kg UXO – high order explosion							
SPL_{pk}	60 to 356	<1	<1	<1	<1	107	2
SEL	4 to 19	<1	<1	<1	8	145	3
907kg UXO – high order explosion							
SPL_{pk}	217 to 1,299	<1	<1	<1	< 1	393	6
SEL	22 to 129	<1	<1	<1	34	534	8

As per the recent NRW (2023) guidance (Table 7.51), updated disturbance range to harbour porpoise due to UXO clearance were modelled using the 140 dB SEL (W_{vhf}) metric (Southall *et al.,* 2019; NRW, 2023). These disturbance distances are presented in Table 7.72, with the highest value of 8.92 km reported for the high order disposal of a 907 kg UXO. The number of animals with the potential to be disturbed has been calculated using the densities for this species as set out in Table 7.17. Disposal of the maximum UXO size of 907 kg has the potential to disturb between 22 and 129 harbour porpoise (based on the SCANS-III estimate of 0.086 animals per km^2 and SCANS-IV estimate of 0.515 animals per km^2, respectively), which equates to 0.03% and 0.21%, respectively, of the population of the Celtic and Irish Seas MU. This is considerably lower than the 217 to 1,299 animals potentially affected by the high order detonation of a 907 kg UXO (based on SPL_{pk}) that was modelled using guidance prior to NRW (2023) (see Table 7.71).

Table 7.72: Potential Disturbance Ranges To Harbour Porpoise And Numbers Of Animals Potentially Affected (Based On New Guidance From NRW (2023))

Charge Weight (kg)	Disturbance Range (m)	Number of Animals
Low order and low-yield donor charge configurations		
0.08	1,500	<1 to 4
0.5	2,435	2 to 10
2 x 0.75 kg	3,120	3 to 16
4 x 0.75 kg	3,600	4 to 21
High-order donor charge options		
1.2	2,975	3 to 15
3.5	3,715	4 to 23
Potential UXOs (high order disposal)		
25	5,290	8 to 46
130	6,830	13 to 76

Charge Weight (kg)	Disturbance Range (m)	Number of Animals
907	8,925	22 to 129

Overall, application of tertiary mitigation (i.e. MMMP) to reduce the risk of PTS will also to some extent reduce the risk of TTS/fleeing, although notably the ranges for the latter are much larger. However, such effects, are reversible and therefore animals are anticipated to fully recover. It is, however, recognised that where tertiary mitigation applies, deterrence measures (i.e. ADD and soft start charges) by their nature would contribute to, rather than reduce, the moving away response.

Adopting a precautionary approach, and with the embedded mitigation adopted, the assessment considered the magnitude of a high order detonation. The magnitude of TTS resulting from a high order detonation is predicted to be of regional spatial extent, short-term duration, and intermittent throughout the construction phase. Both the impact itself (i.e. the increased underwater noise during a detonation event) and effect of TTS are reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be **negligible** for all IEFs. This includes marine turtles, as although they were not concluded in the underwater noise modelling for this impact, the magnitude of effect can be extrapolated from that of the marine mammal IEFs (as per the reasoning provided above for 'Auditory Injury (PTS)').

Sensitivity of Receptor

Auditory Injury (PTS)

Harbour Porpoise

The main acoustical property during the detonation of explosives is a short shock wave, comprising a sharp rise in pressure followed by an exponential decay with a time constant of a few hundred microseconds (volume 3, Underwater Noise Technical Report (RPS Group and Seiche, 2024). In shallow water, the interactions of the shock and acoustic waves create a complex pattern, which was investigated further by Von Benda-Beckmann *et al*. (2015). Due to their high sensitivity to underwater noise, harbour porpoise are the most studied species in the scientific literature. Von Benda-Beckmann *et al*. (2015) reported the impact of explosives on harbour porpoise within the southern North Sea. They investigated the potential for injury to occur as an ear trauma caused by the blast wave at a peak overpressure of 172 kPa (190 dB re. 1 μPa). They measured SEL and peak overpressure at distances up to 2 km from the explosions of seven aerial bombs (charge mass of 263 kg and 121 kg) detonated at approximately 26 m to 28 m depth, on a sandy substrate. The potential for noise-induced PTS to occur was based on a threshold of 190 dB re. 1 μPa^2s (PTS 'very likely to occur') and an onset threshold of 179 dB re. 1 μPa^2s (SEL) (PTS 'increasingly likely to occur') (criteria defined by Lucke *et al*., 2009). Their results suggested that 500 m was the largest distance at which a risk of ear trauma could occur and that noise-induced PTS was likely to occur further than the 2 km range that was measured during the study as the SEL recorded at this distance was 191 dB re. 1 μPa^2s (i.e. 1 dB above the 'very likely to occur' threshold).

Von Benda-Beckmann *et al*. (2015) also modelled possible ranges for 210 explosions that had been logged by the Royal Netherland Navy and the Royal Netherlands Meteorological Institute in 2010 and 2011. Using the empirical measurements of SEL out to 2 km to validate their model, the study found that the effect distances ranged between hundreds of metres to just over 10 km (for charges ranging from 10 kg up to 1,000 kg) (Von Benda-Beckmann *et al.,* 2015). Near the surface, where porpoises are known to spend a considerable amount of time (e.g. 55% based on Teilmann *et al.,* 2007) the SELs were predicted to be lower with effect distances for the onset of PTS just below 5 km (Von Benda-Beckmann *et al.,* 2015). However, whilst the model could provide a reasonable estimate of the SEL within 2 km (since the empirical measurements were made out to this point), estimates above this distance required further validation since the uncorrected model systematically overestimated SEL. More recently, Salomons *et al.* (2021) analysed the sound measurements performed near two UXO detonations (charge masses of 140 kg and 325 kg). From the weighted SEL values and threshold levels from Southall *et al.* (2019), a PTS effect range of 2.5 to 4 km was derived (Salomons *et al.,* 2021). When comparing the experimental data and model predictions, Salomons *et al.* (2021) concluded that harbour porpoise are at risk of PTS at distances of several kilometres from large explosives; between 2 km and 6 km based on 140 kg and 325 kg charge masses, respectively. In addition, 24 harbour porpoise were found dead along the coastline following clearance of ground mines in the Baltic Sea in 2019 (Siebert *et al.,* 2022). Post-mortem examination found that the cause of death was associated with a blast injury in ten of these animals, however the charge masses of the explosives are unknown (Siebert *et al*., 2022).

The use of low order UXO disposal methods has been shown to offer a substantial reduction in acoustic output over traditional high-order detonations, with the SPL_{pk} and SEL_{cum} observed being typically >20 dB lower for the deflagration of the same sized munition (a reduction factor of just over ten in SPL_{pk} and 100 in acoustic energy) (Robinson *et al.,* 2020). This study also demonstrated that the acoustic output depends on the size of the shaped charge, rather than the size of the UXO itself (Robinson *et al.,* 2020). Considering this, the use of low order techniques offers the potential for greatly reduced acoustic sound exposure of marine mammals and marine turtles.

The sensitivity of harbour porpoise to injury from impulsive underwater noise has been described previously for piling (section 7.12.14) and is not repeated here. Overall, harbour porpoise are deemed to have limited tolerance to PTS, high vulnerability, low recoverability, and international value. The sensitivity of harbour porpoise to PTS is therefore considered to be high.

<u>All other Marine Mammal and Marine Turtle IEFs</u>

In comparison to harbour porpoise, however, less is known about the sensitivity of bottlenose dolphin, common dolphin, Risso’s dolphin, minke whale, grey seal, harbour seal, and marine turtles to explosive detonation. One study measured the effect of clearance of relatively small explosives (35 kg charge) at an important feeding area for a resident community of bottlenose dolphin in Portugal (Santos *et al.,* 2010). The authors measured acoustic pressure levels in excess of 170 dB re 1 µPa and no adverse effects in the behaviour or appearance of the dolphins, despite pressure levels being 60 dB higher than ambient sound (Santos *et al.,* 2010). Besides this, there is little published literature for these dolphin species and the assessment is highly precautionary as a result. In addition, evidence of severe blast injuries was recorded in the ears of two humpback whales *Megaptera novaeangliae* which died following a 5,000 kg explosion in Newfoundland, Canada (Ketten *et al.*, 1993). As humpback whale and minke whale are both baleen whales, it is possible that similar injuries would occur for minke whale.

The sensitivity of these IEFs to injury from impulsive underwater noise has been described previously for piling (section 7.12.14) and is not repeated here. Overall, these receptors are deemed to have limited tolerance to PTS, high vulnerability, low recoverability, and international value. The sensitivity of these receptors to PTS is therefore considered to be high.

Behavioural Disturbance (TTS as a Proxy)

Underwater noise generated during UXO clearance has the potential to cause behavioural disturbance. However, there are no agreed thresholds for the onset of a behavioural response generated as a result of an explosion. Southall *et al.* (2007) recommend that the use of TTS onset as an auditory effect may be most appropriate for single pulses (such as UXO detonation) and therefore it has been applied to inform the assessment.

As TTS is temporary and reversible, it is anticipated that any animals experiencing it would recover after they have moved beyond the injury zone are no longer exposed to elevated sound levels. The implication of animals experiencing TTS, leading to potential displacement, is not fully understood, but it is likely that aversive responses to anthropogenic sound could temporarily affect life functions as described in section 7.12.14 for PTS. Therefore, in this respect animals exposed to TTS-inducing sound levels have similar susceptibility as those exposed to levels that could induce PTS. It is important to note, however, given that TTS is only temporary hearing impairment, it is less likely to lead to acute effects and will largely depend on recoverability.

The degree and speed of hearing recovery will depend on the characteristics of the sound the animal is exposed to, and on the degree of shift in hearing experienced.

Harbour Porpoise

The recovery rates of harbour porpoise exposed to a sound source of 75 db re 1 μPa (SEL) over 120 minutes were investigated by SEAMARCO (2011). The results suggested that recovery to the pre-exposure threshold was estimated to be complete within 48 minutes following exposure (the higher the hearing threshold shift, the longer the recovery) (SEAMARCO, 2011).

Kastelein *et al.* (2021) reported that the susceptibility to TTS depends on the frequency of the fatiguing sound causing the shift and the greatest TTS depends on the SPL (and related SEL). In this study, TTS occurrence in a captive harbour porpoise was measured at a range of frequencies typical of high amplitude anthropogenic sounds. The results indicated that the greatest shift in mean TTS occurred at 0.5 kHz with hearing always recovering within 60 minutes after the fatiguing sound stopped (Kastelein *et al.,* 2021). Currently, scientific understanding of the biological effects of TTS is limited to the results of controlled exposure studies on small numbers of captive animals (reviewed in Finneran, 2015), such as the study by Kastelein *et al.* (2021). Caution must be taken when extrapolating these results to how animals may respond in the natural environment as it is not possible to exactly replicate natural environmental conditions, and the small number of test subjects would not account for intraspecific differences (i.e. differences between individuals) or interspecific differences (i.e. extrapolating to other species) in response.

The sensitivity of harbour porpoise to TTS and behavioural disturbance has been described previously for piling (section 7.12.14) and is not repeated here. Overall, since TTS is reversible, harbour porpoise is assessed as having some tolerance, medium vulnerability, high recoverability, and international value. The sensitivity of harbour porpoise to behavioural disturbance (with TTS as a proxy) is therefore considered to be low.

Grey Seal and Harbour Seal

One study on harbour seal found that recovery from TTS to the pre-exposure baseline was estimated to be complete within 72 minutes following exposure to a sound source of 193 dB re1 $\mu Pa^2 s$ (SELcum) over 360 minutes (Kastelein *et al.,* 2018a). SEAMARCO (2011) also demonstrated similar results, which showed that recovery in seals was very fast (around 30 minutes) for small TTS values. The authors demonstrated a linear relationship between TTS values and recovery time – the higher the hearing threshold shift, the longer the recovery (SEAMARCO, 2011). Kastelein *et al*. (2019) also demonstrated rapid recovery from TTS in two harbour seals. The greatest TTS, measured at 22.4 kHz 1 to 4 minutes after cessation of the sound, was 17 dB, but dropped to 3 dB in 1 hour, and hearing recovered fully within 2 hours. The authors noted that harbour seal appears equally susceptible to TTS between 2.5 kHz and 16 kHz (Kastelein *et al.,* 2019).

Based on these results, reduced hearing for a short time is unlikely to largely effect the total foraging period of harbour seal (and therefore grey seal, using harbour seal as a proxy). However, the impact is likely to be ecologically significant if hearing is impaired for longer periods (e.g. hours or days) (SEAMARCO, 2011). Nonetheless, these studies indicate that seal species are less vulnerable to TTS than harbour porpoise for the noise bands tested. In addition, it is expected that animals would move beyond the injury range prior to the onset of TTS. The assessment considered that both grey seal and harbour seal are likely to be able to tolerate the effect without any impact on both reproduction and survival rates and would be able to return to previous behavioural states or activities once the impacts had ceased.

The sensitivity of grey seal and harbour seal to TTS and behavioural disturbance has been described previously for piling (section 7.12.14) and is not repeated here. Overall, since TTS is reversible, grey seal and harbour seal are assessed as having some tolerance, medium vulnerability, high recoverability, and international value. The sensitivity of these receptors to behavioural disturbance (with TTS as a proxy) is therefore considered to be low.

<u>All other Marine Mammal IEFs</u>

Whilst there are no available species-specific recovery rates for bottlenose dolphin, common dolphin, Risso's dolphin, and minke whale to TTS, there is no evidence to suggest that recovery will be significantly different to the recovery rates presented for harbour porpoise, harbour seal, and grey seal. Therefore, it is anticipated that affected animals can recover their hearing after they are no longer exposed to elevated sound levels.

For example, Finneran *et al.* (2000) exposed two captive bottlenose dolphins to sounds that simulated distant underwater explosions and measured their behavioural and auditory responses. The animals were exposed to an intense sound once per day and no auditory shift (i.e. TTS) greater than 6 dB in response to levels up to 221 dB re 1 µPa p-p (peak-peak) was observed. Behavioural shifts, such as delaying approach to the test station and avoiding the 'start' station, were recorded at 196 dB and 209 dB re 1 µPa p-p for the two bottlenose dolphins and continued at higher levels (Finneran *et al.,* 2000). Nowacek *et al.* (2007) discussed several caveats to this study, for example, the signals used in Finneran *et al.* (2000) were distant and the study measured masked-hearing signals. Furthermore, the bottlenose dolphins used in the experiment were also trained and rewarded for tolerating high levels of noise and subsequently, it can be anticipated that behavioural disruption would likely be observed at lower levels in other contexts.

Furthermore, Boisseau *et al.* (2021) demonstrated that minke whales in Iceland avoided a 15 kHz ADD with a source level of 198 dB re 1 µPa re 1 m (rms) and clearly reacted to signals at the likely upper limit of their hearing sensitivity.

It can be anticipated that these IEFs would be able to tolerate the effect without any impact on reproduction or survival rates with ability to return to previous behavioural states or activities once the impacts had ceased. The sensitivity of these IEFs to TTS and behavioural disturbance has been described previously for piling (section 7.12.14) and is not repeated here. Overall, since TTS is reversible, these receptors are assessed as having some tolerance, medium vulnerability, high recoverability, and international value. The sensitivity of these receptors to behavioural disturbance (with TTS as a proxy) is therefore considered to be low.

Significance of Effect

Auditory Injury (PTS)

<u>All Species</u>

Overall, for all IEFs except harbour porpoise, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Overall, for harbour porpoise, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be high. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Behavioural Disturbance (TTS as a Proxy)

<u>All Species</u>

Overall, for all IEFs, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be low. As per Table 7.31, this results in a 'negligible or minor' significance of effect. Given that the effects of this impact are reversible and are not predicted to affect a significant percentage of the relevant MU populations, only a very minor loss or detrimental alteration to these species at a population level is possible (Table 7.27). Therefore, it has been concluded that the effect will be of **negligible adverse** significance, which is **not significant** in EIA terms.

7.12.16 Injury, Disturbance, and Displacement from Underwater Noise Generated during Geophysical and Seismic Site Investigation Surveys

Seismic and site investigation surveys during the construction and operation and maintenance phases have the potential to cause direct or indirect effects (including injury or disturbance). A detailed underwater noise modelling assessment has been carried out to investigate the potential for injurious and behavioural effects as a result of these surveys, using the latest criteria (volume 3, Underwater Noise Technical Report (RPS Group and Seiche, 2024)). This underwater noise modelling is drawn upon in the assessment below.

Sonar-based survey types will be used for the geophysical surveys to be conducted within the Proposed Development. These include MBES and SBP technology. The equipment likely to be used can typically work at a range of signal frequencies, depending on the distance to the bottom and the required resolution. The signal is highly directional, acts like a beam and is emitted in pulses. Sonar-based sources are considered as continuous (non-impulsive) because they generally compromise a single (or multiple discrete) frequency as opposed to a broadband signal with high kurtosis, high peak pressures and rapid rise times. In addition, seismic site investigation surveys will be conducted using VSP technology.

While marine turtles could potentially be affected by geophysical and seismic site investigation surveys, there is a lack of scientific understanding or legislation to thoroughly assess their sensitivity (revied by Nelms *et al.,* 2016). In addition, only three countries (6% of total) which allow seismic testing to be conducted in their waters have developed mandatory mitigation guidelines which include marine turtles. These countries are Brazil, Canada, and the USA (only within the Gulf of Mexico) (Nelms *et al.,* 2016). Additionally, the UK's guidelines on seismic surveys (JNCC, 2017) make a generalised statement acknowledging that *"…other protected fauna, for example turtles, will occur in waters where these guidelines may be used*" and that *"…whilst the appropriate mitigation may require further investigation, the soft-start procedures for marine mammals would also be appropriate for marine turtles…*". However, no mandatory mitigation measures for marine turtles are included by JNCC (2017). Furthermore, there are no thresholds in Popper *et al.* (2014) in relation to HF sonar (>10 kHz) for marine turtles. Thus, marine turtles were not included in the underwater noise modelling for this impact (see volume 3, Underwater Noise Technical Report (RPS Group and Seiche, 2024)).

7.12.16.1 Construction Phase

Magnitude of Impact

Auditory Injury

Marine Mammal IEFs

Potential impacts of site investigation surveys will depend on the characteristic of the source, survey design, frequency bands and water depth. Sonar-based survey equipment has very strong directivity which effectively means that there is only potential for injury when an animal is directly beneath the sound source. Once the animal moves outside of the main beam, there is no potential for injury. The same is true in many cases for TTS where an animal is only exposed to enough energy to cause TTS when inside the direct beam of the sonar. For this reason, many of the TTS and PTS ranges are similar (i.e. limited by the depth of the water). Any shallower waters surveyed would result in shorter injury ranges due to these directivity effects therefore these values represent a worst-case assessment.

The modelling results for MBES and SBP activity are presented in Table 7.73. The highest PTS ranges were 345 m for MBES and 335 for SBP, both for the VHF hearing group (i.e. harbour porpoise). Similarly, the highest TTS ranges of 495 m (MBES) and 655 m (SBP) were also modelled for the VHF hearing group. These PTS ranges are well in line with the standard 500 m mitigation zone that will be applied as part of the MMMP, which is an embedded mitigation measure applicable to this impact (Table 7.32).

Table 7.73: Potential Impact Ranges For Marine Mammals During The Geophysical Surveys Based On Comparison To Southall *et al.* (2019) SEL Thresholds For Non-Impulsive Sound (N/E = Threshold Not Exceeded)

Survey type	Hearing group	Range (m)	
MBES	LF	N/E	40
	HF	105	290
	VHF	345	485
	PCW	5	80
SBP	LF	45	50
	HF	50	260
	VHF	335	655
	PCW	40	50

The modelling results for VSP are presented in Table 7.74. Neither the SEL nor peak PTS threshold was exceeded for the HF hearing group (i.e. dolphin species). The highest PTS injury range (444 m) was modelled for the LF hearing group (i.e. minke whale) against the SEL threshold. This is in line with the standard 500 m mitigation zone will be applied as part of the MMMP, which is an embedded mitigation measure applicable to this impact (Table 7.32).

Table 7.74: Potential Impact Ranges For Marine Mammals During The VSP Survey Based On Comparison To Southall *et al.* (2019) SEL And Peak Thresholds (N/E = Threshold Not Exceeded)

Species Group	Threshold (Weighted SEL)	Range (m)	
LF	PTS – 183 dB re 1 µPa²s	444	13
	TTS – 168 dB re 1 µPa²s	2,941	38
HF	PTS – 185 dB re 1 µPa²s	N/E	N/E
	TTS – 170 dB re 1 µPa²s	4	6
VHF	PTS – 155 dB re 1 µPa²s	235	124
	TTS – 140 dB re 1 µPa²s	1,138	225
PCW	PTS – 185 dB re 1 µPa²s	11	16
	TTS – 170 dB re 1 µPa²s	38	44

The number of animals with the potential to be injured within the modelled ranges for PTS were estimated using the most up to date species-specific density estimates (Table 7.17). These results are presented in Table 7.75. For all species except grey seal, there was less than one animal with the potential to be disturbed due to the MBES and SBP survey activities. For grey seal, 16 individuals could potentially be disturbed from MBES and 18 from SBP (Table 7.75). Across all species, a larger number of animals had the potential to be disturbed by VSP site investigation surveys. Again, the species with the highest number of animals with the potential to be disturbed was grey seal, where 2,155 individuals could potentially experience mild disturbance, and 9 could experience strong disturbance. For all other species, there was less than one animal with the potential to experience strong disturbance from VSP.

Table 7.75: Estimated Number Of Animals With The Potential To Be Disturbed From Geophysical And Seismic Site Investigation Surveys

Activity	Estimated Number of Animals with the Potential to be Disturbed					
	Bottlenose dolphin	Common dolphin	Risso's dolphin	Minke whale	Grey seal	Harbour seal
Geophysical activities – 120 dB SPL_{rms}						
MBES	<1	<1	<1	<1	16	<1
SBP	<1	<1	<1	<1	18	<1
Seismic						
VSP (mild) – 140 dB SPL_{rms}	19	15	17	5	2,155	32
VSP (strong) – 160 dB SPL_{rms}	<1	<1	<1	<1	9	<1

As per Table 7.51, recent guidance from NRW (2023) was used to estimate the number of harbour porpoise with the potential to be disturbed from site investigation surveys. These results are presented in Table 7.76, and indicate that less than one individual has the potential to be disturbed from MBES and SBP surveys. For VSP, the highest number of individuals with the potential to be disturbed at the SCANS-III density estimate of 0.086 animals per km^2 is 33, and at the SCANS-IV estimate of 0.515 animals per km^2 this is 196, calculated using the 140 dB SEL_{ss} threshold (Tougaard, 2021). Overall, the results presented in Table 7.75 and Table 7.76 suggest that a low number of individuals could be disturbed due to MBES and SBP, and experience strong VSP disturbance. Therefore, it is not likely that these activities will impact these species at a population level.

Table 7.76: Estimated Number Of Harbour Porpoise With The Potential To Be Disturbed From Geophysical And Seismic Site Investigation Surveys Using The Latest NRW (2023) Guidance

Activity	Threshold	Number of Harbour Porpoise
Geophysical activities		
MBES	160 dB SPL_{rms}	<1
SBP		<1
Seismic		
VSP	140 dB SEL_{ss}	33 to 196
	143 dB SEL_{ss}	16 to 92
	145 dB SEL_{ss}	7 to 41

Overall, site investigation surveys are considered short term as they will take place over a period of several months. Embedded mitigation for injury during geophysical surveys will involve the use of MMOs and PAM to ensure that the risk of injury over the 500 m mitigation zone is reduced in line with JNCC guidance (JNCC, 2017) (Table 7.32). The largest PTS range was predicted as 444 m (for LF hearing group in response to VSP; Table 7.74) and it is considered that standard industry measures will be effective at reducing the risk of injury over this distance. MBES surveys in shallow waters (<200m) are not typically subject to the requirements of mitigation (JNCC, 2017). Requirements for mitigation will be agreed with the consultees post submission of the ES and prior to any shallow geophysical or seismic survey effort.

Overall, with embedded mitigation applied where required, the impact of geophysical and seismic site investigation surveys leading to PTS is predicted to be of very limited spatial extent, short-term duration (during individual surveys), intermittent over the construction phase, and whilst the impact itself will occur during the construction phase only, the effect of PTS will be permanent. It is predicted that the impact will affect the receptor directly. The magnitude is, therefore, considered to be negligible**.**

Behavioural Disturbance

Marine Mammal IEFs

For all marine mammal hearing groups except harbour porpoise, the maximum disturbance ranges were 1,100 m and 1,180 m for MBES and SBP, respectively (Table 7.77). For harbour porpoise, these ranges were 490 m (MBES) and 430 m (SBP). Table 7.77 also presents the disturbance ranges for VSP, which range from 5 km to 11 km for the different harbour porpoise SEL_{ss} thresholds. For all other hearing groups, mild disturbance (measured against a threshold of 140 dB re 1 µPa (rms)) occurred to 13 km, and strong disturbance (160 dB re 1 µPa (rms)) occurred to 800 m.

Table 7.77: Potential Disturbance Ranges For Marine Mammals Due To MBES, SBP, And VSP, Based On Comparison To NMFS (2005) And Southall *et al.* (2019) Thresholds

Survey type	Threshold	Disturbance Range (m)
MBES	All hearing groups – 120 dB SPL_{rms}	1,100
	Harbour porpoise – 160 dB SPL_{rms}	490
SBP	All hearing groups – 120 dB SPL_{rms}	1,180
	Harbour porpoise – 160 dB SPL_{rms}[10]	430
VSP	Mild (all hearing groups) – 140 dB re 1 µPa (rms)	13,000
	Strong (all hearing groups) – 160 dB re 1 µPa (rms)	800
	Harbour porpoise – 143 dB SEL_{ss}	7,500
	Harbour porpoise – 140 dB SEL_{ss}	11,000
	Harbour porpoise – 145 dB SEL_{ss}	5,000

With impulsive sound sources, there is an understanding of the difference between strong and mild disturbance, whereas for non-impulsive (continuous) sound sources (i.e. MBES and SBP), there is only a single available threshold (120 dB re 1 µPa (rms)) (NMFS, 2005). This threshold has been classed as the distance beyond which no animals would be disturbed. Given that ranges for disturbance from MBES and SBP for all hearing groups (except harbour porpoise) are presented up to the 120 dB re 1 µPa (rms) threshold, and there is no distinction between mild and strong disturbance, it can be assumed that not all animals found within those ranges presented within Table 7.77 would be disturbed. There is also likely to be a proportional response (i.e. not all animals will be disturbed to the same extent), although there is no dose-response curve available to apply in the context of non-impulsive sound sources. Individual life history and context will also influence the likelihood of an individual to exhibit an aversive response to noise. These impacts will not be continuous over the construction phase, instead carried out over a shorter number of days within the period, during the individual survey events. Therefore, given the limited quantitative information available, as described above, any simplified calculation would likely lead to an unrealistic overestimation of the number of animals likely to be disturbed. As such, this value has not been quantified. However, the MBES and SBP surveys will be very short in duration (up to several months), intermittent, and animals are expected to recover quickly after cessation of the activities. This could result in only a minor alteration to the distribution of marine mammals within the regional marine mammal and marine turtle study area. Behavioural disturbance associated with geophysical and seismic site investigation surveys will be reduced by tertiary mitigation summarised in Table 7.32 and described in volume 4: Marine Mammal Mitigation Plan. Similarly, primary measures employed to mitigate injury (Table 7.32) are also expected to reduce disturbance.

Overall, the impact of site investigation surveys leading to behavioural effects is predicted to be of local spatial extent, short term duration, and intermittent over the construction phase. Further, the effect of behavioural disturbance is of high reversibility (with animals returning to baseline levels soon after surveys have ceased). It is predicted that the impact will affect the receptor directly. Therefore, for all IEFs, the magnitude of impact is considered to be low.

Sensitivity of Receptor

Auditory Injury

Marine Mammal IEFs

The sensitivity of all marine mammal IEFs to auditory injury in general has been described previously in greater detail for piling (section 7.12.14) and is not repeated here. Sills *et al.* (2020) evaluated TTS onset levels for impulsive noise in seals following exposure to underwater noise from a seismic air gun and found transient shifts in hearing thresholds at 400 Hz were apparent following exposure to four to ten consecutive pulses (SEL_{cum} 191 – 195 dB re 1 μPa^{2}s; 167 – 171 dB re 1 μPa^{2}s with frequency weighting for PCW).

Modelling has been used to compare potential effects of a non-impulsive sound source (Marine Vibroseis (MV)) and impulsive seismic sources (air gun) on marine mammals (Matthews *et al.,* 2021). The results of this study demonstrated that few marine mammals could be expected to be exposed to potentially injurious sound levels for either source type, but fewer were predicted for MV arrays than air gun arrays. The estimated number of animals exposed to sound levels was also found to be dependent on the selection of evaluation criteria, with more behavioural disturbance predicted for MV arrays compared to air gun arrays when using SPL but the opposite when using frequency-weighted sound fields and a multiple-step, probabilistic, threshold function. Overall, Matthews *et al.* (2021) demonstrated the importance of using both SPL_{pk} and SEL threshold metrics, as they relate to different characteristics of both impulsive and continuous sound (e.g. SPL_{pk} measures acute exposure to high-amplitude sounds whilst SEL looks at accumulative exposure over a set duration).

Ruppel *et al.* (2022) categorised marine acoustic sources into four tiers based on their potential to injure marine mammals using physical criteria about the sources (e.g. source level, transmission frequency, directionality, beamwidth, and pulse repetition rate). Those in Tier Four were considered unlikely to result in ‘incidental take’ (i.e. loss of individuals) of marine mammals and therefore termed “*de minimis”*, and included most high resolution geophysical sources (e.g. MBES, SBP). They also suggested that surveys that simultaneously deploy multiple, non-impulsive de minimis sources are unlikely to result in incidental take of marine mammals.

Overall, marine mammals IEFs are deemed have limited tolerance to PTS, high vulnerability, low recoverability and international value. The sensitivity of the receptors to PTS from elevated underwater noise during site investigation surveys is therefore, considered to be high.

While TTS as a result of this impact could occur, marine mammal IEFs are likely to be able to tolerate the effect of TTS without any impact on both reproduction and survival rates and would be able to return to previous behavioural states or activities once the impacts had ceased. Thus, marine mammals IEFs are considered of medium vulnerability, high tolerance, high recoverability and international value. Therefore, the sensitivity of these receptors to TTS from elevated underwater noise during site investigation surveys is considered to be low.

Behavioural Disturbance

Marine Mammal IEFs

The hearing and vocal ranges of many marine mammals overlap with the transmission frequencies of many commercial sonar systems (approximately 12 – 1,800 kHz) (Richardson *et al.,* 1995). Whilst there are many HF sonar systems with peak frequencies well above marine mammal hearing ranges, it is possible that relatively high levels of sound are also produced as sidebands at lower frequencies (Hayes and Gough, 1992) so may elicit behavioural responses in marine mammals. For example, fine-scale data from harbour porpoises showed different responses to noise exposure when exposed to airgun pulses at ranges of 420 – 690 m with noise level estimates of 135 –147 dB re 1 μPa²s (SEL) (van Beest, *et al.,* 2018). Two individuals used shorter and shallower dives (compared to their natural behaviour) immediately after exposure, whilst one individual displayed rapid and directed movements away from the exposure site. This noise-induced behavioural change typically lasted for eight hours or less, with natural behaviour resumed after 24 hours (van Beest *et al.,* 2018). Stone and Tasker (2006) present results from 201 seismic surveys in the UK and adjacent waters and demonstrated that cetaceans (including bottlenose dolphin and minke whale) can be disturbed by seismic exploration. Small odontocetes showed the strongest lateral spatial avoidance by moving out of the area, whilst baleen whales and killer whales (*Orcinus orca*) showed more localised spatial avoidance, by orienting away from the vessel and increasing distance from source but not leaving the area completely (Stone and Tasker, 2006).

Hermannsen *et. Al.* (2015) investigated the source characteristics and propagation of broadband pulses from a small airgun (10 Hz up to 120 kHz). They confirmed that there are substantial medium-to-high frequency components in airgun pulses, indicating that small odontocetes and seals may be affected by even a single airgun (Hermannsen *et al.,* 2015). However, these findings indicate that in the context of exposure to sonar-like sound sources (e.g. MBES, SBP), marine mammals may exhibit subtle behavioural responses but factors such as species, behavioural context, location, and prey availability may be as important or even more important than the acoustic signals themselves (Ruppel *et. Al.,* 2022). MacGillivray *et al.* (2014) compared sound level above hearing threshold as a function of horizontal distance, for seven acoustic sources including air guns, SBP, MBES and SSS. Weighting sounds according to hearing sensitivity allows assessment of relative exposure risks, and whilst this analysis did not directly relate to potential for behavioural responses, it allowed comparison of modelled acoustic sources. Modelling indicated that odontocetes were most likely to hear sounds from Mid Frequency (MF) sources (e.g. fisheries, communication, and hydrographic systems), baleen whales from LF sources (SBP and airguns), and pinnipeds from both MF and LF sources. Modelled sensation levels for all species were lowest for the HF sources (e.g. SSS and MBES), which operate at the upper limits of the audible spectrum (MacGillivray *et al.,* 2014). Hastie *et al.* (2014) carried out behavioural response tests on grey seals exposed to two HF sonar systems (200 kHz and 375 kHz). Results showed that both systems had significant effects on seal behaviour. When the 200 kHz sonar was active, seals spent significantly more time hauled out and, although they remained swimming during operation of the 375 kHz sonar, they were distributed further from the sonar (Hastie *et al.,* 2014).

Largely, research has focused on the effects of multi-array seismic surveys on marine mammals, and therefore evidence for behavioural responses to sonar-like sources (e.g. MBES, SBPs) is less widely available. Multi-array impulsive sound sources are broadband in character (i.e. produce sound across a wide range of frequencies), unlike sonar-like sources which typically produce more tonal sound either at a discrete frequency or a range of discrete frequencies. However, findings from studies of multi-array impulsive sources may be useful in supporting predictions of behavioural responses of marine mammals to geophysical survey sources in general, given the overlap of parameters that typically characterise sound sources (i.e. transmission frequency; source level; pulse duration) (see MacGillivray *et al.,* 2014; Ruppel *et al*., 2022). Although evidence on the impact of MBES on melon-headed whale (or similar species) behaviour is limited, a 12 kHz MBES has been deemed to be the most plausible trigger for an extreme behavioural response in melon-headed whale (*Peponocephala electra)* (Southall *et al.,* 2013). This exposure resulted in a mass group stranding of melon-headed whale in a shallow lagoon in Madagascar in 2008, which is an area where such open-ocean species would not usually frequent (Southall *et al*., 2013). Whilst an unequivocal cause and effect relationship between

MBES and the strandings cannot be concluded, the authors state that intermittent, repeated sounds of this nature could present a salient and potential aversive stimulus and suggests potential for such behavioural responses (or indirect injury) from MBES should be considered in environmental assessments (Southall *et al.,* 2013). However, a study on the effect of MBES surveys on Cuvier's beaked whale (*Ziphius cavirostris*) in California, USA, reported that vocalisation rate was the only behaviour that changed during exposure to MBES (Kates Varghese *et al*. 2020). The results indicated that there was not a consistent change in foraging behaviour and individuals did not leave the range or stop foraging during the MBES activity (Kates Varghese *et al*. 2020). Similarly, tagged short-finned pilot whale (*Globicephala macrorhynchus)* that were exposed to a Single-Beam Echosounder (SBES), did not change their foraging behaviour, but variance in directionality of movement was observed (Quick *et al.,* 2014). This suggests that individuals increased their vigilance while the SBES was active, although the authors acknowledged that the range of behaviours exhibited could not be directly attributed to SBES operation, and that changes in behaviour were unlikely to be biologically significant (Quick *et al.,* 2014). In a study by Cholewiak *et. Al.* (2017) fewer beaked whale vocalisations were recorded when an SBES source was actively transmitting, suggesting that animals either move away from the area or reduce their foraging activity (although the findings were not statistically significant).

Temporary displacement or change in harbour porpoise echolocation behaviour was recorded in response to a 3D seismic survey in the North Sea (Sarnocińska *et al.,* 2020). No general displacement was detected at 15 km from any seismic activity but decreases in echolocation signals were detected up to 8 to 12 km from the active airguns (Sarnocińska *et al.,* 2020). Based on other studies (Dyndo *et al.,* 2015; Tougaard *et al.,* 2015) harbour porpoise disturbance ranges due to airgun noise are predicted to be smaller than to pile driving noise at the same energy. This is because the perceived noise level of the airgun pulses is predicted to be lower than for pile driving noise due to less energy at the higher frequencies where porpoise hearing is better (Sarnocinska *et al.,* 2020). Similarly, Thompson *et al.* (2013) found acoustic detections of harbour porpoise in a 2,000 km^2 North Sea study area decreased significantly during a commercial 2D seismic survey, but this effect was small in relation to natural variation. Animals were typically detected again at affected sites within a few hours, and the level of response declined through the ten-day survey suggesting exposure led to some tolerance of the activity (Thompson *et al.,* 2013). This suggests that prolonged seismic survey noise did not cause broader-scale displacement into suboptimal or higher-risk habitat. Likewise, no evidence of prolonged or large-scale displacement of humpback whale, sperm whale (*Physeter macrocephalus),* and Atlantic spotted dolphin (*Stenella frontalis*) due to seismic exploration was recorded during a ten-month study off Angola (Weir, 2008).

Aside from displacement or avoidance, other behavioural responses to seismic surveys have been demonstrated (reviewed in Wright and Consentino, 2015). These behavioural responses include cessation of singing (Melcón *et al*., 2012) and alteration of dive and respiration patterns which may lead to energetic burdens on the animals (Gordon *et al*., 2003). It is possible that these behavioural responses may lead to greater effects than expected, such as strandings (Cox *et al.,* 2006; Tyack *et al.,* 2006) or disruptions to migration (Heide-Jørgensen *et al.,* 2013). However, such extreme responses are highly context-dependent and variable, depending on factors such as the activity of the animal at the time (Robertson *et al*., 2013), prior experience to exposure (Andersen *et al.,* 2012), extent or type of disturbance (Melcón *et al*., 2012), environment in which they inhabit (Heide-Jørgensen *et al*., 2013) and the type of survey (as discussed in above for 'Auditory Injury').

It is expected that, to some extent, marine mammals will be able to adapt their behaviour to reduce impacts on survival and reproduction rates and tolerate elevated levels of underwater noise during site investigation surveys. Marine mammals are deemed to have some tolerance, medium vulnerability, high recoverability, and international value. The sensitivity of these receptors to behavioural disturbance from elevated underwater noise during site investigation surveys is therefore considered to be medium.

Significance of Effect

Auditory Injury

Marine Mammal IEFs

Overall, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Behavioural Disturbance

Marine Mammal IEFs

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

7.12.16.2 Operation and Maintenance

Magnitude of Impact

Auditory Injury

Marine Mammal IEFs

Routine geophysical site investigation surveys and/or asset integrity surveys are expected to occur annually over the 25-year operations and maintenance phase (Table 7.23).

An overview of potential impacts from elevated underwater noise due to site investigation surveys are described above for the construction phase and have not been reiterated here. Overall, with embedded mitigation applied where required, this impact is predicted to be of very limited spatial extent, short-term duration (during individual surveys), intermittent over the operations and maintenance phase, and whilst the impact itself will occur during this phase, the effect of PTS will be permanent. It is predicted that the impact will affect the receptor directly. The magnitude is, therefore, considered to be negligible.

Behavioural Disturbance

Marine Mammal IEFs

An overview of potential impacts from elevated underwater noise due to site investigation surveys are described above for the construction phase and have not been reiterated here. Overall, this impact is predicted to be of local spatial extent, short term duration, and intermittent over the operations and maintenance phase. Further, the effect of behavioural disturbance is of high reversibility (with animals returning to baseline levels soon after surveys have ceased). It is predicted that the impact will affect the receptor directly. Therefore, for all IEFs, the magnitude of impact is considered to be low.

Sensitivity of Receptor

Auditory Injury

All Species

The sensitivity of all marine mammal IEFs to auditory injury from underwater noise has been described previously for piling (section 7.12.14) and for site investigation surveys in the construction phase. This information is not repeated here, as the sensitivity of marine mammal IEFs during the operations and maintenance phase is not expected to differ from that of construction phase. Overall, all marine mammal IEFs are deemed to have limited tolerance to auditory injury, high vulnerability, low recoverability, and international value. The sensitivity of these receptors to auditory injury is therefore considered to be **high**.

Since TTS is reversible, all marine mammal and marine turtle IEFs are assessed as having high tolerance, medium vulnerability, high recoverability, and international value. The sensitivity of these receptors to TTS is therefore considered to be low.

Behavioural Disturbance

Marine Mammal IEFs

The sensitivity of marine mammals during the operations and maintenance phase is not expected to differ from the construction phase. The sensitivity of marine mammals to behavioural disturbance as a result of this impact is as described above for the construction phase. All marine mammals are deemed have some tolerance, medium vulnerability, high recoverability, and international value. The sensitivity of these receptors to behavioural disturbance from is therefore considered to be medium.

Significance of Effect

Auditory Injury

Marine Mammal IEFs

Overall, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Behavioural Disturbance

Marine Mammal IEFs

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

7.12.17 Injury, Disturbance, and Displacement from Vessel Activity and other Noise Producing Activities

The impact of vessel use during the construction, operation and maintenance, and decommissioning phases of the Proposed Development have the potential to cause injury, behavioural disturbances, and associated displacement of marine mammals. Noise producing activities (e.g. seabed preparation, drilling, and rock placement over the cables) could additionally result in disturbances to marine mammals within the development area.

The impacts from elevated underwater noise due to vessel use and other activities is based on a vessel and/or activity basis, considering the maximum injury/disturbance range as assessed in volume 3, Underwater Noise Technical Report (RPS Group and Seiche, 2024). However, several activities could be potentially occurring at the same time and therefore ranges of effects may extend from several vessels/locations where the activity is carried out and potentially overlap.

7.12.17.1 Construction Phase

Magnitude of Impact

Auditory Injury

All Species

During the construction phase of the Proposed Development, the increased levels of vessel activity will contribute to total underwater noise levels. The MDS for construction activities is up to a total of 236 construction vessels round trips (Table 7.23). These include heavy lift vessels, tug/anchor handlers, survey vessels, cable lay and installation vessels, and support vessels. Full details are provided in the MDS (Table 7.23). While this will result in an increase in vessel presence, movement will be limited to within the Proposed Development and are likely to follow existing shipping routes while travelling to and from ports. The MDS also accounts for other noise producing activities in the construction phase, such cable laying, cable trenching/cutting, and the use of jack-up rigs (Table 7.23).

Baseline levels of vessel traffic in the eastern Irish Sea are already high, largely due to ferry routes. For example, in 2019, there were 1,912 commercial ferry crossings between Liverpool or Heysham and the Isle of Man, 1,696 crossings between Liverpool and Belfast, 1,087 between Heysham and Warrenpoint (Northern Ireland), and 604 crossings between Heysham and Dublin (Energie Baden-Württemberg (EnBW) and British Petroleum (BP), 2023a). Vessels and construction activities will be temporary and transitory, as opposed to permanent and fixed. In this respect, vessel and construction activity noise is unlikely to differ significantly to that of vessel traffic already in the area.

A detailed underwater noise modelling assessment has been carried out to investigate the potential for injurious effects due to increase underwater noise (non-impulsive sound), using the latest criteria (see volume 3, Underwater Noise Technical Report (RPS Group and Seiche, 2024)). A conservative assumption has been made that all individuals will respond to increased vessel noise. The exposure metrics for different species and flee speeds (as detailed in Table 7.49) were employed. In reality, the distance over which effects may occur will, however, vary according to the species, the ambient sound levels, hearing ability, and behavioural response differences.

The underwater noise modelling results indicate that the threshold for PTS was not exceeded for any species for all vessels and activities. The threshold for TTS was also not exceeded for all species except harbour porpoise (in the VHF hearing group) (Table 7.78). Therefore, there is a negligible risk of PTS occurring to marine mammals as a result of elevated underwater sound due to vessel use, and cable laying, trenching, and jack-up rig activities. These activities were not modelled for marine turtles. However, given that thresholds were not exceeded for all marine mammal hearing groups (except TTS for VHF), the same result has been extrapolated for marine turtles.

Table 7.78: Estimated PTS And TTS Ranges (m) From Different Vessel Types And Activities For The Marine Mammal Hearing Groups (N/E = Threshold Not Exceeded)

Noise Source	Range (m)							
	LF		HF		VHF		PCW	
	PTS	TTS	PTS	TTS	PTS	TTS	PTS	TTS
Vessels								
Anchor handling vessel	N/E	N/E	N/E	N/E	N/E	700	N/E	N/E
Main installation vessel, construction vessel	N/E	N/E	N/E	N/E	N/E	1,440	N/E	N/E
Survey vessel, crew transfer vessels, and support vessels	N/E	N/E	N/E	N/E	N/E	6,740	N/E	N/E

Noise Source	Range (m)							
	LF		HF		VHF		PCW	
	PTS	TTS	PTS	TTS	PTS	TTS	PTS	TTS
Miscellaneous small vessel (e.g. tugs, vessels carrying Remotely Operated Vehicles (ROVs), dive boats, guard vessels)	N/E	N/E	N/E	N/E	N/E	700	N/E	N/E
Activities								
Cable trenching/cutting	N/E	N/E	N/E	N/E	N/E	5,000	N/E	N/E
Cable laying	N/E	N/E	N/E	N/E	N/E	1,440	N/E	N/E
Jack-up rig	N/E	N/E	N/E	N/E	N/E	N/E	N/E	N/E

Overall, for all IEFs, the likelihood of auditory injury is extremely low and the maximum duration of the construction phase is up to two years. Therefore, this impact is predicted to be of limited spatial extent, medium term duration, intermittent and, although the impact itself is reversible (i.e. the elevation in underwater noise only occurs during the activities), the effect of PTS is permanent. It is predicted that the impact will affect the receptor directly. Since the PTS threshold was not predicted to be exceeded for any activities or hearing groups, the magnitude of impact is considered to be negligible.

Behavioural Disturbance

<u>All Species</u>

Behavioural disturbance is only likely to occur if vessel sound and activities exceed the background ambient noise levels. As discussed above for auditory injury, vessel traffic within the Proposed Development is already high, indicating high background ambient noise levels.

As above for auditory injury, a detailed underwater noise modelling assessment has been carried out to investigate the potential for behavioural disturbance due to increase underwater noise (non-impulsive sound), using the latest criteria (see volume 3, Underwater Noise Technical Report (RPS Group and Seiche, 2024)). A conservative assumption has been made that all individuals will respond to increased vessel noise. The exposure metrics for different species and flee speeds (as detailed in Table 7.49) were employed. In reality, the distance over which effects may occur will, however, vary according to the species, the ambient sound levels, hearing ability, and behavioural response differences. It should be borne in mind that there is a considerable degree of uncertainty and variability in the onset of disturbance and therefore any disturbance ranges should be treated as potentially over precautionary.

Based on the results of the underwater noise modelling, the estimated behavioural disturbance ranges for all hearing groups are presented in Table 7.79. The greatest behavioural disturbance range was from survey vessels, crew transfer vessels, and support vessels, with an estimated range of 20 km. Disturbance ranges for other vessels and activities varied from 6.3 to 16 km, with the threshold of disturbance not exceeded for jack-up rig activities.

Table 7.79: Estimated Behavioural Disturbance Ranges (km) From Different Vessel Types And Activities For All Marine Mammal Hearing Groups (N/E = Threshold Not Exceeded)

Noise Source	Disturbance Range (km)
Vessels	

Noise Source	Disturbance Range (km)
Anchor handling vessel	6.3
Main installation vessel, construction vessel	7.5
Survey vessel, crew transfer vessels, and support vessels	20
Miscellaneous small vessel (e.g. tugs, vessels carrying ROVs, dive boats, guard vessels)	6.3
Activities	
Cable trenching/cutting	16
Cable laying	7.5
Jack-up rig	N/E

With impulsive sound sources, there is an understanding of the difference between strong and mild disturbance, whereas for non-impulsive (continuous) sound sources, there is only a single available threshold (120 dB re 1 µPa (rms)) (NMFS, 2005). This threshold has been classed as the distance beyond which no animals would be disturbed. Given that ranges for disturbance for vessels are presented up to the 120 dB re 1 µPa (rms) threshold, and there is no distinction between mild and strong disturbance, it can be assumed that not all animals found within those ranges presented within Table 7.79 would be disturbed. There is also likely to be a proportional response (i.e. not all animals will be disturbed to the same extent), although there is no dose-response curve available to apply in the context of non-impulsive sound sources. Individual life history and context will also influence the likelihood of an individual to exhibit an aversive response to noise. These impacts will not be continuous over the construction phase, instead carried out over a shorter number of days within the period. Therefore, given the limited quantitative information available, as described above, any simplified calculation would likely lead to an unrealistic overestimation of the number of animals likely to be disturbed. As such, this value has not been quantified.

The impact is predicted to be of local spatial extent, medium-term duration, intermittent and reversible (i.e. increased underwater noise only occurs during the vessel presence and activities). Similarly, the effect of behavioural disturbance is reversible as receptors are expected to recover within days, even hours. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be **low.**

Sensitivity of Receptor

Increased vessel movements during the construction phase of the Proposed Development have the potential to result in a range of effects on marine mammals and marine turtles including injury due to elevated underwater noise, avoidance behaviour or displacement, and masking of vocalisations or changes in vocalisation rate.

Auditory Injury

<u>All Species</u>

The sensitivity of all marine mammal and marine turtle IEFs to auditory injury from underwater noise has been described previously for piling (section 7.12.14) and is not repeated here. Overall, all marine mammal and marine turtle IEFs are deemed to have limited tolerance to PTS, high vulnerability, low recoverability, and international value. The sensitivity of these receptors to auditory injury is therefore considered to be high.

Since TTS is reversible, all marine mammal and marine turtle IEFs are assessed as having high tolerance, medium vulnerability, high recoverability, and international value. The sensitivity of these receptors to TTS is therefore considered to be low.

Behavioural Disturbance

Cetacean IEFs

Disturbance levels will be dependent on individual species hearing ranges and background sound levels within the Proposed Development. Species sensitivity to underwater noise produced by vessels is related to species activity at the time of disturbance (International Whaling Commission (IWC), 2006; Senior *et al*., 2008), and the level of response is dependent on vessel type and behaviour (e.g. heading, speed) (Oakley *et al*., 2017; Hermannsen *et al*., 2019).

Cetaceans can both be attracted to and disturbed by vessels. For example, resting dolphins are likely to avoid vessels, foraging dolphins will ignore them, and socialising dolphins may approach vessels (Richardson *et al*., 1995). Species such common dolphin are regularly sighted near vessels and may also approach vessels (e.g. bow-riding). However, dolphins are also known to show aversive behaviours to vessel presence, including increased swimming speed, greater time travelling, less time resting or socialising, avoidance, increased group cohesion, and/or longer dive duration (Miller *et al*., 2008; Marley *et al.,* 2017; Toro *et al*., 2021). Other marine mammals, however, may show higher avoidance of vessels in comparison to dolphins. For example, a study by Meza *et al.* (2020) in the Istanbul Strait (Turkey) found increased foraging in bottlenose dolphin and common dolphin behavioural budgets, but a decrease in time spent foraging by harbour porpoise when exposed to purse seine vessels. In addition, a study of the vessel traffic associated with the construction of subsea gas pipeline in north-west Ireland demonstrated that bottlenose dolphin was positively correlated with overall vessel numbers and the number of construction vessels, but minke whale and grey seal were displaced by high levels of vessel traffic (Anderwald *et al.,* 2013). However, the authors suggested that minke whale and grey seal were avoiding the area due to noise rather than vessel presence. It was, however, unclear whether the bottlenose dolphins were attracted to the vessels themselves or to particularly high prey concentrations within the study area at the time (Anderwald *et al.,* 2013).

A reduction and/or simplification of dolphin vocalisations has been linked to vessel presence and noise. For example, Fouda *et al.* (2018) investigated the effect of concurrent ambient sound levels on social whistle calls produced by bottlenose dolphins in the western North Atlantic. The results demonstrated increases in ship sounds (both within and below the dolphin call bandwidth) resulted in simplified vocal calls, with higher dolphin whistle frequencies and a reduction in whistle contour complexity (Fouda *et al.,* 2018). This sound-induced simplified vocal calls may result in reduced information content and decrease effective communication, parent–offspring proximity, or group cohesion. Similarly, an upward shift in whistle frequency related to vessel presence has also been observed in bottlenose dolphin Walvis Bay, Namibia (Heiler, 2016).

Reactions of marine mammals to noise generate by vessels are often linked to changes in the engine and propeller speed (Richardson *et al.,* 1995). For example, Watkins (1986) reported avoidance behaviour in baleen whales from loud or rapidly changing sound sources, particularly where a boat approached an animal. Disturbance in small cetaceans, (dolphins and porpoises) is likely to be associated with small, fast-moving vessels as these species are more sensitive to HF sound, whilst baleen whales (e.g. minke whale) are likely to be more sensitive to slower moving vessels which emit LF sound. A study in the Moray Firth found that transit of vessels (moving motorised boats) resulted in a nearly 50% reduction of the likelihood of recording bottlenose dolphin prey capture buzzes (Pirotta *et al.,* 2015). The authors also suggested that vessel presence, not just vessel sound, resulted in disturbance of bottlenose dolphins (Pirotta *et al.,* 2015). Similarly, Richardson (2012) investigated the effect of disturbance on bottlenose dolphin community structure in Cardigan Bay, Wales, and found that group size was significantly smaller in areas of high vessel traffic.

As stated, harbour porpoise are VHF cetaceans and are particularly sensitive to high frequency sound. Therefore, they are likely to avoid vessels. Wisniewska *et al*. (2018) studied the temporary change in foraging rates of harbour porpoise in response to vessel sound in coastal waters with high traffic rates. Their results demonstrated that occasional high sound levels coincided with vigorous fluking, bottom diving, interrupted foraging, and even cessation of echolocation, leading to significantly fewer prey capture attempts at received levels greater than 96 dB re 1 μPa (16 kHz third-octave) (Wisniewska *et al*., 2018). Another study in the wider UK found that the occurrence of harbour porpoise declined significantly when the number of vessels in a 5 km^2

area exceeded 20,000 ships per year (approximately 80 ships per day or 18 ships per km^2) (Heinänen and Skov, 2015). Recently, Benhemma-Le Gall *et al.* (2021) compared harbour porpoise occurrence and foraging activity between two OWFs in the Moray Firth. Their results suggested that increased vessel activity (and other construction activities) led to a decrease in harbour porpoise acoustic detections and activity at distances of up to 4 km.

There is, however, evidence of habituation to boat traffic (Vella, 2002) and therefore a slight increase from the existing levels of traffic in the vicinity of the Proposed Development may not result in high levels of disturbance. The Liverpool Bay area already has a high level of anthropogenic activities as a baseline. For example, Lusseau *et al.* (2011) undertook a modelling study on the interaction between bottlenose dolphins and vessels associated with OWF development in the Moray Firth. Their results predicted that increased vessel movements did not have an adverse effect on the local population of bottlenose dolphin, although it did note that foraging may be disrupted by disturbance from vessels, which was also suggested by Benhemma-Le Gall *et al*. (2021).

The presence of vessels in foraging grounds could also result in reduced foraging success. Christiansen *et al*. (2013b) found that the presence of whale-watching boats within an important feeding ground in Iceland led to a reduction in minke whale foraging activity. As minke whale is a capital breeder, this could lead to reduced reproductive success since female body condition is known to affect foetal growth (Christiansen *et al.,* 2014). However, it is worth noting that the study was conducted in Faxafloi Bay (Iceland) where baseline sound levels (compared to the Irish Sea) are very low (McGarry *et al*., 2017). In addition, a subsequent study conducted by Christiansen and Lusseau (2015) in the same study area found no significant long-term effects of disturbance from whale-watching on minke whale vital rates since animals moved into disturbed areas when sandeel numbers were lower across their wider foraging area. A study (albeit on grey seals) by Hastie *et al.* (2021) demonstrated how foraging context is important when interpreting avoidance behaviour and should be considered when predicting the effects of anthropogenic activities. The authors state that avoidance rates depend on the perceived risk (e.g. silence, pile driving noise, operational noise from tidal turbines) versus the quality of the prey patch and highlight that sound exposure in different prey patch qualities may result in markedly different avoidance behaviour (Hastie *et al.,* 2021). Given the existing levels of vessel activity in the Proposed Development shipping and navigation study area (see volume 2, chapter 9) it is expected that cetaceans could tolerate the effects of disturbance without any impact on reproduction and survival rates and would return to previous activities once the impact had ceased.

Vessel movements involved in the construction phase, however, are unlikely to result in barrier effects to migration for these receptors as disturbance ranges will likely constitute a small area in the context of the wider available habitat in the Irish Sea. Overall, the cetacean IEFs are deemed to have some tolerance to behavioural disturbance, medium vulnerability, high recoverability and international value. The sensitivity of these receptors to behavioural disturbance is therefore considered to be medium.

Grey Seal and Harbour Seal

Seals are particularly sensitive to disturbances in regions where vessel traffic overlaps with productive coastal waters (Robards *et al*., 2016). Common reactions to approaching vessels includes increased alertness (Henry and Hammill, 2001), head raising (Niemi*, et al.,* 2013) and flushing off haul-out sites into the sea (Jansen *et al.,* 2015; Andersen *et al*., 2012; Blundell and Pendleton, 2015; Johnson and Acevedo-Gutiérrez, 2007), although it should be noted that the studies listed focussed on vessel presence rather than vessel sound. Recently however, Mikkelsen *et al.* (2019) investigated the behaviour of a tagged grey seal to vessel noise, and reported changes in diving behaviour, switching rapidly from a dive ascent to descent.

In a study of harbour seal in Alaska, haul out probability was adversely affected by vessels, with cruise ships having the strongest effect (Blundell and Pendleton, 2015). Harbour seal have been shown to be alerted and move away when a boat approaches (Andersen *et al.,* 2012; Blundell and Pendleton, 2015), but this response varies by season. When disturbed, hauled-out seals typically flush into the water, which could be detrimental during pupping season (Terhune and Almon, 1983; Johnson and Acevedo-Gutiérrez, 2007). Recently, Pérez Tadeo *et al.* (2021) assessed the responses of grey seal to ecotourism during breeding and pupping seasons at White Strand Beach, south-west Ireland. They found that vessels approaching within 500 m of the beach showed strong influence on the proportion of grey seal entering the water and an increase in vigilance and decrease in resting behaviour (Pérez Tadeo *et al.*, 2021). Similarly, a study on harbour seal showed avoidance behaviour or alert reactions when vessels approached within 100 m of a haul-out (Paterson *et al.,* 2005). This disturbance to seal haul-outs could have adverse consequences during the pupping season, due to trade-offs between feeding and nursing. Andersen *et al.* (2012), reported that harbour seal exhibit weaker and shorter lasting responses to disturbance during the breeding season and appear more reluctant to flee and return to the haul-out site after being disturbed (likely attributed to a trade-off between moving away and nursing, rather than habituation).

Furthermore, the presence of vessels in foraging grounds could result in reduced foraging success, particularly in harbour seals given reduced foraging ranges (approximately 50 km from haul-outs) when compared to grey seals (approximately 100 – 150 km from haul-outs) (SCOS, 2021). However, seals can be curious and have been recorded approaching tour boats that regularly visit an area and may habituate to sounds from tour vessels (Bonner, 1982). Mikkelsen *et al.* (2019) used long term sound and movement tagging data to study reaction of grey seals to vessel noise in the North Sea. They found that grey seal were exposed to audible vessel noise 2.2% – 20.5% of their time when in water and that high vessel noise coincided with interruption of functional behaviours such as resting (Mikkelsen *et al.,* 2019). A study on grey seals by Hastie *et al.* (2021) demonstrated how foraging context is important when interpreting avoidance behaviour and should be considered when predicting the effects of anthropogenic activities. The authors state that avoidance rates depend on the perceived risk (e.g. silence, pile driving noise, operational noise from tidal turbines) versus the quality of the prey patch and highlight that sound exposure in different prey patch qualities may result in markedly different avoidance behaviour (Hastie *et al.,* 2021). Given the existing levels of vessel activity in the Proposed Development shipping and navigation study area (see volume 2, chapter 9) it is expected that seals could tolerate the effects of disturbance without any impact on reproduction and survival rates and would return to previous activities once the impact had ceased.

Vessel movements involved in the construction phase, however, are unlikely to result in barrier effects to migration for these receptors as disturbance ranges will likely constitute a small area in the context of the wider available habitat in the Irish Sea. Overall, grey and harbour seal are deemed to have some tolerance to behavioural disturbance, medium vulnerability, high recoverability and international value. The sensitivity of these receptors to behavioural disturbance is therefore considered to be medium.

<u>Marine Turtle IEFs</u>

Marine turtles are known to migrate through and feed within the regional marine mammal study area during the summer, which is, therefore, considered to be the most sensitive time of year. Vessel movements involved in the construction phase, however, are unlikely to result in barrier effects to migration for these receptors as disturbance ranges will likely constitute a small area in the context of the wider available habitat in the Irish Sea.

Although there is little published data on the behavioural response of marine turtles to vessels, responses are expected to consist of changes in swimming speed or direction, and diving behaviour. However, similar to marine mammals, direct displacement from the Proposed Development marine mammal study area is unlikely. As marine turtles do not nest on beaches in the UK and Ireland, their sensitivity to disturbance in this respect will be low. Offshore waters of the Irish Sea could potentially host important feeding grounds for sea turtles (NPWS, 2019), but the area of likely disturbance as a result of this impact will constitute a very small proportion of available habitat in the context of the wider region.

Given existing baseline levels of traffic within Liverpool Bay, vessels involved in the construction phase are unlikely to increase the risk of disturbance and therefore it is expected that marine turtles could tolerate the effects of disturbance without any impact on reproduction and survival rates and would return to previous activities once the impact had ceased. Overall, marine turtles are deemed to be of low vulnerability, high tolerance, high recoverability and international value. The sensitivity of these receptors to behavioural disturbance is therefore considered to be low.

Significance of Effect

Auditory Injury

All Species

Overall, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Behavioural Disturbance

Marine Mammal IEFs

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Marine Turtle IEF

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

7.12.17.2 Operation and Maintenance Phase

Magnitude of Impact

Auditory Injury

Vessel traffic associated with operation and maintenance activities will result in up to 750 return trips by vessels to and from the Proposed Development over the 25-year lifetime of the Proposed Development (Table 7.23). Over a 25-year period this equates to just 2.5 vessel return trips per month. Vessel presence within the Proposed Development at any one time will be lower during the operation and maintenance than in the construction phase, but will be of a longer duration, over the whole 25-year lifetime of the Proposed Development.

An overview of potential impacts from elevated underwater noise due to vessel use and other activities are described above for the construction phase and have not been reiterated here. The impact is predicted to be of limited spatial extent, long term duration, intermittent, and although the impact itself is reversible (i.e. the elevation in underwater noise only occurs during the activities), the effect of PTS (if it were to occur) is permanent. It is predicted that the impact will affect the receptor directly. Since the PTS threshold was not predicted to be exceeded for any activities or species, the magnitude of impact is considered to be negligible.

Behavioural Disturbance

Vessel activities within the operation and maintenance phase include cable maintenance (Table 7.23). An overview of potential impacts from elevated underwater noise due to vessel use and other activities are described above for the construction phase and have not been reiterated here. The impact is predicted to be of local spatial extent, long-term duration, intermittent and reversible (i.e. the elevation in underwater noise only occurs during the activities). Similarly, the effects of behavioural disturbance are reversible as receptors are expected to recover within hours/days. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be low.

Sensitivity of Receptor

Auditory Injury

All Species

The sensitivity of all marine mammal and marine turtle IEFs to auditory injury from underwater noise has been described previously for piling (section 7.12.14) and is not repeated here. The sensitivity of marine mammal and marine turtle IEFs during the operations and maintenance phase is not expected to differ from the construction phase. Overall, all marine mammal and marine turtle IEFs are deemed to have limited tolerance to auditory injury, high vulnerability, low recoverability, and international value. The sensitivity of these receptors to auditory injury is therefore considered to be high.

Since TTS is reversible, all marine mammal and marine turtle IEFs are assessed as having high tolerance, medium vulnerability, high recoverability, and international value. The sensitivity of these receptors to TTS is therefore considered to be low.

Behavioural Disturbance

Marine Mammal IEFs

The sensitivity of marine mammals during the operations and maintenance phase is not expected to differ from the construction phase. The sensitivity of marine mammals to behavioural disturbance as a result of this impact is as described above for the construction phase. All marine mammals are deemed to have some tolerance to behavioural disturbance, medium vulnerability, high recoverability, and international value. The sensitivity of these receptors to behavioural disturbance is therefore considered to be medium.

Marine Turtle IEFs

The sensitivity of marine turtles during the operations and maintenance phase is not expected to differ from the construction phase. The sensitivity of marine turtles to behavioural disturbance as a result of this impact is as described above for the construction phase. All marine turtles are deemed to be of low vulnerability, high tolerance, high recoverability, and international value. The sensitivity of these receptors to behavioural disturbance is therefore considered to be low.

Significance of Effect

Auditory Injury

All Species

Overall, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Behavioural Disturbance

Marine Mammal IEFs

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Marine Turtle IEF

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

7.12.17.3 Decommissioning Phase

Magnitude of Impact

Auditory Injury

Vessel traffic associated with decommissioning activities will result in up to 128 return trips by vessels to and from the Proposed Development (Table 7.23). Vessel presence within the Proposed Development during the decommissioning will be equal to or lower than that of the construction phase at any one time.

An overview of potential impacts from elevated underwater noise due to vessel use and other activities are described above for the construction phase and have not been reiterated here. The impact is predicted to be of limited spatial extent, long term duration, intermittent, and although the impact itself is reversible (i.e. the elevation in underwater noise only occurs during the activities), the effect of PTS (if it were to occur) is permanent. It is predicted that the impact will affect the receptor directly. Since the PTS threshold was not predicted to be exceeded for any activities or species, the magnitude of impact is considered to be **negligible.**

Behavioural Disturbance

Vessel activities within the decommissioning phase include cable and foundation removal (Table 7.23). An overview of potential impacts from elevated underwater noise due to vessel use and other activities are described above for the construction phase and have not been reiterated here. The impact is predicted to be of local spatial extent, long-term duration, intermittent and reversible (i.e. the elevation in underwater noise only occurs during the activities). Similarly, the effects of behavioural disturbance are reversible as receptors are expected to recover within hours/days. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be low.

Sensitivity of Receptor

Auditory Injury

<u>All Species</u>

The sensitivity of all marine mammal and marine turtle IEFs to auditory injury from underwater noise has been described previously for piling (section 7.12.14) and is not repeated here. The sensitivity of marine mammal and marine turtle IEFs during the decommissioning phase is not expected to differ from the construction phase. Overall, all marine mammal and marine turtle IEFs are deemed to have limited tolerance to auditory injury, high vulnerability, low recoverability, and international value. The sensitivity of these receptors to auditory injury is therefore considered to be high.

Since TTS is reversible, all marine mammal and marine turtle IEFs are assessed as having high tolerance, medium vulnerability, high recoverability, and international value. The sensitivity of these receptors to TTS is therefore considered to be low.

Behavioural Disturbance

<u>Marine Mammal IEFs</u>

The sensitivity of marine mammals during the decommissioning phase is not expected to differ from the construction phase. The sensitivity of marine mammals to behavioural disturbance as a result of this impact is as described above for the construction phase. All marine mammals are deemed to have some tolerance to behavioural disturbance, medium vulnerability, high recoverability, and international value. The sensitivity of these receptors to behavioural disturbance is therefore considered to be medium.

Marine Turtle IEFs

The sensitivity of marine turtles during the decommissioning phase is not expected to differ from the construction phase. The sensitivity of marine turtles to behavioural disturbance as a result of this impact is as described above for the construction phase. All marine turtles are deemed to be of low vulnerability, high tolerance, high recoverability, and international value. The sensitivity of these receptors to behavioural disturbance is therefore considered to be low.

Significance of Effect

Auditory Injury

All Species

Overall, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Behavioural Disturbance

Marine Mammal IEFs

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Marine Turtle IEF

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

7.12.18 Injury due to Collision with Marine Vessels

7.12.18.1 Construction Phase

Increases in marine vessel traffic during the construction phase of the Proposed Development could result in increased collisions risk for marine mammals and marine turtles within the Proposed Development and the surrounding Liverpool Bay.

Magnitude of Impact

All Species IEFs

Vessel traffic associated with construction activities will result in up to 236 return trips by vessels to and from the Proposed Development (Table 7.23). Increased vessel traffic in the construction phase is discussed in greater detail in section 7.12.17 above.

Collision with vessels has the potential to result in fatal and non-fatal injuries for marine mammals and marine turtles (Laist *et al.,* 2001; Hazel *et al.,* 2007; Vanderlaan and Taggart, 2007; Cates *et al.,* 2017; Schoeman *et al.,* 2020). Evidence of fatal collisions has been gathered from carcasses washed up on beaches, caught on vessel bows, and from floating carcasses (Laist *et al*., 2001; Foley *et al.,* 2019; Peltier *et al.,* 2019). Fatal injuries include propeller cuts, bruising, oedema, internal bleeding, and fractures (Jensen and Silber, 2003; Douglas *et al.,* 2008). However, fatalities are often not reported, particularly for marine turtles and smaller marine mammals (Authier *et al.,* 2014; Schoeman *et al.,* 2020). Evidence of non-fatal injuries has been gathered from individuals showing scars and gashes characteristic of collision with propellers (Wells *et al.,* 2008; Luksenburg, 2014). The New York State Marine Mammal and Sea Turtle Stranding Program reported that 10.6% of stranded marine turtles displayed evidence of propeller wounds (Gerle and DiGiovanni, 1998).

Whilst there are a range of vessels likely to be involved in the construction of the Proposed Development, those travelling at higher speeds pose a greater risk of injury due to the potential for stronger impact (Hazel *et al.,* 2007; Work *et al.,* 2010; Schoeman *et al.,* 2020). Vessels travelling at 7 m/s (14 knots) or faster are the most likely to cause death or a serious injury for marine mammals (Laist *et al.,* 2001). Vanderlaan and Taggart (2007) demonstrated the probability of lethal injury for large whales decreased to <50% when large vessels were travelling at 10 knots, and this probability was even lower for small vessels (3 – 6 m length) travelling at 10 knots. However, for marine turtles, vessel operators cannot rely on turtles to actively avoid vessels at speeds above 1.1 m/s (2.2 knots) (Hazel *et al.,* 2007). Work *et al.* (2010) demonstrated that the probability of lethal injury in loggerhead turtle was reduced when small vessels were travelling at 7.5 knots of less. It is likely that a proportion of the vessels associated with the construction phase will be stationary or slow moving throughout the Proposed Development for significant periods of time. Most vessels involved in the construction phase are likely to be travelling at lower speeds than 14 knots, which is suitable for the marine mammal IEFs within the regional marine mammal study area. Lower speeds of 10 knots would be required if a large whale, such as a humpback or fin whale (*Balaenoptera physalus*) was detected during vessel transit. These species are rare within the regional marine mammal study area, but there have been sporadic and isolated sightings in the past. As marine turtles are also infrequently recorded within the regional marine mammal study area, lower speeds would also be required upon sighting. Furthermore, marine turtles are not as easily detected as marine mammals, as they do not produce blows, breach the water, or produce sound detectable by a hydrophone. All vessels will be required to follow an EMP, which outlines instructions for vessel operation including advice to not deliberately approach marine mammals or turtles and to avoid sudden changes in speed or direction. With the EMP in place, the risk of collision is likely to be reduced for marine mammals, and to marine turtles, but to a lower extent.

Many of the vessels involved in the construction phase will be relatively small, such as tugs, ROVs, crew transfer vessels, dive boats, barges, and Rigid Inflatable Boats (RIBs). These smaller vessels will have good manoeuvrability and would be able to avoid any detected marine mammals or turtles (Schoeman *et al.,* 2020). Larger vessels with lower manoeuvrability would need larger distances to avoid an animal, however, would have more time to react as they would be travelling at slower speeds. Additionally, the sound emitted from these vessels could deter marine mammals and potentially marine turtles from the potential ZoI. Finally, the vessel movements will likely follow existing shipping routes, and will be contained within the Proposed Development.

Overall, with the measures to reduce the risk of collision in place (e.g. the EMP), this impact is predicted to be limited and localised spatial extent, medium term duration, intermittent, and of medium to low reversibility (depending on the extent of injuries). It is predicted that this impact will affect the receptor directly. Therefore, the magnitude of impact is conservatively considered to be low.

Sensitivity of Receptor

The majority of scientific publications on vessel collisions focus on large vessels and large, slow swimming baleen whales (Knowlton and Kraus, 2001; Nowacek *et al.,* 2004; Douglas *et al.,* 2008; Van der Hoop *et al.,* 2012). However, a recent review found that smaller whales, dolphins, porpoises, and marine turtles are also affected, but reporting is scarcer (Schoeman *et al.,* 2020).

Marine Mammal IEFs

In general, marine mammals are able to detect and avoid vessels, however, they do not always move out of the path of an approaching vessel (Schoeman *et al.,* 2020). Behaviours such as resting, foraging, nursing, and socialising could distract marine mammals from detecting the risk posed by vessels (Dukas, 2002). As discussed in the 'Magnitude of Impact' section above, vessel collisions can pose a serious risk to marine mammals, and result in serious and fatal injuries.

Harbour porpoise are the most common cetacean in UK and Irish waters, and within the regional marine mammal study area. They are a small, highly mobile species, and have been demonstrated to display avoidance behaviour to vessels (Polacheck and Thorpe, 1990; Camphuysen and Siemensma, 2011).

Furthermore, the most recent report by the UK Cetacean Strandings Investigation Programme detailed that only four out of 53 stranded harbour porpoise in 2015 had died from physical trauma of unknown origin, which could have been due to vessel strikes (UK Cetacean Strandings Investigation Programme, 2015). However, the physical trauma of unknown origin could also be due to undiagnosed bycatch or bottlenose dolphin attacks (IAMMWG *et al.,* 2015). Similarly, the programme only identified five harbour porpoise out of 1,041 strandings had injuries consistent with a fatal impact from vessel strikes between 2000 and 2010 (Jepson, 2005; Deaville and Jepson, 2011). Of these 1,041 stranded harbour porpoise, 48 died of acute physical trauma of unknown origin (Jepson, 2005; Deaville and Jepson, 2011). Overall, it is likely that harbour porpoise will largely be able to avoid vessel collisions within the Proposed Development.

As discussed in the preceding paragraphs, large, slow swimming baleen whales are likely to be the most vulnerable to vessel collisions. Minke whale are baleen whales and the largest marine mammal IEF identified in this assessment, however they are significantly smaller than other baleen whales, such as humpbacks and fin whales. Information on vessel collisions with minke whale is scarce, however there have been various reports of lethal collisions around the UK, including one in Easter Ross, Scotland, one in Shoebury, England (Groves, 2016), and two in Norfolk, England (Aldred, 2013). Similarly, out of 110 fatally stranded minke whale in Scotland between 1992 and 2002, two were killed by vessel strikes (Pierce *et al.,* 2004).

Vessel strikes can result in lethal or non-lethal injuries to dolphins (Schoeman *et al.,* 2020). For example, Dwyer *et al.* (2013) reported short-term survival of a bottlenose dolphin in New Zealand which suffered multiple propeller wounds, including penetration to the bone. Van Waerbeek *et al.* (2007) reported that bottlenose dolphin may receive a moderate impact from collisions, however these may be sustainable at species level because many strikes are nonlethal. However, the proportion of dolphins colliding with vessels is poorly understood. For example, a long-term photo-identification monitoring of 277 resident bottlenose dolphins present in Maui Nui, Hawai'I, reported that only one individual exhibited marks indicative of vessel interactions (Olson *et al.,* 2022). Reports of vessel collisions with other dolphin IEFs identified in this assessment are rare. For example, a common dolphin with deep propeller injuries below the dorsal fin was found dead on a Cornwall beach in 2022 (Morwood, 2022). Additionally, blunt trauma and spinal cord injuries likely due to a vessel collision were determined as the cause of death of a common dolphin in New Zealand (Martinez and Stockin, 2013). Similarly, one individual in a pod of 14 Risso's dolphin observed in the Ionian Sea had injuries indicative of vessel strikes behind the dorsal fin (Menniti and Vella, 2022).

In pinnipeds, trauma ascribed to collisions with vessels has been identified in <2% of both live stranded (Goldstein *et al*., 1999) and dead stranded seals in the USA (Swails, 2005). Furthermore, a study in the Moray Firth, Scotland, demonstrated that seals utilise the same areas as vessels during trips between haul-outs and foraging sites but tended to remain over 20 m from vessels with only three instances over 2,241 days of seal activity resulted in passes at <20 m (Onoufriou *et al.,* 2016). Furthermore, a study on strandings data of harbour seal in the Salish Sea reported 27 cases of fatal propellor strikes between 2002 and 2019 (Olson *et al.,* 2021).

Although the potential for injury due to collision with construction vessels is relatively low, the consequences of collision risk could be fatal. All marine mammal IEFs would be highly vulnerable to a collision, and the effect could potentially cause a change in both reproduction and survival of individuals. However, it is likely that marine mammals will avoid vessels, minimising collision risk. On the basis that not all collisions are lethal, there is considered to be a medium potential for recovery.

Overall, all marine mammal IEFs are deemed to have some tolerance (largely due to avoidance behaviour), medium recoverability and international value. The sensitivity of the receptor is therefore, considered to be medium.

Marine Turtle IEFs

Unlike marine mammals, marine turtles are less likely to be able to identify the direction of the source of vessel noise and avoid approaching vessels (Hazel, 2009). Furthermore, their smaller size in comparison to marine mammals, lack of blow, minimal time spent surfacing, and the inability to detect them using a hydrophone result in marine turtles being more difficult to detect from vessels. Marine turtles appear to be at a higher risk of vessel collision during nesting and breeding seasons (National Oceanic and Atmospheric Administration

(NOAA) Fisheries, 2023), however these occur in their tropical and subtropical habitats, far from the regional marine mammal study area.

Sightings and strandings of marine turtles within the regional marine mammal study area are not particularly common, with minimal information available on these species in UK and Irish waters. In 2021, there were 15 reported strandings of dead marine turtles in the UK and Ireland, with one stranded leatherback turtle in Rosyth, Scotland, with injuries indicative of a propeller strike. However, it is not known if these injuries were the cause of death of if they were inflicted upon the carcass post-mortem (Penrose *et al.,* 2022). In the past five years, only one other fatally stranded turtle with propeller injuries indicative of vessel collision has been reported: a leatherback which was found in Cornwall in 2018 (Penrose and Gander, 2019). Again, it is unknown whether these propeller wounds occurred pre- or post-mortem.

Marine turtles are known to migrate through and feed within the regional marine mammal study area during the summer (albeit it in relatively low numbers), as the offshore waters of the Irish Sea could potentially host important feeding grounds for them (NPWS, 2019). However, as marine turtles do not nest on beaches within the UK and Ireland and are more likely to be present further offshore, the potential for injury due to collision with construction vessels is relatively low. However, the consequences of a potential collision risk could be fatal; all marine turtle IEFs would be highly vulnerable to a collision, and the effect could potentially cause a change in both reproduction and survival of individuals. However, on the basis that not all collisions are lethal, there is considered to be a medium potential for recovery.

Overall, marine turtle IEFs are deemed to have low tolerance, medium recoverability, and international value. The sensitivity of the receptor is therefore, considered to be medium.

Significance of Effect

Marine Mammal IEFs

Overall, the magnitude of impact is deemed to be low and the sensitivity of the receptor is considered to be medium. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Marine Turtle IEFs

Overall, the magnitude of impact is deemed to be low and the sensitivity of the receptor is considered to be medium. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

7.12.18.2 Operation and Maintenance Phase

Increases in marine vessel traffic during the operation and maintenance phase of the Proposed Development could result in increased collisions risk for marine mammals within the Proposed Development and the surrounding Liverpool Bay.

Magnitude of Impact

All Species

Vessel traffic associated with operation and maintenance activities will result in up to 750 return trips by vessels to and from the Proposed Development over the 25-year lifetime of the Proposed Development (Table 7.23). Vessel presence within the Proposed Development at any one time will be lower during the operation and maintenance than in the construction phase, but will be of a longer duration, over the whole 25-year lifetime of the Proposed Development. An overview of the potential for vessel collision is provided within this section for the construction phase and has not been reiterated here.

Overall, with the measures to reduce the risk of collision in place (e.g. the EMP), and the lower volume of vessel traffic associated with the operation and maintenance phase, this impact is predicted to be limited and localised spatial extent, long term duration, intermittent, and of medium to low reversibility (depending on the extent of injuries). It is predicted that this impact will affect the receptor directly. Therefore, the magnitude of impact is conservatively considered to **be low.**

Sensitivity of Receptor

All Species

The sensitivities of marine mammal and turtle IEFs presented in the assessment of this impact in the construction phase equally apply in the operation and maintenance phase (medium).

Significance of Effect

Marine Mammal IEFs

Overall, the magnitude of impact is deemed to be low and the sensitivity of the receptor is considered to be medium. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Marine Turtle IEFs

Overall, the magnitude of impact is deemed to be low and the sensitivity of the receptor is considered to be medium. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

7.12.18.3 Decommissioning Phase

Increases in marine vessel traffic during the decommissioning phase of the Proposed Development could result in increased collisions risk for marine mammals within the Proposed Development and the surrounding Liverpool Bay.

Magnitude of Impact

All Species

Vessel traffic associated with decommissioning activities will result in up to 128 return trips by vessels to and from the Proposed Development (Table 7.23). Vessel presence within the Proposed Development during the decommissioning will be equal to or lower than that of the construction phase at any one time. An overview of the potential for vessel collision is provided within this section for the construction phase and has not been reiterated here.

Overall, with the measures to reduce the risk of collision in place (e.g. the EMP), this impact is predicted to be limited and localised spatial extent, medium duration, intermittent, and of medium to low reversibility (depending on the extent of injuries). It is predicted that this impact will affect the receptor directly. Therefore, the magnitude of impact is conservatively considered to be low.

Sensitivity of Receptor

All Species

The sensitivities of marine mammal and turtle IEFs presented in the assessment of this impact in the construction phase equally apply in the decommissioning phase (medium).

Significance of Effect

Marine Mammal IEFs

Overall, the magnitude of impact is deemed to be low and the sensitivity of the receptor is considered to be medium. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Marine Turtle IEFs

Overall, the magnitude of impact is deemed to be low and the sensitivity of the receptor is considered to be medium. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

7.12.19 Effects on Marine Mammals and Marine Turtles due to changes in Prey Availability

7.12.19.1 Construction Phase

There is potential for changes in prey abundance resulting from construction activities to have a direct impact on the foraging abilities of marine mammals and marine turtles within the Proposed Development and surrounding vicinity.

Magnitude of Impact

All Species

The key prey species for marine mammals include gadoids (e.g. cod, haddock, poor cod, and whiting), forage fish (e.g. herring, sprat, sandeel, mackerel), cephalopods, and flatfish (e.g. dab, flounder, plaice, and sole). These species have been identified as IEFs of varying importance within the regional fish and shellfish ecology study area (Table 7.13), which largely overlaps with the regional marine mammal study area. Consequently, adverse effects on fish and shellfish species within the regional marine mammal study area may have indirect effects on marine mammals.

Key prey for marine turtles includes pelagic invertebrates such as jellyfish, salps, and squid, various smaller fish and crustaceans, and floating seaweed. These prey species are not considered IEFs within the regional marine mammal study area and are also unlikely to be affected by the Proposed Development.

Potential impacts on prey species during the construction phase have been assessed the appropriate MDSs for these receptors. Impacts in the construction phase are:

- temporary subtidal habitat loss and/or disturbance (section 7.12.9);
- long-term subtidal habitat loss (section 7.12.10);
- underwater noise (section 7.12.11); and
- increased SSCs and associated deposition (7.12.12).

No significant adverse effects were predicted to occur to the prey species of marine mammals or marine turtles due to activities within the construction phase. Therefore, changes in prey availability are predicted to be of local spatial extent, medium duration, intermittent, and high reversibility. Therefore, the magnitude of this impact is considered **low**.

Sensitivity of Receptor

Marine Mammal IEFs

Although foraging strategies vary between species, marine mammals often exploit a range of prey species depending on season and availability and can cover extensive distances to forage. Although site-fidelity is observed, such as the resident population of bottlenose dolphin in Cardigan Bay and seals returning to the same haul-outs to breed, marine mammals are largely unconfined to one location. They can move freely to exploit prey resources and have large home ranges. For example, grey seal in the English Channel have been recorded undertaking foraging trips of up to 350 km (Vincent, *et al.,* 2016), and up to 2,100 km in the North Sea (McConnell, *et al.,* 1999). As the impacts to prey species will be largely localised within the Proposed Development and may be intermittent or not affect the entire area at any one time, only a small area will potentially be affected in comparison to available foraging habitat within the regional marine mammal study area.

Furthermore, the fish and shellfish communities present within the Proposed Development are characteristic of the regional marine mammal study area. Therefore, it can be assumed that there will be similar prey species available within the wider area. However, there may be an energetic cost associated with increased foraging distances for harbour porpoise and harbour seal. Harbour porpoise have a high surface area to volume ratio and live in cold, high latitude waters (Rojano-Doñate, *et al.,* 2018). Therefore, they have a high metabolic rate in order to maintain optimal body temperature (Rojano-Doñate, *et al.,* 2018). They meet their high metabolic demands by undertaking continuous shallow foraging dives (Wisniewska *et al.,* 2016, 2018; McDonald, *et al.,* 2021). Harbour seal are not observed foraging as far offshore as grey seal, and typically remain within 50 km of their haul-out sites (SCOS, 2021). Despite this, if harbour porpoise and harbour seal do have to travel further for alternative foraging grounds, the impacts to prey species are predicted to be short-term and reversible (i.e. increased underwater noise would occur during noise producing activities). Harbour porpoise were observed to resume normal activity levels a few days after cessation of piling at two Danish offshore wind farms (Tougaard *et al.,* 2003, 2005). A similar response was observed in harbour seal, with no significant displacement recorded during the construction of multiple wind projects in The Wash, England, and displacement limited to piling activities. Within two hours of cessation of piling, harbour seal distribution had returned to non-piling conditions (Russell *et al.,* 2016). It is likely that during construction marine mammals may temporarily shift their foraging efforts to other areas within the regional marine mammal study area due to disturbances to benthic habitat and associated resources (Fiorentino and Wieting, 2014). Therefore, it is expected that all marine mammal IEFs would be able to tolerate the effect without any impact on reproduction and survival rates and would be able to return to previous activities once the impact had ceased.

However, minke whale is potentially vulnerable to impacts to Irish Sea herring stocks. There are two known herring stocks in Irish Waters, and minke whale distribution appears to mirror these stocks in Manx Waters, thus within the Proposed Development marine mammal study area. The Manx herring stock spawns on the east coast of the Isle of Man in September and October (Bowers, 1969), with minke whale regularly observed on the east coast during these months. The Manx herring stock and the Mourne herring stock overlap on the west coast of the Isle of Man during the summer (Bowers, 1980). Although significantly higher minke whale sighting rates often occur in habitats associated with sandeel presence, an area of high occupancy coincided with high densities of sprat during spring (Anderwald, *et al.,* 2012). Hence, their ability to switch between different prey according to their seasonal availability and the low energetic cost of swimming (Blix and Folkow, 1995) indicates that minke whale would be able to respond to temporal changes in pelagic prey concentrations.

Overall, all marine mammals, except for minke whale, are deemed to be able to tolerate changes in prey availability, have high recoverability and high international value. The sensitivity of the receptor is therefore, considered to be low.

For minke whale, due to their reliance on herring as a primary food source in the Irish Sea, they are deemed to have some tolerance to changes in prey availability, have high recoverability and international value. The sensitivity of the receptor is therefore, considered to be medium.

Marine Turtle IEFs

Diet varies across the six species of marine turtles with the potential to be present within the regional marine mammal study area. Leatherback turtle is the most frequently seen marine turtle in UK and Irish waters, and they predominantly prey on soft and gelatinous pelagic invertebrates, such as jellyfish, salps, and cephalopods (Dodge *et al.,* 2011). This species undertakes extensive migrations in order to forage in different areas (Eckert *et al.,* 2006; Caut *et al.,* 2009), thus is likely to be able to tolerate unexpected changes in prey availability, although they are unlikely to occur for these species as a result of the construction of the Proposed Development. Other species, such as green, hawksbill, Kemp’s ridley, loggerhead, and olive ridley sea turtles are rarer in Uk and Irish waters but could potentially be present. Clyde-Brockway *et al.* (2022) analysed diet composition of green and hawksbill sea turtles using stable isotope analysis and concluded that these species forage at multiple tropic levels and their diet was influenced by the availability of prey within the environment.

Green turtle diet was also shown to vary with season and foraging grounds (Carrión-Cortez *et al.,* 2010), suggesting tolerance to availability of prey species. Similarly, species such as Kemp's ridley sea turtle and loggerhead sea turtle consume a wide range of shellfish, particularly crustaceans (Burke *et al.,* 1994; Donaton *et al.,* 2019).

It is likely that construction will not impact prey species for marine turtles. In the unlikely event that these prey species are impacted, marine turtles will be able to exploit other species or forage elsewhere in the regional marine mammal study area. Therefore, it is expected that marine turtles would be able to tolerate the effect without any impact on reproduction and survival rates and would be able to return to previous activities once the impact had ceased.

Overall, all marine turtles are deemed to be able to tolerate changes in prey availability (which are also highly unlikely to occur due to the Proposed Development), have high recoverability and high international value. The sensitivity of the receptor is therefore, considered to be low.

Significance of Effect

Marine Mammal IEFs

Overall, for all marine mammal IEFs except minke whale, the magnitude of the impacts is deemed to be low for all species, and the sensitivity of the receptor is considered to be low. There would be no change to the international value of these species. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Overall, for minke whale, the magnitude of the impacts is deemed to be low, and the sensitivity of the receptor is considered to be medium. There would be no change to the international value of these species. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Marine Turtle IEFs

Overall, the magnitude of the impacts is deemed to be low for all species, and the sensitivity of the receptor is considered to be low. There would be no change to the international value of these species. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

7.12.19.2 Operation and Maintenance Phase

There is potential for changes in prey abundance resulting from operation and maintenance activities to have a direct impact on the foraging abilities of marine mammals and marine turtles within the Proposed Development and surrounding vicinity.

Magnitude of Impact

All Species

Potential impacts on prey species during the operation and maintenance phase have been assessed using the appropriate MDSs for these receptors. These impacts are temporary subtidal habitat loss and/or disturbance (section 7.12.9) and long-term subtidal habitat loss (section 7.12.10).

No significant adverse effects were predicted to occur to the prey species of marine mammals or marine turtles due to activities within the operation and maintenance phase. Therefore, changes in prey availability are predicted to be of local spatial extent, long-term duration, continuous, and high reversibility. Therefore, the magnitude of impact is considered low.

Sensitivity of Receptor

All Species

The sensitivities of all marine mammal and marine turtle IEFs presented in the assessment of this impact in the construction phase equally apply in the operation and maintenance phase (low to medium).

Significance of Effect

Marine Mammal IEFs

Overall, for all marine mammal IEFs except minke whale, the magnitude of the impacts is deemed to be low for all species, and the sensitivity of the receptor is considered to be low. There would be no change to the international value of these species. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Overall, for minke whale, the magnitude of the impacts is deemed to be low, and the sensitivity of the receptor is considered to be medium. There would be no change to the international value of these species. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Marine Turtle IEFs

Overall, the magnitude of the impacts is deemed to be low for all species, and the sensitivity of the receptor is considered to be low. There would be no change to the international value of these species. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms

7.12.19.3 Decommissioning Phase

There is potential for changes in prey abundance resulting from decommissioning activities to have a direct impact on the foraging abilities of marine mammals and marine turtles within the Proposed Development and surrounding vicinity.

Magnitude of Impact

All Species

Potential impacts on prey species during the construction phase have been assessed using the appropriate MDSs for these receptors. Impacts in the decommissioning phase are:

- temporary subtidal habitat loss and/or disturbance (section 7.12.9);
- long-term subtidal habitat loss (section 7.12.10);
- underwater noise (section 7.12.11); and
- increased SSCs and associated deposition (7.12.12).

No significant adverse effects were predicted to occur to the prey species of marine mammals or marine turtles due to activities within the decommissioning phase. Therefore, changes in prey availability are predicted to be of local spatial extent, long-term duration, continuous, and high reversibility. Therefore, the magnitude of impact is considered to be **low**.

Sensitivity of Receptor

All Species

The sensitivities of all marine mammal and marine turtle IEFs presented in the assessment of this impact in the construction phase equally apply in the decommissioning phase (low to medium).

Significance of Effect

Marine Mammal IEFs

Overall, for all marine mammal IEFs except minke whale, the magnitude of the impacts is deemed to be low for all species, and the sensitivity of the receptor is considered to be low. There would be no change to the international value of these species. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Overall, for minke whale, the magnitude of the impacts is deemed to be low, and the sensitivity of the receptor is considered to be medium. There would be no change to the international value of these species. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Marine Turtle IEFs

Overall, the magnitude of the impacts is deemed to be low for all species, and the sensitivity of the receptor is considered to be low. There would be no change to the international value of these species. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

7.13 Cumulative Effects Assessment

7.13.1 Methodology

The Cumulative Effects Assessment (CEA) investigated the impact associated with the Proposed Development with other plans, projects, and activities. The plans, projects, and activities were selected as relevant to the CEA are based upon the results of a screening exercise (for full details see volume 3, RPS Group (2024d). The plans, projects, and activities have been individually considered for screening in or out of this chapter's CEA based upon data confidence, effect-receptor pathways, and the spatial/temporal scales involved.

The marine biodiversity CEA methodology has followed the methodology set out in volume 1, chapter 5. As part of the assessment, all plans, projects, and activities considered alongside the Proposed Development have been allocated into 'tiers' reflecting their current stage within the planning and development process. The tiered approach to the CEA is as follows:

- Tier 1:
  - under construction;
  - permitted application;
  - submitted application; and
  - those currently operational that were not operational when baseline data were collected, and/or those that are operational but have an ongoing impact.
- Tier 2:
  - the scoping report has been submitted and is in the public domain.
- Tier 3:
  - the scoping report has not been submitted and is not in the public domain;
  - identified in the relevant development plan for the Proposed Development; and
  - identified in other plans or programmes.
- Tier 4:
  - no publicly available information.

This tiered approach has been adopted to provide a clear assessment of the Proposed Development alongside other projects, plans and activities. The specific plans, projects, and activities scoped into the CEA, are outlined in for each topic below in their respective sections.

As outlined in volume 1, chapter 3, the construction phase of the Proposed Development is anticipated to start in 2024, to enable operation to commence during 2026/2027. Although a two-year construction phase is anticipated, at this stage, indicative timelines for construction activities do continue into 2026. For example, the installation of a jacket, topside, and piling for the new Douglas platform is currently anticipated to take place over 29 days in April 2026. Therefore, as a precaution, plans, projects, and activities with a construction phase commencing in 2026 are included in the CEA, although it should be noted that cumulative effects will be of a lesser extent due to the reduced temporal overlap.

7.13.2 Benthic Subtidal and Intertidal Ecology

The CEA study area for this topic was defined as the study area used for Physical Processes (Figure 7.12). All plans, projects, and activities identified within this area were assessed and sorted into tiers using the methodology described in section 7.13.1 above.

The specific plans, projects, and activities scoped into the CEA for benthic subtidal and intertidal ecology are outlined in Table 7.80 and in Figure 7.12.

For benthic subtidal and intertidal ecology, a number of the impacts considered for the Proposed Development alone (Table 7.21) have not been considered within the CEA due to their localised and temporally restricted nature. These impacts include:

- Increased temperature impacting benthic communities (section 7.12.5).
- Impacts resulting from the release of sediment bound contaminants (section 7.12.7).
- Accidental pollution to the surrounding area (section 7.12.8).

7.13.2.1 Maximum Design Scenario

The MDS presented in Table 7.81 has been selected as those with the potential to result in the greatest effect on benthic subtidal and intertidal receptors. The potential cumulative effects presented and assessed in this section were based on the PDE provided in volume 1, chapter 3, as well as the information available on other plans, projects, and activities. Effects of adverse significance are not expected to arise should another a different development scenario to that assessed here be taken forward to the final design scheme.

Table 7.80: List Of Other Plans, Projects, And Activities Considered Within The CEA For Benthic Subtidal And Intertidal Ecology

Project/Plan/Activity	Status	Distance from Proposed Development (km)	Description	Construction Period (if applicable)	Operation and Maintenance Period (if applicable)	Overlap with the Proposed Development
Tier 1						
Offshore Renewables						
Burbo Bank Extension OWF cable repair and remediation	Operational (with ongoing activities)	0.00	Export cable repair and remediation activities over the 25-year lifetime of the Burbo Bank Extension OWF.	N/a	2017–- 2042	These activities overlap spatially with the Proposed Development and temporally with the construction and operation and maintenance phases of the Proposed Development.
Awel y Môr OWF	Consented	1.10	Proposed renewable energy project, 10.50 km off the coast of North Wales, of up to 1.1 GW. Proposed for a maximum of 50 turbines, associated transmission assets, and cabling (including and interlink cable with Gwynt y Môr OWF).	2026 – 2030	2030 – 2055	This project will overlap with all three phases of the Proposed Development.
Mona OWF Suction Bucket Trails	Consented	5.60	The works proposed within this Marine Licence Application consist of trialling suction bucket foundations	2023 to June 2024	N/A	The suction bucket trials may overlap with early construction activities of the Proposed Development.

Project/Plan/Activity	Status	Distance from Proposed Development (km)	Description	Construction Period (if applicable)	Operation and Maintenance Period (if applicable)	Overlap with the Proposed Development
			to assess the install viability within the Mona OWF Array Area, which is predominantly within Welsh waters.			
Deposits and Removal						
Burbo Bank Extension OWF Disposal Site IS153	Operational (with ongoing activities)	0.50	Deposit of substances at sea, construction works, removal of sediment, and disposal of inert material during drilling for the Burbo Bank Extension OWF.	N/a	2017–- 2042	These activities overlap with the construction and operation and maintenance phases of the Proposed Development.
Hilbre Swash	Operational (with ongoing activities)	0.00	Licence to extract up to 12 million tonnes of aggregate (mainly sand) over 15 years.	N/a	2015 – 2029	Aggregate extraction activities within this project will overlap temporally with the construction and operation and maintenance phases of the Proposed Development. This project also spatially overlaps with the Proposed Development.
Mostyn Energy Park Expansion	Submitted	2.30	Extension of the Mostyn Energy Park at the Port of Mostyn. Requires construction of a	2023 to 2025	2025 to 2030	Activities will overlap with the construction and operation and maintenance phases of

Project/Plan/Activity	Status	Distance from Proposed Development (km)	Description	Construction Period (if applicable)	Operation and Maintenance Period (if applicable)	Overlap with the Proposed Development
			360 m quay, reclamation of 3.5 ha area, capital dredging of new berth pockets and re-dredging of approach channel. Use of dredged material for fill material for reclamation, disposal of dredged material at Mostyn Deep. Maintenance dredging of new and existing berths, approach channel and harbour area.			the Proposed Development.
Tier 2						
Offshore Renewables						
Mona OWF	Pre-application	5.53	Proposed renewable energy project, 28.20 km off the coast of North Wales, of up to 350 MW.	2026–- 2028	2029–- 2089	This project will overlap with all three phases of the Proposed Development.
Cables and Pipelines						
Morgan and Morecambe OWF Transmission Assets	Pre-application	3.00	The transmission assets for the Morgan and Morecambe OWF	2028–- 2029	2030–- 2065	This project will overlap with the operations and maintenance and decommissioning phases of the Proposed Development.

Project/Plan/Activity	Status	Distance from Proposed Development (km)	Description	Construction Period (if applicable)	Operation and Maintenance Period (if applicable)	Overlap with the Proposed Development
Tier 3						
Cables and Pipelines						
MaresConnect – Wales – Ireland Interconnector Cable	Planning application not yet submitted	10.00	A proposed 750 MW subsea and underground electricity interconnector system, linking the electricity grids in the UK and Ireland.	2025	2027–- 2037	This project will overlap with the construction and operations and maintenance phases of the Proposed Development.
Tier 4						
Offshore Renewables						
Removal of a meteorological mast at Gwynt y Môr OWF	Issued (variation to an existing marine licence)	0.00	A seabed survey and removal of topside lattice structures, monopiles, and scour protection.	N/a	Licence issued for 2022–- 2027	Although no information on the timeline of this project is available, the Marine License is issued for between 2022 and 2027. Therefore, this activity will overlap with the operations and maintenance phase of the Proposed Development. This project also spatially overlaps with the Proposed Development.

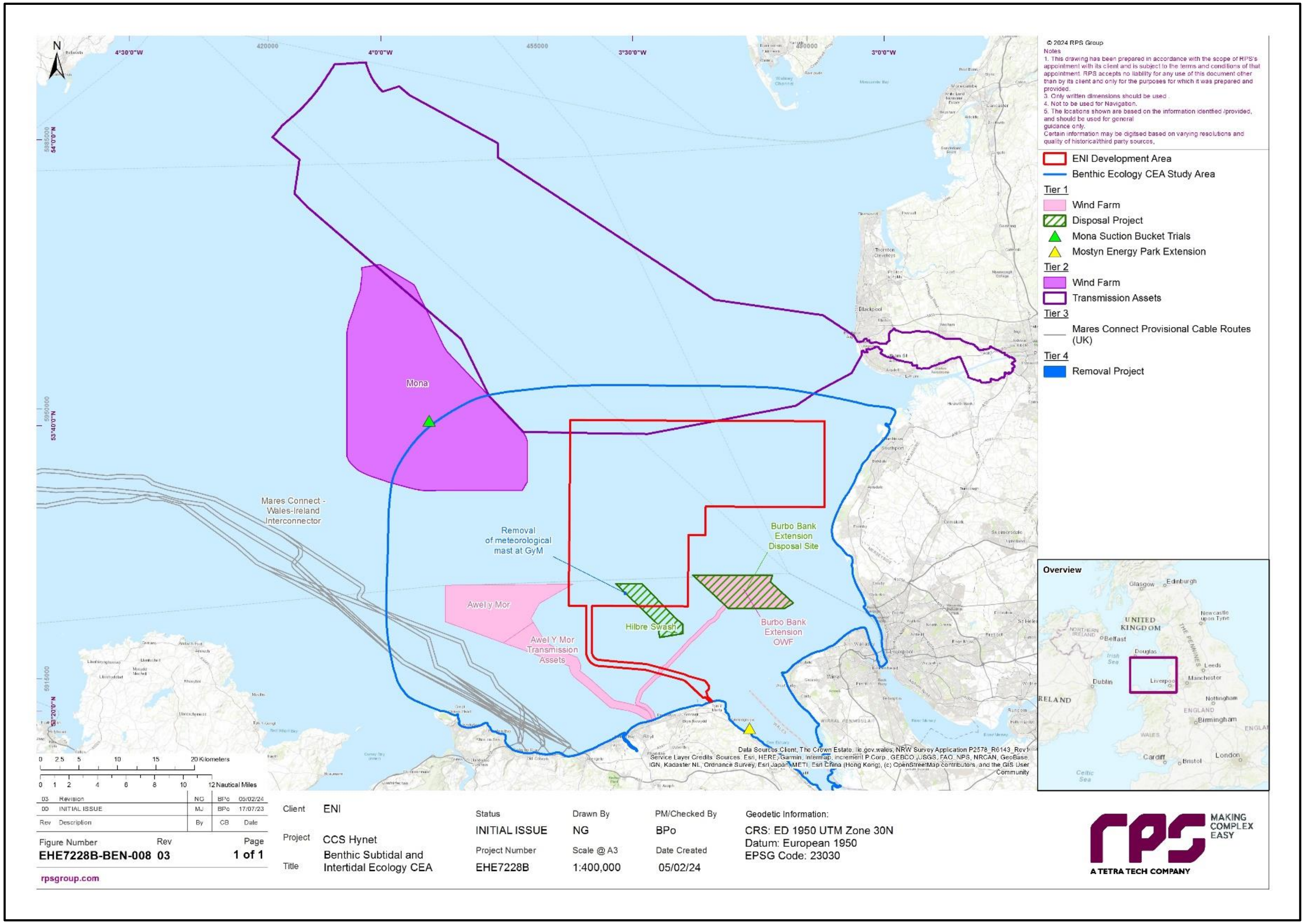

Figure 7.12: Plans, Projects, And Activities Screened Into The CEA For Benthic Subtidal And Intertidal Ecology

Table 7.81: MDS Considered For The Assessment Of Potential Cumulative Effects On Benthic Subtidal And Intertidal Ecology

Potential Cumulative Effect	Phase	MDS	Justification
Temporary subtidal habitat loss and/or disturbance	C	The MDS is as described for the Proposed Development (Table 7.21) and assessed cumulatively with the following plans, projects, and activities: **Tier 1:** Offshore Renewables: • Burbo Bank Extension OWF cable repair and remediation; and • Awel y Môr OWF. Deposits and Removal: • Burbo Bank Extension OWF Disposal Site IS153; • Hilbre Swash; and • Mostyn Energy Park Expansion. **Tier 2:** Offshore Renewables: • Mona OWF. **Tier 3:** Cables and Pipelines: • MaresConnect Wales – Ireland Interconnector Cable. **Tier 4:** Offshore Renewables: • Removal of a meteorological mast at Gwynt y Môr OWF.	These projects involve activities which will result in temporary subtidal habitat loss and/or disturbance which may contribute to the impact upon a habitat that the Proposed Development will also affect.
	O	The MDS is as described for the Proposed Development (Table 7.21) and assessed cumulatively with the following plans, projects, and activities: **Tier 1:** Offshore Renewables: • Burbo Bank Extension OWF cable repair and remediation; and • Awel y Môr OWF. Deposits and Removal:	

Potential Cumulative Effect	Phase	MDS	Justification
		• Burbo Bank Extension OWF Disposal Site IS153; and • Hilbre Swash. **Tier 2:** Offshore Renewables: • Mona OWF. Cables and Pipelines: • Morgan and Morecambe OWF Transmission Assets. **Tier 3:** Cables and Pipelines: • MaresConnect Wales – Ireland Interconnector Cable. **Tier 4:** Offshore Renewables: • Removal of a meteorological mast at Gwynt y Môr OWF.	
	D	The MDS is as described for the Proposed Development (Table 7.21) and assessed cumulatively with the following plans, projects, and activities: **Tier 1:** Offshore Renewables: • Awel y Môr OWF. **Tier 2:** Offshore Renewables: • Mona OWF. Cables and Pipelines: • Morgan and Morecambe OWF Transmission Assets.	
Increased SSCs and associated deposition	C	The MDS is as described for the Proposed Development (Table 7.21) and assessed cumulatively with the following plans, projects, and activities:	These projects involve activities which may impact the tidal/wave regime and sediment

Potential Cumulative Effect	Phase	MDS	Justification
		Tier 1: Offshore Renewables: • Burbo Bank Extension OWF cable repair and remediation; • Awel y Môr OWF; and • Mona OWF Suction Bucket Trails. Deposits and Removal: • Burbo Bank Extension OWF Disposal Site IS153; • Mostyn Energy Park Expansion; and • Hilbre Swash. **Tier 2:** Offshore Renewables: • Mona OWF. **Tier 3:** Cables and Pipelines: • MaresConnect Wales – Ireland Interconnector Cable. **Tier 4:** Offshore Renewables: • Removal of a meteorological mast at Gwynt y Môr OWF.	transport during their temporal overall with the Proposed Development.
	D	The MDS is as described for the Proposed Development (Table 7.21) and assessed cumulatively with the following plans, projects, and activities: **Tier 1:** Offshore Renewables: • Awel y Môr OWF. **Tier 2:** Offshore Renewables: • Mona OWF. Cables and Pipelines: • Morgan and Morecambe OWF Transmission Assets.	

Potential Cumulative Effect	Phase	MDS	Justification
Long-term subtidal habitat loss	C and O	The MDS is as described for the Proposed Development (Table 7.21) and assessed cumulatively with the following plans, projects, and activities: **Tier 1:** Offshore Renewables: • Awel y Môr OWF. Deposits and Removals: • Mostyn Energy Park Expansion. **Tier 2:** Offshore Renewables: • Mona OWF. Cables and Pipelines: • Morgan and Morecambe OWF Transmission Assets. **Tier 3:** Cables and Pipelines: • MaresConnect Wales – Ireland Interconnector Cable.	These projects involve the installation of hard structures on the seabed which will cause long-term subtidal habitat loss within the CEA benthic ecology study area.
	D	The MDS is as described for the Proposed Development (Table 7.21) and assessed cumulatively with the following plans, projects, and activities: **Tier 1:** Offshore Renewables: • Awel y Môr OWF. **Tier 2:** Offshore Renewables: • Mona OWF. Cables and Pipelines: • Morgan and Morecambe OWF Transmission Assets.	
Introduction of artificial habitat and colonisation of hard structures	O	The MDS is as described for the Proposed Development (Table 7.21) and assessed cumulatively with the following plans, projects, and activities:	These projects involve the installation of hard structures on the seabed which may be

Potential Cumulative Effect	Phase	MDS	Justification
		Tier 1: Offshore Renewables: • Awel y Môr OWF. **Tier 2:** Offshore Renewables: • Mona OWF. Cables and Pipelines: • Morgan and Morecambe OWF Transmission Assets. **Tier 3:** Cables and Pipelines: • MaresConnect Wales – Ireland Interconnector Cable.	colonised by new communities within the CEA benthic ecology study area.
Increased risk of introduction and spread of INNS	C	The MDS is as described for the Proposed Development (Table 7.21) and assessed cumulatively with the following plans, projects, and activities: **Tier 1:** Offshore Renewables: • Awel y Môr OWF; and • Mona OWF Suction Bucket Trails. Deposits and Removals: • Mostyn Energy Park Expansion. **Tier 2:** Offshore Renewables: • Mona OWF. Cables and Pipelines: • Morgan and Morecambe OWF Transmission Assets. **Tier 3:** Cables and Pipelines: • MaresConnect Wales – Ireland Interconnector Cable.	These projects involve the installation of hard structures on the seabed which may be colonised by INNS within the CEA benthic ecology study area.

Potential Cumulative Effect	Phase	MDS	Justification
	O	The MDS is as described for the Proposed Development (Table 7.21) and assessed cumulatively with the following plans, projects, and activities: **Tier 1:** Offshore Renewables: • Awel y Môr OWF. Deposits and Removals: • Mostyn Energy Park Expansion. **Tier 2:** Offshore Renewables: • Mona OWF. Cables and Pipelines: • Morgan and Morecambe OWF Transmission Assets. **Tier 3:** Cables and Pipelines: • MaresConnect Wales – Ireland Interconnector Cable.	
	D	The MDS is as described for the Proposed Development (Table 7.21) and assessed cumulatively with the following plans, projects, and activities: **Tier 1:** Offshore Renewables: • Awel y Môr OWF. **Tier 2:** Offshore Renewables: • Mona OWF. Cables and Pipelines: • Morgan and Morecambe OWF Transmission Assets.	

7.13.3 Temporary Habitat Loss and/or Disturbance

There is the potential for cumulative temporary habitat loss and/or disturbance as a result of activities associated with the Proposed Development and other plans, projects, and activities. Activities include cable burial, jack-up vessel use, anchor placements, seabed preparation, dredging, aggregate extraction, cables and pipelines laying, and remedial work. For the purposes of this ES, this additive impact has been assessed within the benthic subtidal and intertidal ecology CEA study area, using the tiered approach outlined above in section 7.13.1.

All plans, projects, and activities screened into the assessment for cumulative effects from this impact are either on-going activities or projects with sufficient information in the public domain. The plans, projects, and activities within each tier screened into the CEA for each phase of development are illustrated in Table 7.81.

7.13.3.1 Tier 1

Construction Phase

Magnitude of Impact

Subtidal Habitats and Species

Predicted cumulative temporary habitat loss and/or disturbance from each of the Tier 1 plans, projects, and activities during the construction phase of the Proposed Development are presented in Table 7.82 together with a breakdown of the sources of this data and any assumptions made where necessary information was not presented. For all the Tier 1 plans, projects, and activities during the construction phase of the Proposed Development, the cumulative temporary habitat loss and/or disturbance is estimated at 18.97 km^2 (including the values for the Proposed Development provided in Table 7.21).

The construction phase of the Proposed Development is between 2024 and 2026, while that of Awel y Môr OWF is currently anticipated as 2026 to 2030 (Table 7.88). Therefore, there may be some overlap between the construction phases of both projects, however it should be noted that it any cumulative impacts will be of a lesser extent than if the two projects overlapped for a longer period of time (i.e. over multiple years).

For the aggregate extraction at the Hilbre Swash site, the overall licenced area for this site is 21.79 km^2. However, the Crown Estate reports that, in 2021, only 3.97% of the total area of seabed licenced to be dredged in the North West region was actively dredged (The Crown Estate and MPA Marine Aggregates, 2021). For the purposes of this assessment, the MDS assumes that a precautionary 5% of the total licensed area of Hilbre Swash will be actively dredged during this period. It is unlikely that the whole site will be active at once, therefore the impact associated with aggregate extraction at this site will be spread over the full length of the 15-year licence therefore resulting in longer-term low-level disturbance.

Dredging activities associated with the Mostyn Energy Park Expansion have been estimated to result in temporary subtidal habitat loss of 3.16 ha (31,600 m^2), with recolonisation expected to occur over a short period of time (although any indication on this time period was not provided in the Environmental Statement for this project (ABPmer, 2022)).

Table 7.82: Cumulative Temporary Habitat Loss And/Or Disturbance For The Construction Phase Of Tier 1 Plans, Projects, And Activities Identified

Project	Predicted Temporary Habitat Loss and/or Disturbance (km^2)	Cause of Temporary Habitat Loss and/or Disturbance	Source
Proposed Development	**1.91**	**See Table 7.21**	**Table 7.21**
Offshore Renewables			
Burbo Bank Extension OWF Cable Repair and Remediation	0.03	Cable repair and remediation activities.	EnBW and BP (2023b)
Awel y Môr OWF	15.91	Jack-up events, anchoring, cable installation, and seabed preparation.	RWE Renewables UK (2021a)
Deposits and Removals			
Hilbre Swash	1.09	Aggregate extraction (mainly sand). The values provided in the preceding column represent the area of the project as no values specific to this impact were available.	EnBW and BP (2023b)
Burbo Bank Extension OWF Disposal Site IS153	Not available	Dredging and disposal	-
Mostyn Energy Park Expansion	0.03	Removal of seabed material during dredging	ABPmer (2022)
Total	**18.97**		

The cumulative impact on the subtidal habitats and species IEFs is predicted to be of local spatial extent (given the low disturbance footprints), short term duration (over the two-year construction phase), intermittent, and of high reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Intertidal Habitats and Species

The Tier 1 projects will not cumulatively interact with this impact in the intertidal zone of the Proposed Development due to their distance from the landfall (Figure 7.12). Therefore, the intertidal habitats and species IEF has not been considered further in this Tier 1 assessment.

Designated Sites

As above for the intertidal habitats and species IEF, there are no Tier 1 projects that cumulatively overlap with the Dee Estuary/Aber Dyfrdwy SAC IEF due to their distance from the landfall. Therefore, the Dee Estuary/Aber Dyfrdwy SAC IEF has not been considered further in this Tier 1 assessment.

As the Fylde MCZ IEF is not in the vicinity of any of the Tier 1 projects, cumulative effects due to this impact will not occur. Therefore, the Fylde MCZ IEF has not been considered further in this Tier 1 assessment.

Sensitivity of the Receptor

The sensitivity of the subtidal habitats and species IEFs are as previously described for the construction phase of the Proposed Development alone (see section 7.12.1).

The subtidal habitats and species IEFs are deemed to be of medium vulnerability, high recoverability, and local to national value. The sensitivity of these receptors is therefore, considered to be medium.

Significance of Effect

Overall, for the subtidal habitats and species IEFs, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the cumulative effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Operations and Maintenance Phase

Magnitude of Impact

Subtidal Habitats and Species

Predicted cumulative temporary habitat loss and/or disturbance from each of the Tier 1 plans, projects, and activities during the operations and maintenance phase of the Proposed Development are presented in Table 7.83, together with a breakdown of the sources of this data and any assumptions made where necessary information was not presented. For all the Tier 1 plans, projects, and activities during the operations and maintenance phase of the Proposed Development, the cumulative temporary habitat loss and/or disturbance is estimated at 1.49 km^2 (including the values for the Proposed Development provided in Table 7.21).

Table 7.83: Cumulative Temporary Habitat Loss And/Or Disturbance For The Operations And Maintenance Phase Of Tier 1 Plans, Projects, And Activities Identified

Project	Predicted Temporary Habitat Loss and/or Disturbance (km^2)	Cause of Temporary Habitat Loss and/or Disturbance	Source
Proposed Development	**0.07**	**See Table 7.21**	**Table 7.21**
Offshore Renewables			
Burbo Bank Extension OWF Cable Repair and Remediation	0.03	Cable repair and remediation activities.	EnBW and BP (2023b)
Awel y Môr OWF	0.30	Cable repair and remediation activities and jack-up activities for platform and turbine maintenance.	RWE Renewables UK (2021a)
Deposits and Removals			
Hilbre Swash	1.09	Aggregate extraction (mainly sand). The values provided in the preceding column represent the area of the project as no values specific to this impact were available.	EnBW and BP (2023b)
Burbo Bank Extension OWF Disposal Site IS153	Not available	Dredging and disposal	-
Total	**1.49**		

The cumulative impact on the subtidal habitats and species IEFs is predicted to be of local spatial extent (given the low disturbance footprints), long-term duration (over the operations and maintenance phase), intermittent, and of high reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Sensitivity of the Receptor

The sensitivity of the subtidal habitats and species IEFs are as previously described for the construction phase of the Proposed Development alone (see section 7.12.1).

The subtidal habitats and species IEFs are deemed to be of medium vulnerability, high recoverability, and local to national value. The sensitivity of these receptors is therefore, considered to be medium.

Significance of Effect

Overall, for the subtidal habitats and species IEFs, the magnitude of impact was deemed to be low, and the sensitivity of the receptor was considered to be medium. Therefore, the cumulative effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Decommissioning Phase

Magnitude of Impact

<u>Subtidal Habitats and Species</u>

The only Tier 1 project which has been identified in the CEA with the potential to result in cumulative temporary habitat loss and/or disturbance during the decommissioning phase of the Proposed Development was Awel y Môr OWF. There were no values provided for the footprint of temporary habitat loss and/or disturbance for this project, however they will not exceed that of the construction phase (15.91 km^2) and are likely to be lower in reality, due to the absence of seabed preparation (RWE Renewables UK, 2021a). Similarly, these values are also not available for the Proposed Development (Table 7.21) but are also likely to be similar to that of the construction phase (1.91 km^2). Therefore, the cumulative temporary habitat loss and/or disturbance is estimated at 17.82 km^2, and it should be noted that this value is likely to be higher than reality.

The cumulative impact on the subtidal habitats and species IEFs is predicted to be of local spatial extent (given the low potential disturbance footprints), short-term duration (over the decommissioning phase), intermittent, and of high reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Sensitivity of the Receptor

The sensitivity of the subtidal habitats and species IEFs are as previously described for the construction phase of the Proposed Development alone (see section 7.12.1).

The subtidal habitats and species IEFs are deemed to be of medium vulnerability, high recoverability, and local to national value. The sensitivity of these receptors is therefore, considered to be medium.

Significance of Effect

Overall, for the subtidal habitats and species IEFs, the magnitude of impact was deemed to be low, and the sensitivity of the receptor was considered to be medium. Therefore, the cumulative effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

7.13.3.2 Tier 2

Construction Phase

Magnitude of Impact

<u>Subtidal Habitats and Species</u>

The only Tier 2 project which has been identified in the CEA with the potential to result in cumulative temporary habitat loss and/or disturbance during the construction phase of the Proposed Development was Mona OWF.

Within the MDS for this project, up to 131.07 km^2 of temporary habitat loss and/or disturbance was predicted to occur (EnBW and BP, 2023b).

Therefore, the cumulative temporary habitat loss and/or disturbance is estimated at 132.98 km^2 (including the values for the Proposed Development provided in Table 7.21).

The cumulative impact on the subtidal habitats and species IEFs is predicted to be of regional spatial extent (given the larger disturbance footprints than for the Tier 1 assessment), short term duration (over the two-year construction phase), intermittent, and of high reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Intertidal Habitats and Species

The Tier 2 project will not cumulatively interact with this impact in the intertidal zone of the Proposed Development due to their distance from the landfall (Figure 7.12). Therefore, the intertidal habitats and species IEF has not been considered further in this Tier 2 assessment.

Designated Sites

As above for the intertidal habitats and species IEF, there are no Tier 2 projects that cumulatively overlap with the Dee Estuary/Aber Dyfrdwy SAC IEF due to their distance from the landfall. Therefore, the Dee Estuary/Aber Dyfrdwy SAC IEF has not been considered further in this Tier 2 assessment.

As the Fylde MCZ IEF is not in the vicinity of any the Tier 2 project mentioned above, cumulative effects due to this impact will not occur. Therefore, the Fylde MCZ IEF has not been considered further in this assessment for the construction phase.

Sensitivity of the Receptor

The sensitivity of the subtidal habitats and species IEFs are as previously described for the construction phase of the Proposed Development alone (see section 7.12.1).

The subtidal habitats and species IEFs are deemed to be of medium vulnerability, high recoverability, and local to national value. The sensitivity of these receptors is therefore, considered to be medium.

Significance of Effect

Overall, for the subtidal habitats and species IEFs, the magnitude of impact was deemed to be low, and the sensitivity of the receptor was considered to be medium. Therefore, the cumulative effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Operation and Maintenance Phase

Magnitude of Impact

Subtidal Habitats and Species

There were two Tier 2 projects identified in the CEA with the potential for cumulative temporary habitat loss and/or disturbance in the operations and maintenance phase: Mona OWF and Morgan and Morecambe OWF Transmission Assets. The construction phases of these two projects also overlap with the operation and maintenance phase of the Proposed Development. Predicted cumulative temporary habitat loss and/or disturbance from each of the Tier 2 plans, projects, and activities during the operations and maintenance phase of the Proposed Development are presented in Table 7.84 together with a breakdown of the sources of this data and any assumptions made where necessary information was not presented. For all the Tier 2 plans, projects, and activities during the operations and maintenance phase of the Proposed Development, the cumulative temporary habitat loss and/or disturbance is estimated at 148.75 km^2 (including the values for the Proposed Development provided in Table 7.21).

At the time of writing, there was no publicly available information to quantify the footprint of temporary habitat loss and/or disturbance due to the Morgan and Morecambe OWF Transmission Assets. Therefore, these values are not included in the total calculation presented in the paragraph above. As the transmission assets only involves cables, it is likely that the disturbance footprint of temporary habitat loss and/or disturbance will be of a lower extent to that presented for Mona OWF (which includes offshore export cables).

Table 7.84: Cumulative Temporary Habitat Loss And/Or Disturbance For The Operations And Maintenance Phase Of Tier 2 Plans, Projects, And Activities Identified

Project	Predicted Temporary Habitat Loss and/or Disturbance (km^2)	Cause of Temporary Habitat Loss and/or Disturbance	Source
Proposed Development	**0.07**	**See Table 7.21**	**Table 7.21**
Offshore Renewables			
Mona OWF	Construction: 131.07 Operation and maintenance: 17.61	Jack-up events and cable repair and remediation.	EnBW and BP (2023b)
Cables and Pipelines			
Morgan and Morecambe OWF Transmission Assets	Not available	Only the Scoping Report is currently available for this project, so no footprint of disturbance is available. However, the construction and operations and maintenance phases of this project overlap with the operations and maintenance phase of the Proposed Development. Therefore, activities such as jack-up events, anchoring, seabed preparation, cable laying, and cable maintenance will result in temporary habitat loss and/or disturbance.	-
Total	**148.75**		

The cumulative impact on the subtidal habitats and species IEFs is predicted to be of regional spatial extent (given the larger disturbance footprints than for the Tier 1 assessment), long-term duration (over the operations and maintenance phase), intermittent, and of high reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Designated Sites

As the Fylde MCZ IEF overlaps with the Morgan and Morecambe OWF Transmission Assets, the information provided above for 'Subtidal Habitats and Species IEFs' is also applicable. Thus, the cumulative impact on the Fylde MCZ IEF is predicted to be of local spatial extent (given the lower disturbance footprints than in the construction phase), long-term duration (over the operations and maintenance phase), intermittent, and of high reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Sensitivity of the Receptor

The sensitivity of the subtidal habitats and species IEFs and the Fylde MCZ IEF are as previously described for the construction phase of the Proposed Development alone (see section 7.12.1).

The subtidal habitats and species IEFs and the Fylde MCZ IEF are deemed to be of medium vulnerability, high recoverability, and local to national value. The sensitivity of these receptors is therefore, considered to be medium.

Significance of Effect

Overall, for the subtidal habitats and species IEFs and the Fylde MCZ IEF, the magnitude of impact was deemed to be low, and the sensitivity of the receptor was considered to be medium. Therefore, the cumulative effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Decommissioning Phase

Magnitude of Impact

Subtidal Habitats and Species

There were two Tier 2 projects identified in the CEA with the potential for cumulative temporary habitat loss and/or disturbance in the decommissioning phase of the Proposed Development: Mona OWF and Morgan and Morecambe OWF Transmission Assets. The operations and maintenance phases of these two projects will overlap with the decommissioning phase of the Proposed Development, therefore the footprint of temporary habitat loss and/or disturbance for these projects is as above for the operations and maintenance phase (at least 17.61 km^2; Table 7.84).

The total predicted footprint of temporary subtidal habitat loss and/or disturbance is not available for the decommissioning phase of the Proposed Development (Table 7.21) but is likely to be similar to that of the construction phase (1.91 km^2). Therefore, the cumulative temporary habitat loss and/or disturbance is estimated at 19.52 km^2.

It should be noted that this is likely to be lower than reality due to the absence of publicly available information to quantify the footprint of temporary habitat loss and/or disturbance due to the Morgan and Morecambe OWF Transmission Assets. Therefore, these values are not included in the total calculation presented in the paragraph above.

The cumulative impact on the subtidal habitats and species IEFs is predicted to be of local spatial extent (given the lower disturbance footprints than in the operation and maintenance phase), short term duration (over the decommissioning phase), intermittent, and of high reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Designated Sites

As the Fylde MCZ IEF overlaps with the Morgan and Morecambe OWF Transmission Assets, the information provided above for 'Subtidal Habitats and Species IEFs' is also applicable. Thus, the cumulative impact on the Fylde MCZ IEF is predicted to be of local spatial extent (given the lower disturbance footprints than in the construction phase), short term duration (over the decommissioning phase), intermittent, and of high reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Sensitivity of the Receptor

The sensitivity of the subtidal habitats and species IEFs and the Fylde MCZ IEF are as previously described for the construction phase of the Proposed Development alone (see section 7.12.1).

The subtidal habitats and species IEFs and the Fylde MCZ IEF are deemed to be of medium vulnerability, high recoverability, and local to national value. The sensitivity of these receptors is therefore, considered to be medium.

Significance of Effect

Overall, for the subtidal habitats and species IEFs and the Fylde MCZ IEF, the magnitude of impact was deemed to be low, and the sensitivity of the receptor was considered to be medium. Therefore, the cumulative effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

7.13.3.3 Tier 3

Construction and Operation and Maintenance Phases

Magnitude of Impact

Subtidal Habitats and Species

The only Tier 3 project which has been identified in the CEA with the potential to result in cumulative temporary habitat loss and/or disturbance during the construction and operation and maintenance phases of the Proposed Development was the MaresConnect interconnector cable. There is, however, currently no information on the impact that the MaresConnect interconnector cable will have on benthic ecology receptors. A planning application is predicted to be submitted in 2024 which will identify and assess these impacts (MaresConnect, 2023).

The activities associated with the MaresConnect interconnector cable which are likely to result in temporary habitat loss and/or disturbance are similar to those expected for the installation of cables for the Proposed Development. Construction is planned to occur in 2025 and the project is anticipated to become operational in 2027 (MaresConnect, 2023), although it should be noted that these timeframes are only indicative at this stage. The construction activities are likely to involve cable installation such as jet trenching, and the installation of cable protection. Operation and maintenance activities are likely to involve the repair and reburial of cables.

The cumulative impact on the subtidal habitats and species IEFs is predicted to be of local spatial extent, short term duration (for the individual construction and operation and maintenance activities), intermittent, and of high reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Intertidal Habitats and Species

The Tier 3 project will not cumulatively interact with this impact in the intertidal zone of the Proposed Development due to its distance from the landfall (Figure 7.12). Therefore, the intertidal habitats and species IEF has not been considered further in this Tier 3 assessment.

Designated Sites

As above for the intertidal habitats and species IEF, there are no Tier 3 projects that cumulatively overlap with the Dee Estuary/Aber Dyfrdwy SAC IEF due to their distance from the landfall. Therefore, the Dee Estuary/Aber Dyfrdwy SAC IEF has not been considered further in this Tier 3 assessment.

As the Fylde MCZ IEF is does not overlap with the MaresConnect Interconnector Cable, cumulative effects due to this impact will not occur. Therefore, the Fylde MCZ IEF has not been considered further in this Tier 3 assessment.

Sensitivity of the Receptor

The sensitivity of the subtidal habitats and species IEFs are as previously described for the construction phase of the Proposed Development alone (see section 7.12.1).

The subtidal habitats and species IEFs are deemed to be of medium vulnerability, high recoverability, and local to national value. The sensitivity of these receptors is therefore, considered to be medium.

Significance of Effect

Overall, for the subtidal habitats and species IEFs, the magnitude of impact was deemed to be low, and the sensitivity of the receptor was considered to be medium. Therefore, the cumulative effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Decommissioning Phase

There were no Tier 3 plans, projects, or activities identified in the CEA with the potential to result in cumulative temporary habitat loss and/or disturbance during the decommissioning phase of the Proposed Development.

7.13.3.4 Tier 4

Construction and Operation and Maintenance Phases

Magnitude of Impact

Subtidal Habitats and Species

The only Tier 4 project which has been identified in the CEA with the potential to result in cumulative temporary habitat loss and/or disturbance during the construction and operation and maintenance phases of the Proposed Development was the removal of a meteorological mast at Gwynt y Môr OWF. There is, however, currently no information on the impact that this project will have on benthic ecology receptors.

The activities associated with this project which are likely to result in temporary habitat loss and/or disturbance are anchoring and the use of jack-up vessels for the removal of topside lattice structures, monopiles, and scour protection. There is no timeline for these works currently publicly available, however the marine license was issued for 2022 – 2027. Therefore, while these activities may overlap with the entire construction phase of the Proposed Development, they should be completed shortly after the operation and maintenance phase of the Proposed Development begins (within 2026).

The cumulative impact on the subtidal habitats and species IEFs is predicted to be of local spatial extent, short term duration (for the individual activities), intermittent, and of high reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Intertidal Habitats and Species

The Tier 4 project will not cumulatively interact with this impact in the intertidal zone of the Proposed Development due to its distance from the landfall (Figure 7.12). Therefore, the intertidal habitats and species IEF has not been considered further in this Tier 4 assessment.

Designated Sites

As above for the intertidal habitats and species IEF, there are no Tier 4 projects that cumulatively overlap with the Dee Estuary/Aber Dyfrdwy SAC IEF due to their distance from the landfall. Therefore, the Dee Estuary/Aber Dyfrdwy SAC IEF has not been considered further in this Tier 4 assessment.

As the Fylde MCZ IEF is does not overlap with Tier 4 project, cumulative effects due to this impact will not occur. Therefore, the Fylde MCZ IEF has not been considered further in this Tier 4 assessment.

Sensitivity of the Receptor

The sensitivity of the subtidal habitats and species IEFs are as previously described for the construction phase of the Proposed Development alone (see section 7.12.1).

The subtidal habitats and species IEFs are deemed to be of medium vulnerability, high recoverability, and local to national value. The sensitivity of these receptors is therefore, considered to be medium.

Significance of Effect

Overall, for the subtidal habitats and species IEFs, the magnitude of impact was deemed to be low, and the sensitivity of the receptor was considered to be medium. Therefore, the cumulative effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Decommissioning Phase

There were no Tier 4 plans, projects, or activities identified in the CEA with the potential to result in cumulative temporary habitat loss and/or disturbance during the decommissioning phase of the Proposed Development.

7.13.4 Increased SSCs and Associated Deposition

There is the potential for cumulative increased SSCs and associated deposition as a result of activities associated with the Proposed Development and other plans, projects, and activities. Activities include seabed preparation, dredging, aggregate extraction, and cables and pipelines laying. For the purposes of this ES, this additive impact has been assessed within the benthic subtidal and intertidal ecology CEA study area, using the tiered approach outlined above in section 7.13.1.

All plans, projects, and activities screened into the assessment for cumulative effects from this impact are either on-going activities or projects with sufficient information in the public domain. The plans, projects, and activities within each tier screened into the CEA for each phase of development are illustrated in Table 7.81.

7.13.4.1 Tier 1

Construction Phase

Magnitude of Impact

All Benthic Subtidal and Intertidal IEFs

There is potential for cumulative impacts with six Tier 1 projects in the construction phase:

- Burbo Bank Extension OWF cable repair and remediation;
- Awel y Môr OWF
- Mona OWF Suction Bucket Trials;
- Mostyn Energy Park Expansion;
- Hilbre Swash; and
- Burbo Bank Extension OWF Disposal Site IS153.

The construction phase of the Proposed Development coincides with construction activities of the Awel y Môr OWF, such as seabed preparation, drilling, cable installation, and HDD. However, in the Preliminary Environmental Information Report (PEIR) for Awel y Môr, this impact has been determined as localised within one tidal excursion, short-term, intermittent, and reversible upon benthic subtidal and intertidal receptors (RWE Renewables UK, 2021a). The Awel y Môr Offshore Wind Farm also involves the installation of an interlink cable with the Gywnt y Môr Offshore Wind Farm, with the magnitude of suspended sediments likely being of a similar magnitude to offshore export cable installation. Thus, again it can be expected a cumulative effect that may arise would do so within the natural variability of background levels, and only occur if cable installation operations occurred simultaneously. Furthermore, the construction phase of the Proposed Development is between 2024 and 2026, while that of Awel y Môr OWF is currently anticipated as 2026 to 2030 (Table 7.88). Therefore, there may be some overlap between the construction phases of both projects, however it should be noted that it any cumulative impacts will be of a lesser extent than if the two projects overlapped for a longer period of time (i.e. over multiple years).

The construction phase of the Proposed Development also coincides with cable repair and maintenance activities at the Burbo Bank Extension OWF and disposal at site IS153. However, as this only involves intermittent maintenance and disposal work, this impact has been determined as of limited spatial extent, short-term, intermittent, and reversible upon benthic subtidal and intertidal receptors.

The construction phase of the Proposed Development also encompasses aggregate extraction the Hilbre Swash licensed area, located within the Proposed Development. Resultant plumes from the disposal of dredged material and extraction of aggregate would be advected on the tidal current running in parallel and not coincide with the Proposed Development.

As part of the Mona Offshore Wind Farm application, a series of suction bucket foundation trials were consented to, to validate the suitability of foundation and optimise design. These works occur within the Mona Array Area at up to 30 locations, using a variety of parameters to best inform final design. At each location, the trial may be undertaken up to 3 times and once all activities at the site are complete the full removal of foundation would occur before moving to the next location to repeat (MarineSpace Ltd., 2023). Although the trials of foundation installation and subsequent removal may mobilise sediment within the Mona Array Area, the small scale nature associated with the installation/removal of one foundation at a time would be expected to produce a small plume with much of the sediment suspended settling in the vicinity of the structures. This, paired with the fact that the Mona Array Area is largely advected on tidal currents and situated approximately 5.60 km north west of the Proposed Development (at its closest point), indicate that if an overlap in SSC or deposition did occur between the projects, that it would do so at background levels. The Mona OWF suction bucket trials have only been assessed for this impact, as the WFD Compliance Assessment concluded that an assessment on ecological impacts was not required, given the low potential for impact.

The construction phase of the Proposed Development is expected to coincide with the construction and operation and maintenance phases of the Mostyn Energy Park Extension and associated maintenance dredging activities. This development, within the Dee Estuary, involves the construction of a 360 m length of new quay wall, the infilling of a 3.5 ha area behind the new quay wall (requiring 600,000 m^3 of infill material, 500,000 m^3 of which will be sourced from dredging activity arisings) (ABPmer, 2022). Alongside the new quay wall a dredged berth pocket will be required to a depth of -11 m CD (400,000 m^3), whilst re-dredging of the existing berth pocket along the existing quay wall to -9 m CD will be required (400,000 m^3) (ABPmer, 2022). The largest dredging operation will take the form of the re-dredging of the main navigation channel to a depth of -4 m CD (3,000,000 m^3) (ABPmer, 2022). Both seabed preparation and cable installation activities produce SSC plumes that extend into the Dee Estuary and overlap with the location of construction activities and dredging at the Port of Mostyn Energy Park Expansion, however, they do so at background levels i.e. < 3 mg/l. It can therefore be judged that although a cumulative impact may arise, the change in SSC would be of negligible significance and recoverable.

The largest overlap in SSC would occur if the disposal of dredged material within the Mostyn Deep disposal site occurred simultaneously with cable installation activities or seabed preparation across West Hoyle Bank, however even in this case, overlapping plumes in the vicinity of West Hoyle Bank and within the Dee Estuary would be of limited magnitude due to the decreases in SSC and deposition observed with distance from respective works. Noting also that sediment plumes would be traversing in parallel and not towards one another as they are advected on the same tidal current. Maximum SSC values in the area of overlap can be up to 100 mg/l for both plumes combined, however, the more representative average plumes are expected to have SSC values of negligible difference to background levels when they coincide. Likewise, sedimentation over the bank can be considered minor and the overall cumulative impact between the disposal of dredged material and the Proposed Development can be considered to be negligible, of local extent and short-term duration. The cumulative impact relating to overlap between operation and maintenance activities from the Mostyn Energy Park Extension and construction activities related to the Proposed Development are expected to be of a similar magnitude to the dredging/disposal activities described above, only of a smaller scale in line with reduced dredge volumes associated with maintenance works rather than construction works.

The cumulative impact on the benthic subtidal and intertidal IEFs is predicted to be of local spatial extent, short term duration (for the individual activities), intermittent, and of high reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Sensitivity of the Receptor

Subtidal Habitats and Species

The sensitivity of the subtidal habitats and species IEFs and are as previously described for the construction phase of the Proposed Development alone (see section 7.12.2).

The ‘Subtidal sands and gravels’ IEF is deemed to be of low vulnerability, medium to high recoverability, and national value. Therefore, the sensitivity of this receptor to this impact is considered to be low.

Overall, the ‘Mud habitats in deep water’ IEF and Ross worm IEF are deemed to be of low to no vulnerability, high recoverability, and national value. Therefore, the sensitivity of these receptors to this impact is considered to be negligible.

Overall, the ‘Subtidal mixed muddy sediment’ IEF is deemed to be of medium vulnerability, medium recoverability, and national value. Therefore, the sensitivity of this receptor to this impact is considered to be medium.

Intertidal Habitats and Species

The sensitivity of the intertidal habitats and species IEFs and are as previously described for the construction phase of the Proposed Development alone (see section 7.12.2).

Overall, the ‘Mudflats and sandflats not covered by seawater at low tide’ IEF is deemed to be of low vulnerability, high recoverability, and international value. Therefore, the sensitivity of this receptor to this impact is considered to be low.

Designated Sites

As detailed in Table 7.10, the sensitivities presented for the ‘Mudflats and sandflats not covered by seawater at low tide’ IEF in the preceding section is applicable to the Dee Estuary/Aber Dyfrdwy SAC IEF. Thus, the Dee Estuary/Aber Dyfrdwy SAC IEF is deemed to be of low vulnerability, high recoverability, and international value. The sensitivity of the receptor is therefore, considered to be low.

The Fylde MCZ IEF is deemed to be of low vulnerability, medium to high recoverability, and national value. The sensitivity of the receptor is therefore, considered to be low.

Significance of Effect

Subtidal Habitats and Species

Overall, for the ‘Subtidal sands and gravels IEF’, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

For the ‘Mud habitats in deep water’ IEF and Ross worm IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be negligible. Therefore, the cumulative effect is considered be of **negligible adverse** significance, which is **not significant** in EIA terms.

Overall, for the ‘Subtidal mixed muddy sediment’ IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

Intertidal Habitats and Species

Overall, for the ‘Mudflats and sandflats not covered by seawater at low tide’ IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

Designated Sites

Overall, for the Dee Estuary/Aber Dyfrdwy SAC and Fylde MCZ IEFs, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

Decommissioning Phase

Magnitude of Impact

All IEFs

The decommissioning phase of the Proposed Development coincides with operation and maintenance and decommissioning activities of the Awel y Môr OWF, such as cable maintenance, cable removal, and foundation removal. However, in the PEIR for Awel y Môr, this impact has been determined as localised within one tidal excursion, short-term, intermittent, and reversible upon benthic subtidal and intertidal receptors (RWE Renewables UK, 2021a).

The cumulative impact on the benthic subtidal and intertidal IEFs is predicted to be of local spatial extent, short term duration (for the individual activities), intermittent, and of high reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as presented above for the construction phase and is not repeated here for brevity.

Significance of Effect

Subtidal Habitats and Species

Overall, for the ‘Subtidal sands and gravels IEF’, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

For the ‘Mud habitats in deep water’ IEF and Ross worm IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be negligible. Therefore, the cumulative effect is considered be of **negligible adverse** significance, which is **not significant** in EIA terms.

Overall, for the ‘Subtidal mixed muddy sediment’ IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

Intertidal Habitats and Species

Overall, for the ‘Mudflats and sandflats not covered by seawater at low tide’ IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

Designated Sites

Overall, for the Dee Estuary/Aber Dyfrdwy SAC and Fylde MCZ IEFs, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

7.13.4.2 Tier 2

Construction Phase

Magnitude of Impact

All IEFs

There is the potential for cumulative impacts with one Tier 2 project in the construction phase: Mona OWF. Construction activities may result in increased SSC. For the Mona OWF, modelling suggested that average SSCs during the course of the construction activities was expected to be <300 mg/l with a plume envelope width of approximately 20 km, which corresponds to the local tidal excursion (EnBW and BP, 2023b). Sediments deposited on slack tide in the north-east of the Mona Array Area are expected to be resuspended on subsequent tides. Typically, this plume concentration will be <10 mg/l, and this reduces as distance from the site increases due to natural sediment dispersal. Three days after installation of foundations, sediment concentrations are expected to reduce, with sedimentation and resuspension occurring dependent on the current speed and tidal cycle. Peak concentrations in a resuspension event at this point are likely to reach a maximum of <30mg/l, compared to average concentrations of a maximum of 3mg/l in the area normally (EnBW and BP, 2023b).

The increased SSCs from construction activities in the Mona OWF would be of limited spatial extent and intermittent in frequency and unlikely to interact with sediment plumes from the Proposed Development. As described in section 7.12.2, modelling for the Proposed Development suggested that material was retained in the sediment cell and would be subsequently assimilated into the existing sediment transport regime.

The cumulative effect is predicted to be of local spatial extent, short term duration (over the two-year construction phase), intermittent (due to the construction activities), and high reversibility. Therefore, the magnitude of impact is considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as presented above for the Tier 1 assessment and is not repeated here for brevity.

Significance of Effect

Subtidal Habitats and Species

Overall, for the ‘Subtidal sands and gravels IEF’, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

For the ‘Mud habitats in deep water’ IEF and Ross worm IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be negligible. Therefore, the cumulative effect is considered be of **negligible adverse** significance, which is **not significant** in EIA terms.

Overall, for the ‘Subtidal mixed muddy sediment’ IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

Intertidal Habitats and Species

Overall, for the ‘Mudflats and sandflats not covered by seawater at low tide’ IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

Designated Sites

Overall, for the Dee Estuary/Aber Dyfrdwy SAC and Fylde MCZ IEFs, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

Decommissioning Phase

Magnitude of Impact

All IEFs

There is potential for cumulative impacts with two Tier 2 projects in the decommissioning phase: Mona OWF and the Morgan and Morecambe OWF Transmission Assets. In the decommissioning phase of the Proposed Development, infrastructure removal could result in increased SSCs. The decommissioning phase of the Proposed Development will coincide with the operations and maintenance phases of these two Tier 2 projects. During their operations and maintenance phases, cable repair and reburial has the potential to result in increased SSCs. These activities would be of limited spatial extent, intermittent in frequency, and unlikely to interact with sediment plumes from the Proposed Development. As described in section 7.12.2, increased SSCs in the decommissioning phase of the Proposed Development are expected to be similar or lower to those of the construction phase, which was assessed as having a low magnitude of impact.

The construction phase of the Morgan and Morecambe OWF Transmission Assets will also coincide with the decommissioning phase of the Proposed Development. At the time of writing, there was no publicly available information to quantify the increased SSCs and associated deposition due to the Morgan and Morecambe OWF Transmission Assets. As the transmission assets only involves cables, it is likely sedimentation will be of a lower extent to that of Mona OWF (which includes offshore export cables).

Overall, the cumulative effect is predicted to be of local spatial extent, short term duration (over the two-year decommissioning phase), intermittent (due to the individual activities), and high reversibility. Therefore, the magnitude of impact is considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as presented above for the Tier 1 assessment and is not repeated here for brevity.

Significance of Effect

Subtidal Habitats and Species

Overall, for the ‘Subtidal sands and gravels IEF’, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

For the ‘Mud habitats in deep water’ IEF and Ross worm IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be negligible. Therefore, the cumulative effect is considered be of **negligible adverse** significance, which is **not significant** in EIA terms.

Overall, for the ‘Subtidal mixed muddy sediment’ IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

Intertidal Habitats and Species

Overall, for the ‘Mudflats and sandflats not covered by seawater at low tide’ IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

Designated Sites

Overall, for the Dee Estuary/Aber Dyfrdwy SAC and Fylde MCZ IEFs, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

7.13.4.3 Tier 3

Construction and Operation and Maintenance Phases

Magnitude of Impact

All IEFs

The only Tier 3 project which has been identified in the CEA with the potential to result in increased SSCs and associate deposition during the construction and operation and maintenance phases of the Proposed Development was the MaresConnect interconnector cable. There is, however, currently no information on the impact that the MaresConnect interconnector cable will have on benthic ecology receptors. A planning application is predicted to be submitted in 2024 which will identify and assess these impacts (MaresConnect, 2023).

The activities associated with the MaresConnect interconnector cable which are likely to result in increased SSCs and associated deposition are similar to those expected for the installation of cables for the Proposed Development. Construction is planned to occur in 2025 and the project is anticipated to become operational in 2027 (MaresConnect, 2023), although it should be noted that these timeframes are only indicative at this stage. The construction activities are likely to involve cable installation such as jet trenching, and the installation of cable protection. Operation and maintenance activities are likely to involve the repair and reburial of cables.

The cumulative impact is predicted to be of local spatial extent, short term duration (for the individual construction and operation and maintenance activities), intermittent, and of high reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as presented above for the Tier 1 assessment and is not repeated here for brevity.

Significance of Effect

Subtidal Habitats and Species

Overall, for the ‘Subtidal sands and gravels IEF’, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

For the ‘Mud habitats in deep water’ IEF and Ross worm IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be negligible. Therefore, the cumulative effect is considered be of **negligible adverse** significance, which is **not significant** in EIA terms.

Overall, for the ‘Subtidal mixed muddy sediment’ IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

Intertidal Habitats and Species

Overall, for the 'Mudflats and sandflats not covered by seawater at low tide' IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

Designated Sites

Overall, for the Dee Estuary/Aber Dyfrdwy SAC and Fylde MCZ IEFs, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

Decommissioning Phase

There were no Tier 3 plans, projects, or activities identified in the CEA with the potential to result in cumulative increased SSCs and associated deposition during the decommissioning phases of the Proposed Development.

7.13.4.4 Tier 4

Construction and Operation and Maintenance Phases

Magnitude of Impact

All IEFs

The only Tier 4 project which has been identified in the CEA with the potential to result in cumulative increased SSCs and associated deposition during the construction and operation and maintenance phases of the Proposed Development was the removal of a meteorological mast at Gwynt y Môr OWF. There is, however, currently no information on the impact that this project will have on benthic ecology receptors.

The activities associated with this project which are likely to result in increased SSCs and associated deposition are anchoring and the use of jack-up vessels for the removal of topside lattice structures, monopiles, and scour protection. There is no timeline for these works currently publicly available, however the marine license was issued for 2022 – 2027. Therefore, while these activities may overlap with the entire construction phase of the Proposed Development, they should be completed shortly after the operation and maintenance phase of the Proposed Development begins (within 2026).

The cumulative impact is predicted to be of local spatial extent, short term duration (for the individual activities), intermittent, and of high reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as presented above for the Tier 1 assessment and is not repeated here for brevity.

Significance of Effect

Subtidal Habitats and Species

Overall, for the 'Subtidal sands and gravels IEF', the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

For the 'Mud habitats in deep water' IEF and Ross worm IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be negligible. Therefore, the cumulative effect is considered be of **negligible adverse** significance, which is **not significant** in EIA terms.

Overall, for the 'Subtidal mixed muddy sediment' IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

Intertidal Habitats and Species

Overall, for the 'Mudflats and sandflats not covered by seawater at low tide' IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

Designated Sites

Overall, for the Dee Estuary/Aber Dyfrdwy SAC and Fylde MCZ IEFs, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

Decommissioning Phase

There were no Tier 4 plans, projects, or activities identified in the CEA with the potential to result in cumulative increased SSCs and associated deposition during the decommissioning phases of the Proposed Development.

7.13.5 Long-Term Subtidal Habitat Loss

Long-term subtidal habitat loss may result from the physical presence of foundations, cable crossing protection, and rock placement. For the purposes of this ES, this additive impact has been assessed within the benthic subtidal and intertidal ecology CEA study area, using the tiered approach outlined above in section 7.13.1.

All plans, projects, and activities screened into the CEA for this impact are either on-going activities or projects with sufficient information in the public domain. The plans, projects, and activities within each tier screened into the CEA for each phase of development are illustrated in Table 7.81.

7.13.5.1 Tier 1

Construction and Operation and Maintenance Phases

Magnitude of Impact

Subtidal Habitats and Species

There is the potential for cumulative impacts with two Tier 1 projects in the construction and operation and maintenance phases: Awel y Môr OWF and the Mostyn Energy Park Expansion. The MDS for Awel y Môr OWF assumes up to 1.61 km^2 of long-term subtidal habitat loss due to the footprint of turbines, foundations, meteorological mast, and cable protection (RWE Renewables UK, 2021a). ~~Therefore, there is potential for a total of up to 1.67 km^2 of long-term subtidal habitat loss (including the values assumed in the MDS for the Proposed Development; Table 7.21).~~The MDS for this impact for the Mostyn Energy Park Expansion accounts for a footprint of long-term habitat loss of up to 3.49 ha (34,900 m^2) (ABPmer, 2022). Therefore, there is potential for a total of up to 1.71 km^2 of long-term subtidal habitat loss as a result of the Proposed Development and the Tier 1 projects.

The potential for secondary scour as a result of infrastructure placed on the seabed was not assessed for the Mostyn Energy Park Expansion or Awel y Môr OWF. However, the assessment for the Awel y Môr OWF concluded that the use of correctly designed scour protection at foundations and sufficiently buried cables would prevent primary scouring and have no significant effects on the benthic environment (RWE Renewables, 2021a). Any changes to seabed morphology were predicted to be highly local, and physical processes such as tidal flows and sediment transport limited to within 1 km of the Awel y Môr Array Area (RWE Renewables, 2021a). Therefore, it is not expected that impacts from the presence of Awel y Môr project infrastructure will accumulate with the highly local changes to seabed morphology and subtidal habitats due to the presence of cable crossings under the scope of the Proposed Development.

Overall, the cumulative effect is predicted to be of local spatial extent (given the low footprint of disturbance), long term duration, continuous, and low reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude is considered to be low.

Intertidal Habitats and Species

The Tier 1 projects will not cumulatively interact with this impact in the intertidal zone of the Proposed Development due to their distance from the landfall (Figure 7.12). Therefore, the intertidal habitats and species IEF has not been considered further in this Tier 1 assessment.

Designated Sites

As above for the intertidal habitats and species IEF, there are no Tier 1 projects that cumulatively overlap with the Dee Estuary/Aber Dyfrdwy SAC IEF due to their distance from the landfall. Therefore, the Dee Estuary/Aber Dyfrdwy SAC IEF has not been considered further in this Tier 1 assessment.

As the Fylde MCZ IEF is does not overlap with the Awel y Môr OWF, cumulative effects due to this impact will not occur. Therefore, the Fylde MCZ IEF has not been considered further in this Tier 1 assessment.

Sensitivity of the Receptor

The sensitivity of the subtidal habitats and species IEFs are as previously described for the construction phase of the Proposed Development alone (see section 7.12.3).

Overall, all IEFs except Ross worm are deemed to be of high vulnerability, low recoverability, and national to international value. Therefore, the sensitivity of these receptors to this impact is considered to be high.

The Ross worm IEF is deemed to be of high vulnerability, medium recoverability, and local value. Therefore, the sensitivity of the receptor to this impact is considered to be medium.

Significance of Effect

Overall, for all IEFs except Ross worm, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be high. As per Table 7.31, this yields a ‘Minor to moderate’ significance. Given the low disturbance footprint and that only one project was identified in the Tier 1 assessment, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

For the Ross worm IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

Decommissioning Phase

Magnitude of Impact

Subtidal Habitats and Species

There is the potential for cumulative impacts with one Tier 1 project in the decommissioning phase: Awel y Môr OWF. The MDS for Awel y Môr OWF assumes up to 1.61 km^2 of long-term subtidal habitat loss due to the removal of infrastructure installed in the construction phase (RWE Renewables UK, 2021a). Therefore, there is potential for a total of up to 1.67 km^2 of long-term subtidal habitat loss (including the footprint of infrastructure that will be removed from the Proposed Development; Table 7.21).

Overall, the cumulative effect is predicted to be of local spatial extent (given the low footprint of disturbance), long term duration, continuous, and low reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude is considered to be low.

Sensitivity of the Receptor

The sensitivity of the subtidal habitats and species IEFs are as previously described for the construction phase of the Proposed Development alone (see section 7.12.3).

Overall, all IEFs except Ross worm are deemed to be of high vulnerability, low recoverability, and national to international value. Therefore, the sensitivity of these receptors to this impact is considered to be high.

The Ross worm IEF is deemed to be of high vulnerability, medium recoverability, and local value. Therefore, the sensitivity of the receptor to this impact is considered to be medium.

Significance of Effect

Overall, for all IEFs except Ross worm, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be high. As per Table 7.31, this yields a 'Minor to moderate' significance. Given the low disturbance footprint and that only one project was identified in the Tier 1 assessment, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

For the Ross worm IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

7.13.5.2 Tier 2

Construction and Operation and Maintenance Phases

Magnitude of Impact

Subtidal Habitats and Species

Both construction and operations and maintenance phases of the Proposed Development may interact cumulatively one Tier 2 project: the Mona OWF. They also coincide with the operations and maintenance phase of the Morgan and Morecambe OWF Transmission Assets. Predicted cumulative long-term subtidal habitat loss from both Tier 2 plans, projects, and activities during the construction and operation and maintenance phases of the Proposed Development are presented in Table 7.85 together with a breakdown of the sources of this data and any assumptions made where necessary information was not presented.

For both the Tier 2 plans, projects, and activities during the construction and operations and maintenance phases of the Proposed Development, the cumulative long-term subtidal habitat loss is estimated at 2.42 km^2 (including the values for the Proposed Development provided in Table 7.21). There was no publicly available figure of predicted long-term subtidal habitat loss available for the Morgan and Morecambe OWF Transmission Assets, however given the nature of this project, these are likely to be similar or lower than those presented for the Mona OWF in Table 7.85.

Table 7.85: Cumulative Long-Term Subtidal Habitat Loss For The Construction And Operation And Maintenance Phases Of Tier 2 Plans, Projects, And Activities Identified

Project	Predicted Long-Term Subtidal Habitat Loss (km^2)	Cause of Long-Term Subtidal Habitat Loss	Source
Proposed Development	**0.06**	**See Table 7.21**	**See Table 7.21**

Project	Predicted Long-Term Subtidal Habitat Loss (km^2)	Cause of Long-Term Subtidal Habitat Loss	Source
Offshore Renewables			
Mona OWF	2.36	Presence of foundations and cable, cable crossing, and scour protection.	EnBW and BP (2023b)
Cables and Pipelines			
Morgan and Morecambe OWF Transmission Assets	Not available	Only the Scoping Report is currently available for this project, so no footprint of disturbance is available. However, installation of foundations and cable, cable corssing, and scour protection will result in long-term subtidal habitat loss.	-
Total	**2.42**		

The PEIR for Mona OWF included an assessment on changes in physical processes, which included scour effects as a result of installed infrastructure. The impact of secondary scour, and potential long term habitat loss and disturbance was not included (EnBW and BP, 2023b). However, any changes caused by the addition of project infrastructure at the Mona OWF to the water column and seabed will have largely localised impacts to physical processes, with changes to tidal currents and sediment transport being limited to the immediate vicinity of installations (EnBw and BP, 2023b). Extrapolating from this, it is considered unlikely that secondary scour will occur as a result of infrastructure associated with the Mona OWF. Similar information is not currently available in the Scoping Report for the Morgan and Morecambe OWF Transmission Assets.

Overall, the cumulative effect is predicted to be of local spatial extent (given the low footprints for disturbance), long term duration, continuous, and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.

Intertidal Habitats and Species

The Tier 2 projects will not cumulatively interact with this impact in the intertidal zone of the Proposed Development due to their distance from the landfall (Figure 7.12). Therefore, the intertidal habitats and species IEF has not been considered further in this Tier 2 assessment.

Designated Sites

As above for the intertidal habitats and species IEF, there are no Tier 2 projects that cumulatively overlap with the Dee Estuary/Aber Dyfrdwy SAC IEF due to their distance from the landfall. Therefore, the Dee Estuary/Aber Dyfrdwy SAC IEF has not been considered further in this Tier 2 assessment.

As the Fylde MCZ IEF overlaps with the Morgan and Morecambe OWF Transmission Assets, the information provided above for 'Subtidal Habitats and Species IEFs' is also applicable. Thus, the cumulative impact on the Fylde MCZ IEF is predicted to be of local spatial extent (given the low footprints for disturbance), long term duration, continuous, and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as presented above for the Tier 1 assessment and is not repeated here for brevity.

Significance of Effect

Overall, for all IEFs except Ross worm, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be high. As per Table 7.31, this yields a 'Minor to moderate' significance. Given the low disturbance footprint and that only three projects were identified in the Tier 2 assessment, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

For the Ross worm IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

Decommissioning Phase

Magnitude of Impact

Subtidal Habitats and Species

The decommissioning phase of the Proposed Development may interact cumulatively with the operations and maintenance phases of two Tier 2 projects: Mona OWF, and Morgan and Morecambe OWF Transmission Assets. Predicted cumulative long-term subtidal habitat loss from each of the Tier 2 plans, projects, and activities during their operation and maintenance phases are presented in Table 7.85, together with a breakdown of the sources of this data and any assumptions made where necessary information was not presented. This is estimated as 2.36 km^2. This impact is likely to be of a lower extent than in the construction and operation and maintenance phase, as the MDS for the Proposed Development assumes that all infrastructure will be removed (with only some rock placement remaining *in situ*).

There was no publicly available figure of predicted long-term subtidal habitat loss available for the Morgan and Morecambe OWF Transmission Assets, however given the nature of this project, these are likely to be similar or lower than that presented for Mona OWF in Table 7.85.

Overall, the cumulative effect is predicted to be of local spatial extent (given the low footprints for disturbance), long term duration, continuous, and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.

Designated Sites

As the Fylde MCZ IEF overlaps with the Morgan and Morecambe OWF Transmission Assets, the information provided above for ‘Subtidal Habitats and Species IEFs’ is also applicable. Thus, the cumulative impact on the Fylde MCZ IEF is predicted to be of local spatial extent (given the low footprints for disturbance), long term duration, continuous, and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as presented above for the Tier 1 assessment and is not repeated here for brevity.

Significance of Effect

Overall, for all IEFs except Ross worm, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be high. As per Table 7.31, this yields a ‘Minor to moderate’ significance. Given the low disturbance footprint and that only three projects were identified in the Tier 2 assessment, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

For the Ross worm IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

7.13.5.3 Tier 3

Construction and Operation and Maintenance Phases

Magnitude of Impact

Subtidal Habitats and Species

There was one Tier 3 project identified in the CEA with the potential to result in cumulative long-term subtidal habitat loss during the construction and operation and maintenance phases of the Proposed Development: The MaresConnect interconnector cable. However, there is currently no information on the impact that this project will have on benthic ecology. A planning application is predicted to be submitted in 2024 which will identify these impacts (MaresConnect, 2023).

Cable protection associated with the MaresConnect interconnector cable is likely to result in long-term subtidal habitat loss, similar to those expected for the cables of the Tier 1 and 2 projects. Construction is likely to occur in 2025 and the protection is anticipated to become operational in 2027 (MaresConnect 2023), although it should be noted that these timeframes are only indicative at this stage.

The cumulative effect is predicted to be of regional spatial extent (as the cable runs between Wales and Ireland), long-term duration, continuous and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.

Intertidal Habitats and Species

The MaresConnect interconnector cable will not cumulatively interact with this impact in the intertidal zone of the Proposed Development due to its distance from the landfall (Figure 7.12). Therefore, the intertidal habitats and species IEF has not been considered further in this Tier 3 assessment.

Designated Sites

As above for the intertidal habitats and species IEF, there are no Tier 3 projects that cumulatively overlap with the Dee Estuary/Aber Dyfrdwy SAC IEF due to their distance from the landfall. Therefore, the Dee Estuary/Aber Dyfrdwy SAC IEF has not been considered further in this Tier 3 assessment.

As the Fylde MCZ IEF is does not overlap with the MaresConnect interconnector cable, cumulative effects due to this impact will not occur. Therefore, the Fylde MCZ IEF has not been considered further in this Tier 3 assessment.

Sensitivity of the Receptor

The sensitivity of the receptor is as presented above for the Tier 1 assessment and is not repeated here for brevity.

Significance of Effect

Overall, for all IEFs except Ross worm, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be high. As per Table 7.31, this yields a ‘Minor to moderate’ significance. Given the low disturbance footprint and that only one project was identified in the Tier 3 assessment, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

For the Ross worm IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

Decommissioning Phase

There were no Tier 3 plans, projects, or activities identified in the CEA with the potential to result in cumulative long-term subtidal habitat loss during the decommissioning phases of the Proposed Development.

7.13.5.4 Tier 4

There were no Tier 4 plans, projects, or activities identified in the CEA with the potential to result in cumulative long-term subtidal habitat loss during the construction, operations and maintenance, and decommissioning phases of the Proposed Development.

7.13.6 Introduction of Artificial Habitat and Colonisation of Hard Structures

The introduction of hard substrate into areas of predominantly soft sediments has the potential to alter community composition and biodiversity within the CEA benthic ecology study area. For the purposes of this ES, this additive impact has been assessed within the benthic subtidal and intertidal ecology CEA study area, using the tiered approach outlined above in section 7.13.1.

All plans, projects, and activities screened into the CEA for this impact are either on-going activities or projects with sufficient information in the public domain. The plans, projects, and activities within each tier screened into the CEA for each phase of development are illustrated in Table 7.81.

7.13.6.1 Tier 1

Operation and Maintenance Phase

Magnitude of Impact

Subtidal Habitats and Species

There is potential for cumulative impacts with one Tier 1 project in the operation and maintenance phase: Awel y Môr OWF. The MDS for Awel y Môr OWF assumes up to 1.48 km^2 of introduced hard substrate (RWE Renewables UK, 2021a). Therefore, there is potential for a total of up to 1.54 km^2 of long-term subtidal habitat loss (including the values assumed in the MDS for the Proposed Development; Table 7.21).

As presented for the Tier 1 assessment above in section 7.13.5, the potential for secondary scour as a result of infrastructure placed on the seabed was not assessed for the Awel y Môr OWF. However, the assessment concluded that the use of correctly designed scour protection at foundations and sufficiently buried cables would prevent primary scouring and have no significant effects on the benthic environment (RWE Renewables, 2021a). Any changes to seabed morphology were predicted to be highly local, and changes to physical processes such as tidal flows and sediment transport limited to within 1 km of the Awel y Môr Array Area (RWE Renewables, 2021a). Therefore, it is not expected that impacts from the presence of Awel y Môr project infrastructure will accumulate with the highly local changes to seabed morphology and subtidal habitats due to the presence of cable crossings under the scope of the Proposed Development. Therefore, it is not expected that any cumulative secondary scour will prevent colonisation of hard structures associated with the Tier 1 projects.

Overall, the cumulative effect is predicted to be of local spatial extent (given the low footprint of disturbance), long term duration, continuous, and low reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude is considered to be low.

Intertidal Habitats and Species

The Tier 1 project will not cumulatively interact with this impact in the intertidal zone of the Proposed Development due to their distance from the landfall (Figure 7.12). Therefore, the intertidal habitats and species IEF has not been considered further in this Tier 1 assessment.

Designated Sites

As above for the intertidal habitats and species IEF, there are no Tier 1 projects that cumulatively overlap with the Dee Estuary/Aber Dyfrdwy SAC IEF due to their distance from the landfall. Therefore, the Dee Estuary/Aber Dyfrdwy SAC IEF has not been considered further in this Tier 1 assessment.

As the Fylde MCZ IEF is does not overlap with the Awel y Môr OWF, cumulative effects due to this impact will not occur. Therefore, the Fylde MCZ IEF has not been considered further in this Tier 1 assessment.

Sensitivity of the Receptor

The sensitivity of the subtidal habitats and species IEFs are as previously described for the construction phase of the Proposed Development alone (see section 7.12.4).

Overall, the subtidal habitats and species IEFs are deemed to be of high vulnerability, low recoverability, and local to national value. Therefore, the sensitivity of these receptors to this impact is considered to be high.

Significance of Effect

Overall, for all subtidal habitats and species IEFs, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be high. As per Table 7.31, this yields a 'Minor to moderate' significance. Given the low disturbance footprint and that only one project was identified in the Tier 1 assessment, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

7.13.6.2 Tier 2

Operation and Maintenance Phase

Magnitude of Impact

Subtidal Habitats and Species

The operations and maintenance phase of the Proposed Development may interact cumulatively with those of two Tier 2 projects, Mona OWF, and Morgan and Morecambe OWF Transmission Assets. The Morgan and Morecambe OWF Transmission Assets construction phase will also overlap with the operation and maintenance phase of the Proposed Development. Predicted cumulative introduced hard substrate from both of the Tier 2 plans, projects, and activities during their operation and maintenance phases are presented in Table 7.86 together with a breakdown of the sources of this data and any assumptions made where necessary information was not presented.

For both the Tier 2 plans, projects, and activities during operations and maintenance phases of the Proposed Development, the cumulative introduced hard substrate is estimated at 2.90 km^2 (including the values for the Proposed Development provided in Table 7.21). There was no publicly available figure available for the Morgan and Morecambe OWF Transmission Assets, however given the nature of this project, these are likely to be similar or lower than those presented for Mona OWF in Table 7.86.

Table 7.86: Cumulative Introduced Hard Substrate For The Operation And Maintenance Phases Of Tier 2 Plans, Projects, And Activities Identified

Project	Predicted Introduced Hard Substrate (km^2)	Reason for Introduction of Hard Substrate	Source
Proposed Development	**0.06**	**See Table 7.21**	**See Table 7.21**
Offshore Renewables			
Mona OWF	2.85	Presence of foundations and protection for cables, cable crossing, and scour.	EnBW and BP (2023b)
Cables and Pipelines			
Morgan and Morecambe OWF Transmission Assets	Not available	Only the Scoping Report is currently available for this project, so no footprint of disturbance is available. However, installation of foundations and protection for cables, cable crossing, and scour will result in long-term subtidal habitat loss.	-
Total	**2.90**		

As presented for the Tier 2 assessment above in section 7.13.5, the potential for secondary scour as a result of infrastructure placed on the seabed was not assessed in the PEIR for the Mona OWF and information was not available in the Scoping Report for the Morgan and Morecambe OWF Transmission Assets. The PEIR for Mona OWF, however, included an assessment on changes in physical processes, which included primary scour effects as a result of installed infrastructure (EnBW and BP, 2023b). Any changes caused by the addition of project infrastructure at the Mona OWF to the water column and seabed will have largely localised impacts to physical processes, with changes to tidal currents and sediment transport being limited to the immediate vicinity of installations (EnBw and BP, 2023b). Extrapolating from this, it is considered unlikely that secondary scour will occur as a result of infrastructure associated with the Mona OWF. Therefore, it is not expected that impacts from the presence of project infrastructure associated with the Tier 2 projects will accumulate with the highly local changes to seabed morphology and subtidal habitats due to the presence of cable crossings under the scope of the Proposed Development. Therefore, it is not expected that any cumulative secondary scour will prevent colonisation of hard structures associated with the Tier 1 projects.

Overall, the cumulative effect is predicted to be of local spatial extent (given the low footprints for disturbance), long-term duration, continuous, and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.

Intertidal Habitats and Species

The Tier 2 projects will not cumulatively interact with this impact in the intertidal zone of the Proposed Development due to their distance from the landfall (Figure 7.12). Therefore, the intertidal habitats and species IEF has not been considered further in this Tier 2 assessment.

Designated Sites

As above for the intertidal habitats and species IEF, there are no Tier 2 projects that cumulatively overlap with the Dee Estuary/Aber Dyfrdwy SAC IEF due to their distance from the landfall. Therefore, the Dee Estuary/Aber Dyfrdwy SAC IEF has not been considered further in this Tier 2 assessment.

As the Fylde MCZ IEF overlaps with the Morgan and Morecambe OWF Transmission Assets, the information provided above for ‘Subtidal Habitats and Species IEFs’ is also applicable. Thus, the cumulative impact on the Fylde MCZ IEF is predicted to be of local spatial extent (given the low footprints for disturbance), long-term duration, continuous, and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.

Sensitivity of the Receptor

The sensitivity of the subtidal habitats and species IEFs are as previously described for the construction phase of the Proposed Development alone (see section 7.12.4).

Overall, the subtidal habitats and species IEFs and Fylde MCZ IEF are deemed to be of high vulnerability, low recoverability, and local to international value. Therefore, the sensitivity of these receptors to this impact is considered to be high.

Significance of Effect

Overall, for the subtidal habitats and species IEFs and Fylde MCZ IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be high. As per Table 7.31, this yields a 'Minor to moderate' significance. Given the low disturbance footprint and that only one project was identified in the Tier 3 assessment, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

7.13.6.3 Tier 3

Operation and Maintenance Phase

Magnitude of Impact

Subtidal Habitats and Species

There is the potential for cumulative impacts with one Tier 3 project in the operation and maintenance phase: The MaresConnect interconnector cable. However, there is currently no information on the impact that this project will have on benthic ecology. A planning application is predicted to be submitted in 2024 which will identify these impacts (MaresConnect, 2023).

Cable protection associated with the MaresConnect interconnector cable will represent introduction of hard substrates, similar to that expected for the cables of the Tier 1 and 2 projects. Construction is likely to occur in 2025 and the protection is anticipated to become operational in 2027 (MaresConnect 2023), although it should be noted that these timeframes are only indicative at this stage.

The cumulative effect is predicted to be of regional spatial extent (as the cable runs between Wales and Ireland), long-term duration, continuous and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.

Intertidal Habitats and Species

The MaresConnect interconnector cable will not cumulatively interact with this impact in the intertidal zone of the Proposed Development due to its distance from the landfall (Figure 7.12). Therefore, the intertidal habitats and species IEF has not been considered further in this Tier 3 assessment.

Designated Sites

As above for the intertidal habitats and species IEF, there are no Tier 3 projects that cumulatively overlap with the Dee Estuary/Aber Dyfrdwy SAC IEF due to their distance from the landfall. Therefore, the Dee Estuary/Aber Dyfrdwy SAC IEF has not been considered further in this Tier 3 assessment.

As the Fylde MCZ IEF is does not overlap with the MaresConnect interconnector cable, cumulative effects due to this impact will not occur. Therefore, the Fylde MCZ IEF has not been considered further in this Tier 3 assessment.

Sensitivity of the Receptor

The sensitivity of the subtidal habitats and species IEFs are as previously described for the construction phase of the Proposed Development alone (see section 7.12.4).

Overall, the subtidal habitats and species IEFs are deemed to be of high vulnerability, low recoverability, and local to national value. Therefore, the sensitivity of these receptors to this impact is considered to be high.

Significance of Effect

Overall, for the subtidal habitats and species IEFs, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be high. As per Table 7.31, this yields a 'Minor to moderate' significance. Given the low disturbance footprint and that only one project was identified in the Tier 3 assessment, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

7.13.7 Increased Risk of Introduction and Spread of INNS

Cumulative increased risk of introduction or spread of INNS may result from the physical presence of introduced hard substrate and increased vessel activity in the region associated with other project activities. For the purposes of this ES, this additive impact has been assessed within the benthic subtidal and intertidal ecology CEA study area, using the tiered approach outlined above in section 7.13.1.

All plans, projects, and activities screened into the CEA for this impact are either on-going activities or projects with sufficient information in the public domain. The plans, projects, and activities within each tier screened into the CEA for each phase of development are illustrated in Table 7.81.

7.13.7.1 Tier 1

Construction Phase

Magnitude of Impact

Subtidal Habitats and Species

There is the potential for cumulative impacts with three Tier 1 projects in the construction phase: Awel y Môr OWF, Mona OWF suction bucket trials, and the Mostyn Energy Park Expansion. The MDS for Awel y Môr OWF assumes up to 1.61 km^2 of introduced hard substrate (RWE Renewables UK, 2021a). Therefore, there is potential for a total of up to 1.67 km^2 of hard substrate to be colonised by INNS (including the values assumed in the MDS for the Proposed Development; Table 7.21). There will be no hard substrates installed at the latter two Tier 1 projects, and they are only considered cumulatively due to the potential for increased vessel presence associated with them. The MDS for Awel y Môr OWF includes up to 99 vessels over the construction phase, with up to 35 on-site at one time (RWE Renewables UK, 2021c). There will be up to 236 vessel round trips in the construction phase of the Proposed Development (Table 7.21). Values on the number of vessels associated with the Mona OWF suction bucket trials and the Mostyn Energy Park Expansion were not provided in their respective documentation (ABPmer, 2022, MarineSpace Ltd., 2023), but these are unlikely to be larger than those provided for the Awel y Môr OWF or the Proposed Development, given their smaller scale.

Overall, the cumulative effect is predicted to be of local spatial extent (due to low footprint of introduced hard substrate), long term duration, intermittent (in terms of invasions), and low reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Intertidal Habitats and Species

The Tier 1 projects will not cumulatively interact with this impact in the intertidal zone of the Proposed Development due to their distance from the landfall (Figure 7.12). Therefore, the intertidal habitats and species IEF has not been considered further in this Tier 1 assessment.

Designated Sites

As above for the intertidal habitats and species IEF, there are no Tier 1 projects that cumulatively overlap with the Dee Estuary/Aber Dyfrdwy SAC IEF due to their distance from the landfall. Therefore, the Dee Estuary/Aber Dyfrdwy SAC IEF has not been considered further in this Tier 1 assessment.

As the Fylde MCZ IEF is does not overlap with the Awel y Môr OWF, cumulative effects due to this impact will not occur. Therefore, the Fylde MCZ IEF has not been considered further in this Tier 1 assessment.

Sensitivity of the Receptor

The sensitivity of the subtidal habitats and species IEFs are as previously described for the construction phase of the Proposed Development alone (see section 7.12.6).

Overall, all subtidal habitats and species IEFs are deemed to be of high vulnerability, low recoverability, and local to national value. The sensitivity of these IEFs is therefore, considered to be high.

Significance of Effect

Overall, for all subtidal habitats and species IEFs, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be high. As per Table 7.31, this yields a 'Minor to moderate' significance. Given the low disturbance footprint and that only one project was identified in the Tier 1 assessment, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

Operation and Maintenance Phase

Magnitude of Impact

Subtidal Habitats and Species

There is potential for cumulative impacts with two Tier 1 projects in the operation and maintenance phase: Awel y Môr OWF and the Mostyn Energy Park Expansion. The MDS for Awel y Môr OWF assumes up to 1.61 km^2 of introduced hard substrate to be present within this phase (RWE Renewables UK, 2021a). Therefore, there is potential for a total of up to 1.67 km^2 of hard substrate to be colonised by INNS (including the values assumed in the MDS for the Proposed Development; Table 7.21). Furthermore, the MDS for Awel y Môr OWF includes up to 1,232 vessel return trips annually over the 25-year operation and maintenance phase (30,800 total) (RWE Renewables UK, 2021a). There will be up to 750 vessel round trips over the operation and maintenance phase of the Proposed Development (Table 7.21). Values on the number of vessels associated with Mostyn Energy Park Expansion were not provided (ABPmer, 2022), but these are unlikely to be larger than those provided for the Awel y Môr OWF or the Proposed Development, given their smaller scale. Further, there will be no hard substrate installed as a result of the Mostyn Energy Park Expansion, therefore, this project is likely to represent a lower risk of introduction and spread of INNS than the Proposed Development or the Awel y Môr OWF.

Overall, the cumulative effect is predicted to be of local spatial extent (due to low footprint of introduced hard substrate), long term duration, intermittent (in terms of invasions), and low reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Sensitivity of the Receptor

The sensitivity of the subtidal habitats and species IEFs are as previously described for the construction phase of the Proposed Development alone (see section 7.12.6).

Overall, all subtidal habitats and species IEFs are deemed to be of high vulnerability, low recoverability, and local to national value. The sensitivity of these IEFs is therefore, considered to be high.

Significance of Effect

Overall, for all subtidal habitats and species IEFs, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be high. As per Table 7.31, this yields a 'Minor to moderate' significance. Given the low disturbance footprint and that only one project was identified in the Tier 1 assessment, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

Decommissioning Phase

Magnitude of Impact

Subtidal Habitats and Species

There is the potential for cumulative impacts with one Tier 1 project in the decommissioning phase: Awel y Môr OWF. The decommissioning phase of the Proposed Development overlaps with the operation and maintenance phase of Awel y Môr OWF. Therefore, the 1.61 km^2 of hard substrate introduced in the Awel y Môr OWF operation and maintenance phase is applicable to this impact (RWE Renewables UK, 2021a). Furthermore, the MDS for Awel y Môr OWF includes up to 1,232 vessel return trips annually within the operation and maintenance phase (30,800 total) (RWE Renewables UK, 2021a). Therefore, there will be up to 2,464 vessel return trips potentially overlapping with the two-year decommissioning phase of the Proposed Development. This will be in addition to up to 128 vessel round trips associated with the decommissioning of the Proposed Development (Table 7.21).

Overall, the cumulative effect is predicted to be of local spatial extent (due to low footprint of introduced hard substrate), short-term duration (over the two-year decommissioning phase), intermittent (in terms of invasions), and low reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Sensitivity of the Receptor

The sensitivity of the subtidal habitats and species IEFs are as previously described for the construction phase of the Proposed Development alone (see section 7.12.6).

Overall, all subtidal habitats and species IEFs are deemed to be of high vulnerability, low recoverability, and local to national value. The sensitivity of these IEFs is therefore, considered to be high.

Significance of Effect

Overall, for all subtidal habitats and species IEFs, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be high. As per Table 7.31, this yields a 'Minor to moderate' significance. Given the low disturbance footprint and that only one project was identified in the Tier 1 assessment, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

7.13.7.2 Tier 2

Construction Phase

Magnitude of Impact

Subtidal Habitats and Species

The construction phase of the Proposed Development may interact cumulatively with that of one Tier 2 project: the Mona OWF.

The MDS for the Mona OWF assumes up to 2.85 km^2 of introduced hard substrate (EnBW and BP, 2023b). Therefore, there is potential for a total of up to 2.91 km^2 of hard substrate to be colonised by INNS (including the values assumed in the MDS for the Proposed Development; Table 7.21). Furthermore, the MDS for Mona OWF includes up to 2,004 vessel round trips over the construction phase (EnBW and BP, 2023b). There will be up to 236 vessel round trips in the construction phase of the Proposed Development (Table 7.21).

Overall, the cumulative effect is predicted to be of local spatial extent (due to low footprint of introduced hard substrate), long term duration, intermittent (in terms of invasions), and low reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Intertidal Habitats and Species

The Mona OWF will not cumulatively interact with this impact in the intertidal zone of the Proposed Development due to its distance from the landfall (Figure 7.12). Therefore, the intertidal habitats and species IEF has not been considered further for the construction phase.

Designated Sites

As above for the intertidal habitats and species IEF, there are no Tier 2 projects that cumulatively overlap with the Dee Estuary/Aber Dyfrdwy SAC IEF due to their distance from the landfall. Therefore, the Dee Estuary/Aber Dyfrdwy SAC IEF has not been considered further for the construction phase.

As the Fylde MCZ IEF is does not overlap with the Awel y Môr OWF, cumulative effects due to this impact will not occur. Therefore, the Fylde MCZ IEF has not been considered further for the construction phase.

Sensitivity of the Receptor

The sensitivity of the subtidal habitats and species IEFs are as previously described for the construction phase of the Proposed Development alone (see section 7.12.6).

Overall, all subtidal habitats and species IEFs are deemed to be of high vulnerability, low recoverability, and local to national value. The sensitivity of these IEFs is therefore, considered to be high.

Significance of Effect

Overall, for all subtidal habitats and species IEFs, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be high. As per Table 7.31, this yields a ‘Minor to moderate’ significance. Given the low disturbance footprint and that only one project was identified in the Tier 2 assessment, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

Operation and Maintenance Phase

Magnitude of Impact

Subtidal Habitats and Species

The operations and maintenance phase of the Proposed Development may interact cumulatively with those of two Tier 2 projects, Mona OWF, and Morgan and Morecambe OWF Transmission Assets. The Morgan and Morecambe OWF Transmission Assets construction phase will also overlap with the operation and maintenance phase of the Proposed Development. Predicted cumulative impacts from both Tier 2 plans, projects, and activities during their operation and maintenance phases are presented in Table 7.87 together with a breakdown of the sources of this data and any assumptions made where necessary information was not presented.

For both the Tier 2 plans, projects, and activities during operations and maintenance phases of the Proposed Development, the cumulative introduced hard substrate is estimated at 2.90 km^2 (including the values for the Proposed Development provided in Table 7.21). There was no publicly available figure available for the Morgan and Morecambe OWF Transmission Assets, however given the nature of this project, these are likely to be similar or lower than those presented for the Mona OWF Table 7.87.

Overall, the cumulative effect is predicted to be of local spatial extent (due to low footprint of introduced hard substrate), long term duration, intermittent (in terms of invasions), and low reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Table 7.87: Cumulative Introduced Hard Substrate And Vessel Return Trips For The Operation And Maintenance Phases Of Tier 2 Plans, Projects, And Activities Identified

Project	Predicted Introduced Hard Substrate (km^2) and Vessel Traffic	Reason for Impact	Source
Offshore Renewables			
Mona OWF	2.85 km^2 of introduced hard substrate and up to 82,285 vessel return trips over then entire operation and maintenance phase	Presence of foundations and protection for cables, cable crossing, and scour. Vessel traffic can also pose a risk of introduction of INNS through ballast water or attached to hulls.	EnBW and BP (2023b)
Cables and Pipelines			
Morgan and Morecambe OWF Transmission Assets	Not available	Only the Scoping Report is currently available for this project, so no footprint of disturbance is available. However, installation of foundations and protection for cables, cable crossing, and scour will result in potential habitat for colonisation by INNS. Increased vessel traffic will also provide a vector for INNS transport.	-

Intertidal Habitats and Species

The Tier 2 projects will not cumulatively interact with this impact in the intertidal zone of the Proposed Development due to their distance from the landfall (Figure 7.12). Therefore, the intertidal habitats and species IEF has not been considered further in this Tier 2 assessment.

Designated Sites

As above for the intertidal habitats and species IEF, there are no Tier 2 projects that cumulatively overlap with the Dee Estuary/Aber Dyfrdwy SAC IEF due to their distance from the landfall. Therefore, the Dee Estuary/Aber Dyfrdwy SAC IEF has not been considered further in this Tier 2 assessment.

As the Fylde MCZ IEF overlaps with the Morgan and Morecambe OWF Transmission Assets, the information provided above for ‘Subtidal Habitats and Species IEFs’ is also applicable. Thus, the cumulative impact on the Fylde MCZ IEF is predicted to be of local spatial extent (due to low footprint of introduced hard substrate), long term duration, intermittent (in terms of invasions), and low reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Sensitivity of the Receptor

The sensitivity of the subtidal habitats and species IEFs are as previously described for the construction phase of the Proposed Development alone (see section 7.12.6).

Overall, the subtidal habitats and species IEFs and Fylde MCZ IEF are deemed to be of high vulnerability, low recoverability, and local to international value. Therefore, the sensitivity of these receptors to this impact is considered to be high.

Significance of Effect

Overall, for the subtidal habitats and species IEFs and Fylde MCZ IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be high. As per Table 7.31, this yields a 'Minor to moderate' significance. Given the low disturbance footprint and that only two projects were identified in the Tier 2 assessment, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

Decommissioning Phase

Magnitude of Impact

Subtidal Habitats and Species

The decommissioning phase of the Proposed Development may interact cumulatively with the operations and maintenance phases of two Tier 2 projects: Mona OWF, and Morgan and Morecambe OWF Transmission Assets. For the Mona OWF, up to 2.85 km^2 of hard substrate will be present within its operation and maintenance phase, which could potentially be colonised by INNS (EnBW and BP, 2023b). There was no publicly available figure available for the Morgan and Morecambe OWF Transmission Assets, however given the nature of this project, these are likely to be similar or lower than that presented for the Mona OWF. During the decommissioning phase of the Proposed Development, the MDS assumes that all infrastructure will be removed, although some rock placement will remain *in situ.* The MDS for Mona OWF includes up to 2,351 vessel return trips per year during its operation and maintenance phase (EnBW and BP, 2023b). This means that up to 4,702 of these may occur during the two-year decommissioning phase of the Proposed Development. This will be in addition to up to 128 vessel round trips associated with the decommissioning of the Proposed Development (Table 7.21).

Overall, the cumulative effect is predicted to be of local spatial extent (given the low footprints for disturbance), long term duration, continuous, and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.

Designated Sites

As the Fylde MCZ IEF overlaps with the Morgan and Morecambe OWF Transmission Assets, the information provided above for 'Subtidal Habitats and Species IEFs' is also applicable. Thus, the cumulative impact on the Fylde MCZ IEF is predicted to be of local spatial extent (given the low footprints for disturbance), long term duration, continuous, and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.

Sensitivity of the Receptor

The sensitivity of the subtidal habitats and species IEFs are as previously described for the construction phase of the Proposed Development alone (see section 7.12.6).

Overall, the subtidal habitats and species IEFs and Fylde MCZ IEF are deemed to be of high vulnerability, low recoverability, and local to international value. Therefore, the sensitivity of these receptors to this impact is considered to be high.

Significance of Effect

Overall, for the subtidal habitats and species IEFs and Fylde MCZ IEF, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be high. As per Table 7.31, this yields a 'Minor to moderate' significance. Given the low disturbance footprint and that only two projects were identified in the Tier 2 assessment, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

7.13.7.3 Tier 3

Construction and Operation and Maintenance Phase

Magnitude of Impact

<u>Subtidal Habitats and Species</u>

There is the potential for cumulative impacts with one Tier 3 project in the both the construction and operation and maintenance phases: The MaresConnect interconnector cable. However, there is currently no information on the impact that this project will have on benthic ecology. A planning application is predicted to be submitted in 2024 which will identify these impacts (MaresConnect, 2023).

Cable protection associated with the MaresConnect interconnector cable will represent introduction of hard substrates that could be colonised by INNS, similar to that expected for the cables of the Tier 1 and 2 projects. Increased vessel traffic during the construction and operation and maintenance phase of this project could also provide additional vectors for transmission of INNS. Construction of the MaresConnect interconnector cable is likely to occur in 2025 and the protection is anticipated to become operational in 2027 (MaresConnect 2023), although it should be noted that these timeframes are only indicative at this stage.

The cumulative effect is predicted to be of regional spatial extent (as the cable runs between Wales and Ireland), long-term duration, continuous and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.

<u>Intertidal Habitats and Species</u>

The MaresConnect interconnector cable will not cumulatively interact with this impact in the intertidal zone of the Proposed Development due to its distance from the landfall (Figure 7.12). Therefore, the intertidal habitats and species IEF has not been considered further in this Tier 3 assessment.

<u>Designated Sites</u>

As above for the intertidal habitats and species IEF, there are no Tier 3 projects that cumulatively overlap with the Dee Estuary/Aber Dyfrdwy SAC IEF due to their distance from the landfall. Therefore, the Dee Estuary/Aber Dyfrdwy SAC IEF has not been considered further in this Tier 3 assessment.

As the Fylde MCZ IEF is does not overlap with the MaresConnect interconnector cable, cumulative effects due to this impact will not occur. Therefore, the Fylde MCZ IEF has not been considered further in this Tier 3 assessment.

Sensitivity of the Receptor

The sensitivity of the subtidal habitats and species IEFs are as previously described for the construction phase of the Proposed Development alone (see section 7.12.6).

Overall, the subtidal habitats and species IEFs are deemed to be of high vulnerability, low recoverability, and local to international value. Therefore, the sensitivity of these receptors to this impact is considered to be high.

Significance of Effect

Overall, for the subtidal habitats and species IEFs, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be high. As per Table 7.31, this yields a 'Minor to moderate' significance. Given the low disturbance footprint and that only one project was identified in the Tier 3 assessment, the cumulative effect is considered be of **minor adverse** significance, which is **not significant** in EIA terms.

7.13.7.4 Tier 4

There were no Tier 4 plans, projects, or activities identified within the CEA for the construction, operation and maintenance, and decommissioning phases of this impact.

7.13.8 Conclusion

Overall, there were no significant cumulative effects identified for any tiers in the CEA for benthic subtidal and intertidal ecology.

7.13.9 Fish and Shellfish Ecology

The CEA study area for this topic was defined by a 50 km buffer around the Proposed Development (Figure 7.13). For the impact of underwater noise during the construction phase, a larger buffer of 100 km was used to account for a greater ZoI associated with underwater noise (especially piling). All plans, projects, and activities identified within this area were assessed and sorted into tiers using the methodology described in section 7.13.1 above.

The specific plans, projects, and activities scoped into the CEA for fish and shellfish ecology are outlined in Table 7.88 and in Figure 7.13.

7.13.9.1 Maximum Design Scenario

The MDS presented in Table 7.89 has been selected as those with the potential to result in the greatest effect on fish and shellfish receptors. The potential cumulative effects presented and assessed in this section were based on the PDE provided in volume 1, chapter 3, as well as the information available on other plans, projects, and activities. Effects of adverse significance are not expected to arise should another a different development scenario to that assessed here be taken forward to the final design scheme.

Table 7.88: List Of Other Plans, Projects, And Activities Considered Within The CEA For Fish And Shellfish Ecology

Project/Plan/Activity	Status	Distance from Proposed Development (km)	Description	Construction Period (if applicable)	Operation and Maintenance Period (if applicable)	Overlap with the Proposed Development
Tier 1						
Offshore Renewables						
Burbo Bank Extension OWF cable repair and remediation	Operational (with ongoing activities)	0.00	Export cable repair and remediation activities over the 25-year lifetime of the Burbo Bank Extension OWF.	N/a	2017–- 2042	These activities overlap spatially with the Proposed Development and temporally with the construction and operation and maintenance phases of the Proposed Development.
Awel y Môr OWF	Consented	1.10	Proposed renewable energy project, 10.50 km off the coast of North Wales, of up to 1.1 GW. Proposed for a maximum of 50 turbines, associated transmission assets, and cabling (including and interlink cable with Gwynt y Môr OWF).	2026 – 2030	2030 – 2055	This project will overlap with all three phases of the Proposed Development.
Mona OWF Suction Bucket Trails	Consented	5.60	The works proposed within this Marine Licence	2023 to June 2024	N/A	The suction bucket trials may overlap with early construction activities of the

Project/Plan/Activity	Status	Distance from Proposed Development (km)	Description	Construction Period (if applicable)	Operation and Maintenance Period (if applicable)	Overlap with the Proposed Development
			Application consist of trialling suction bucket foundations to assess the install viability within the Mona OWF Array Area, which is predominantly within Welsh waters.			Proposed Development.
Deposits and Removal						
Burbo Bank Extension OWF Disposal Site IS153	Operational (with ongoing activities)	0.50	Deposit of substances at sea, construction works, removal of sediment, and disposal of inert material during drilling for the Burbo Bank Extension OWF.	N/a	2017–- 2042	These activities overlap with the construction and operation and maintenance phases of the Proposed Development.
Hilbre Swash	Operational (with ongoing activities)	0.00	Licence to extract up to 12 million tonnes of aggregate (mainly sand) over 15 years.	N/a	2015 – 2029	Aggregate extraction activities within this project will overlap temporally with the construction and operation and maintenance phases of the Proposed Development. This project also spatially overlaps with the Proposed Development.

Project/Plan/Activity	Status	Distance from Proposed Development (km)	Description	Construction Period (if applicable)	Operation and Maintenance Period (if applicable)	Overlap with the Proposed Development
Mostyn Energy Park Expansion	Submitted	2.30	Extension of the Mostyn Energy Park at the Port of Mostyn. Requires construction of a 360 m quay, reclamation of 3.5 ha area, capital dredging of new berth pockets and re-dredging of approach channel. Use of dredged material for fill material for reclamation, disposal of dredged material at Mostyn Deep. Maintenance dredging of new and existing berths, approach channel and harbour area.	2023 to 2025	2025 to 2030	Activities will overlap with the construction and operation and maintenance phases of the Proposed Development.
Tier 2						
Offshore Renewables						
Mona OWF	Pre-application	5.53	Proposed renewable energy project, 28.20 km off the coast of North Wales, of up to 350 MW.	2026–- 2028	2029–- 2089	This project will overlap with all three phases of the Proposed Development.

Project/Plan/Activity	Status	Distance from Proposed Development (km)	Description	Construction Period (if applicable)	Operation and Maintenance Period (if applicable)	Overlap with the Proposed Development
Morgan OWF Generation Assets	Pre-application	7.53	The generation assets for the Morgan OWF, which has a capacity of 1.5 GW.	2026–- 2028	2029–- 2089	Temporally, the construction, operations and maintenance, and decommissioning phases of this project will overlap with the construction and operations and maintenance phases of the Proposed Development.
Morecambe OWF Generation Assets	Pre-application	30.00	The generation assets for the Morgan OWF, which has a capacity of 480 MW.	2026–- 2028	2029–- 2089	This project will overlap with all three phases of the Proposed Development.
Mooir Vannin OWF	Pre-application	63.00	OWF off the coast of the Isle of Man, with up to 100 turbines and a capacity for 100 MW.	2030 – 2032	2032 - 2067	The construction and operation and maintenance phases of this project will overlap with the operation and maintenance phase of the Proposed Development.
Cables and Pipelines						
Morgan and Morecambe OWF Transmission Assets	Pre-application	3.00	The transmission assets for the Morgan and Morecambe OWF	2028–- 2029	2030–- 2065	This project will overlap with the operations and maintenance and decommissioning phases of the

Project/Plan/Activity	Status	Distance from Proposed Development (km)	Description	Construction Period (if applicable)	Operation and Maintenance Period (if applicable)	Overlap with the Proposed Development
						Proposed Development.
Tier 3						
Cables and Pipelines						
MaresConnect – Wales – Ireland Interconnector Cable	Planning application not yet submitted	10.00	A proposed 750 MW subsea and underground electricity interconnector system, linking the electricity grids in the UK and Ireland.	2025	2027–- 2037	This project will overlap with the construction and operations and maintenance phases of the Proposed Development.
Tier 4						
Offshore Renewables						
Removal of a meteorological mast at Gwynt y Môr OWF	Issued (variation to an existing marine licence)	0.00	A seabed survey and removal of topside lattice structures, monopiles, and scour protection.	N/a	Licence issued for 2022–-2027	Although no information on the timeline of this project is available, the Marine License is issued for between 2022 – 2027. Therefore, this activity will overlap with the operations and maintenance phase of the Proposed Development. This project also spatially overlaps with the Proposed Development.

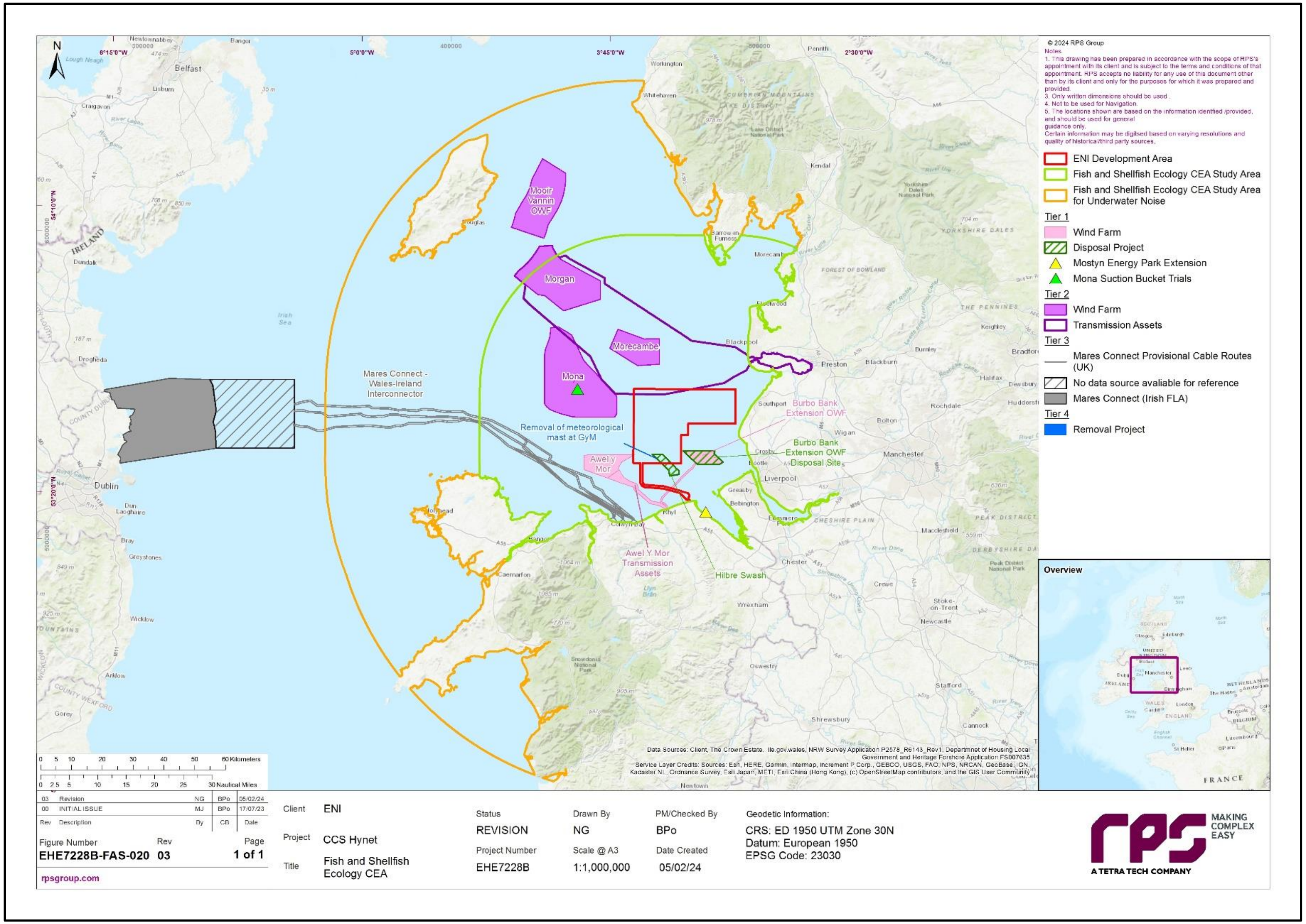

Figure 7.13: Plans, Projects, And Activities Screened Into The CEA For Fish And Shellfish Ecology

Table 7.89: MDS Considered For The Assessment Of Potential Cumulative Effects On Fish And Shellfish Ecology

Potential Cumulative Effect	Phase	MDS	Justification
Temporary subtidal habitat loss and/or disturbance	C	The MDS is as described for the Proposed Development (Table 7.22) and assessed cumulatively with the following plans, projects, and activities: **Tier 1:** Offshore Renewables: • Burbo Bank Extension OWF cable repair and remediation; • Awel y Môr OWF. Deposits and Removal: • Burbo Bank Extension OWF Disposal Site IS153; • Hilbre Swash; and • Mostyn Energy Park Expansion. **Tier 2:** Offshore Renewables: • Mona OWF; • Morgan OWF Generation Assets; and • Morecambe OWF Generation Assets. **Tier 3:** Cables and Pipelines: • MaresConnect Wales – Ireland Interconnector Cable **Tier 4:** Offshore Renewables: • Removal of a meteorological mast at Gwynt y Môr OWF.	These projects involve activities which will result in temporary subtidal habitat loss and/or disturbance which may contribute to the impact upon a habitat that the Proposed Development will also affect.
	O	The MDS is as described for the Proposed Development (Table 7.22) and assessed cumulatively with the following plans, projects, and activities: **Tier 1:** Offshore Renewables: • Burbo Bank Extension OWF cable repair and remediation; and	

Potential Cumulative Effect	Phase	MDS	Justification
		• Awel y Môr OWF. Deposits and Removal: • Burbo Bank Extension OWF Disposal Site IS153; and • Hilbre Swash. **Tier 2:** Offshore Renewables: • Mona OWF; • Morgan OWF Generation Assets; and • Morecambe OWF Generation Assets. Cables and Pipelines: • Morgan and Morecambe OWF Transmission Assets. **Tier 3:** Cables and Pipelines: • MaresConnect Wales – Ireland Interconnector Cable. **Tier 4:** Offshore Renewables: Removal of a meteorological mast at Gwynt y Môr OWF.	
	D	The MDS is as described for the Proposed Development (Table 7.22) and assessed cumulatively with the following plans, projects, and activities: **Tier 1:** Offshore Renewables: • Awel y Môr OWF. **Tier 2:** Offshore Renewables: • Mona OWF; • Morgan OWF Generation Assets; and • Morecambe OWF Generation Assets. Cables and Pipelines:	

Potential Cumulative Effect	Phase	MDS	Justification
		• Morgan and Morecambe OWF Transmission Assets.	
Increased SSCs and associated deposition	C	The MDS is as described for the Proposed Development (Table 7.22) and assessed cumulatively with the following plans, projects, and activities: **Tier 1:** Offshore Renewables: • Burbo Bank Extension OWF cable repair and remediation; and • Awel y Môr OWF; and • Mona OWF Suction Bucket Trails. Deposits and Removal: • Burbo Bank Extension OWF Disposal Site IS153; • Hilbre Swash; and • Mostyn Energy Park Expansion. **Tier 2:** Offshore Renewables: • Mona OWF; • Morgan OWF Generation Assets; and • Morecambe OWF Generation Assets. **Tier 3:** Cables and Pipelines: • MaresConnect Wales – Ireland Interconnector Cable **Tier 4:** Offshore Renewables: • Removal of a meteorological mast at Gwynt y Môr OWF.	These projects involve activities which may impact the tidal/wave regime and sediment transport during their temporal overall with the Proposed Development.
	D	The MDS is as described for the Proposed Development (Table 7.22) and assessed cumulatively with the following plans, projects, and activities: **Tier 1:** Offshore Renewables:	

Potential Cumulative Effect	Phase	MDS	Justification
		• Awel y Môr OWF. **Tier 2:** Offshore Renewables: • Mona OWF; • Morgan OWF Generation Assets; and • Morecambe OWF Generation Assets. Cables and Pipelines: • Morgan and Morecambe OWF Transmission Assets.	
Long-term subtidal habitat loss	C and O	The MDS is as described for the Proposed Development (Table 7.22) and assessed cumulatively with the following plans, projects, and activities: **Tier 1:** Offshore Renewables: • Awel y Môr OWF. Deposits and Removals: • Mostyn Energy Park Expansion. **Tier 2:** Offshore Renewables: • Mona OWF; • Morgan OWF Generation Assets; and • Morecambe OWF Generation Assets. Cables and Pipelines: • Morgan and Morecambe OWF Transmission Assets. **Tier 3:** Cables and Pipelines: • MaresConnect Wales – Ireland Interconnector Cable.	These projects involve the installation of hard structures on the seabed which will cause long-term subtidal habitat loss within the CEA fish and shellfish ecology study area.
	D	The MDS is as described for the Proposed Development (Table 7.22) and assessed cumulatively with the following plans, projects, and activities: **Tier 1:**	

Potential Cumulative Effect	Phase	MDS	Justification
		Offshore Renewables: • Awel y Môr OWF. **Tier 2:** Offshore Renewables: • Mona OWF; • Morgan OWF Generation Assets; and • Morecambe OWF Generation Assets. Cables and Pipelines: • Morgan and Morecambe OWF Transmission Assets.	
Underwater noise impacting fish and shellfish receptors	C	The MDS is as described for the Proposed Development (Table 7.22) and assessed cumulatively with the following plans, projects, and activities: **Tier 1:** Offshore Renewables: • Awel y Môr OWF. **Tier 2:** Offshore Renewables: • Mona OWF; • Morgan OWF Generation Assets; and • Morecambe OWF Generation Assets.	These projects all involve activities which will result in increased underwater noise which may coincide with that of construction activities for the Proposed Development. These may contribute to the impact upon fish and shellfish receptors.

7.13.10 Temporary Subtidal Habitat Loss and/or Disturbance

There is the potential for cumulative temporary habitat loss and/or disturbance as a result of activities associated with the Proposed Development and other plans, projects, and activities. Activities include cable burial, jack-up vessel use, anchor placements, seabed preparation, dredging, aggregate extraction, cables and pipelines laying, and remedial work. For the purposes of this ES, this additive impact has been assessed within the fish and shellfish ecology CEA study area, using the tiered approach outlined above in section 7.13.1.

All plans, projects, and activities screened into the assessment for cumulative effects from this impact are either on-going activities or projects with sufficient information in the public domain. The plans, projects, and activities within each tier screened into the CEA for each phase of development are illustrated in Table 7.89.

7.13.10.1 Tier 1

Construction Phase

Magnitude of Impact

<u>All Species</u>

There is potential for cumulative impacts with five Tier 1 projects in the construction phase:

- Burbo Bank Extension OWF cable repair and remediation;
- Awel y Môr OWF;
- Hilbre Swash;
- Mostyn Energy Park Expansion; and
- Burbo Bank Extension OWF Disposal Site IS153.

The cumulative magnitude for this impact is as described for benthic subtidal and intertidal ecology (see section 7.13.3). For all the Tier 1 plans, projects, and activities during the construction phase of the Proposed Development, the cumulative temporary habitat loss and/or disturbance is estimated at 18.97 km^2 (including the values for the Proposed Development provided in Table 7.21).

The construction phase of the Proposed Development is between 2024 and 2026, while that of Awel y Môr OWF is currently anticipated as 2026 to 2030 (Table 7.88). Therefore, there may be some overlap between the construction phases of both projects, however it should be noted that it any cumulative impacts will be of a lesser extent than if the two projects overlapped for a longer period of time (i.e. over multiple years).

Dredging activities associated with the Mostyn Energy Park Expansion have been estimated to result in temporary subtidal habitat loss of 3.16 ha (31,600 m^2), with recolonisation expected to occur over a short period of time (although any indication on this time period was not provided in the Environmental Statement for this project (ABPmer, 2022)).

The cumulative impact on fish and shellfish IEFs is predicted to be of local spatial extent (given the low disturbance footprints), short term duration (over the two-year construction phase), intermittent, and of high reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as described above for the Proposed Development alone (see section 7.12.9)

Marine Fish

Overall, most fish IEFs (such as pelagic spawners, elasmobranchs, and flatfish) are deemed to be of low vulnerability, high recoverability and local to national importance. The sensitivity of the receptor is therefore considered to be low.

Sandeel are deemed to be of high vulnerability, high recoverability and of regional importance. The sensitivity of sandeel is therefore considered to be medium.

Herring are deemed to be of high vulnerability, medium recoverability and of national importance, which would normally generate a medium to high sensitivity. However, the sensitivity of herring to this impact is considered to be low, due to the limited suitable spawning sediments within the Proposed Development and the core herring spawning ground being located well outside and to the north-east of the regional fish and shellfish ecology study area off the coast of the Isle of Man.

Shellfish

Overall, spiny lobster are deemed to be of medium vulnerability, low to medium recoverability, and of national importance. The sensitivity of the receptor is therefore considered to be medium.

European lobster and Norway lobster are deemed to be of high vulnerability, medium to high recoverability and of local importance. The sensitivity of the receptor is therefore considered to be medium.

King and queen scallop are deemed to be of medium vulnerability, high recoverability, and of local importance. The sensitivity of the receptor is therefore considered to be low.

All other shellfish IEFs are deemed to be of medium vulnerability, medium recoverability, and of local importance. The sensitivity of the receptor is therefore considered to be medium.

Diadromous Fish

Overall, diadromous fish species are deemed to be of low vulnerability, high recoverability and national to international importance. As such, the sensitivity of the receptor is therefore considered to be low.

Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the sensitivity of the freshwater pearl mussel IEF is also considered to be low.

Significance of Effect

Marine Fish

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of most marine fish IEFs is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For sandeel, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For herring, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

Shellfish

For spiny lobster, European lobster and Norway lobster, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For king and queen scallop, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For all other shellfish IEFs, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

<u>Diadromous Fish</u>

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the significance of the effect on the freshwater pearl mussel IEF is also considered to be **minor adverse.**

Operation and Maintenance Phase

Magnitude of Impact

<u>All Species</u>

There is potential for cumulative impacts with four Tier 1 projects in the operation and maintenance phase:

- Burbo Bank Extension OWF cable repair and remediation;
- Awel y Môr OWF;
- Hilbre Swash; and
- Burbo Bank Extension OWF Disposal Site IS153.

The cumulative magnitude for this impact is as described for benthic subtidal and intertidal ecology (see section 7.13.3). For all the Tier 1 plans, projects, and activities during the operations and maintenance phase of the Proposed Development, the cumulative temporary habitat loss and/or disturbance is estimated at 1.49 km^2 (including the values for the Proposed Development provided in Table 7.21).

The cumulative impact on fish and shellfish IEFs is predicted to be of local spatial extent (given the low disturbance footprints), long-term duration (over the operations and maintenance phase), intermittent, and of high reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as described above the Construction Phase and is not repeated here for brevity.

Significance of Effect

<u>Marine Fish</u>

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of most marine fish IEFs is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For sandeel, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For herring, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

Shellfish

For spiny lobster, European lobster and Norway lobster the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For king and queen scallop, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms

For all other shellfish IEFs, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

Diadromous Fish

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the significance of the effect on the freshwater pearl mussel IEF is also considered to be **minor adverse.**

Decommissioning Phase

Magnitude of Impact

All Species

The only Tier 1 project which has been identified in the CEA with the potential to result in cumulative temporary habitat loss and/or disturbance during the decommissioning phase of the Proposed Development was Awel y Môr OWF. There were no values provided for the footprint of temporary habitat loss and/or disturbance for this project, however they will not exceed that of the construction phase (15.91 km^2) and are likely to be lower in reality due to the absence of seabed preparation (RWE Renewables UK, 2021a). Similarly, these values are also not available for the Proposed Development (Table 7.21) but are also likely to be similar to that of the construction phase (1.91 km^2). Therefore, the cumulative temporary habitat loss and/or disturbance is estimated at 17.82 km^2, and it should be noted that this is likely to be higher than reality.

Therefore, the cumulative impact is predicted to be of local spatial extent (given the low potential disturbance footprints, short-term duration (over the decommissioning phase), intermittent, and of high reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as described above the construction phase and is not repeated here for brevity.

Significance of Effect

Marine Fish

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of most fish IEFs is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For sandeel, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For herring, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

Shellfish

For spiny lobster, European lobster and Norway lobster the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For king and queen scallop, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms

For all other shellfish IEFs, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

Diadromous Fish

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the significance of the effect on the freshwater pearl mussel IEF is also considered to be **minor adverse.**

7.13.10.2 Tier 2

Construction Phase

Magnitude of Impact

All Species

There is potential for cumulative impacts with three Tier 2 projects in the construction phase: Mona OWF, Morgan OWF Generation Assets, and Morecambe OWF Generation Assets. Predicted cumulative temporary habitat loss and/or disturbance from each of the Tier 2 plans, projects, and activities during the construction phase of the Proposed Development are presented in Table 7.90 together with a breakdown of the sources of these data. For all the Tier 2 plans, projects, and activities during the construction phase of the Proposed Development, the cumulative temporary habitat loss and/or disturbance is estimated at 223.84 km^2 (including the values for the Proposed Development provided in Table 7.21).

Table 7.90: Cumulative Temporary Habitat Loss And/Or Disturbance For The Construction Phase Of Tier 2 Plans, Projects, And Activities Identified

Project	Predicted Temporary Habitat Loss and/or Disturbance (km^2)	Cause of Temporary Habitat Loss and/or Disturbance	Source
Offshore Renewables			
Mona OWF	131.07	Jack-up events, cable installation, sand wave clearance, anchoring, and cable removal.	EnBW and BP (2023b)

Project	Predicted Temporary Habitat Loss and/or Disturbance (km^2)	Cause of Temporary Habitat Loss and/or Disturbance	Source
Morgan OWF Generation Assets	87.36	Jack-up events, cable installation, sand wave clearance, anchoring, and cable removal.	EnBW and BP (2023c)
Morecambe OWF Generations Assets	3.5	Jack-up vessel use and installation of cables, turbine and platform foundations.	Morecambe Offshore Wind Limited (2023)
Total	**221.93**		

Therefore, the cumulative impact is predicted to be of regional spatial extent (given the larger disturbance footprints than for the Tier 1 assessment), short term duration (over the two-year construction phase), intermittent, and of high reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as described above the Tier 1 assessment and is not repeated here for brevity.

Significance of Effect

Marine Fish

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of most marine fish IEFs is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For sandeel, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For herring, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

Shellfish

For spiny lobster, European lobster and Norway lobster the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For king and queen scallop, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms

For all other shellfish IEFs, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

Diadromous Fish

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the significance of the effect on the freshwater pearl mussel IEF is also considered to be **minor adverse.**

Operation and Maintenance Phase

Magnitude of Impact

All Species

There is potential for cumulative impacts with four Tier 2 projects in the operation and maintenance phase:

- Mona OWF;
- Morgan OWF Generation Assets;
- Morecambe OWF Generation Assets; and
- Morgan and Morecambe OWF Transmission Assets.

The operation and maintenance phase of the Proposed Development will overlap with both the construction and operation and maintenance phases of these four Tier 2 projects. Predicted cumulative temporary habitat loss and/or disturbance from each of the Tier 2 plans, projects, and activities during the operation and maintenance phase of the Proposed Development are presented in Table 7.91 together with a breakdown of the sources of these data. For all the Tier 2 plans, projects, and activities during the operation and maintenance phase of the Proposed Development, the cumulative temporary habitat loss and/or disturbance is estimated at 251.28 km^2 (including the values for the Proposed Development provided in Table 7.21).

At the time of writing, there was no publicly available information to quantify the footprint of temporary habitat loss and/or disturbance due to the Morgan and Morecambe OWF Transmission Assets. Therefore, these values are not included in the total calculation presented in the paragraph above. As the transmission assets only involves cables, it is likely that the disturbance footprint of temporary habitat loss and/or disturbance will be of a lower extent to that presented for Mona OWF (which includes offshore export cables).

Table 7.91: Cumulative Temporary Habitat Loss And/Or Disturbance For The Construction And Operations And Maintenance Phase Of Tier 2 Plans, Projects, And Activities Identified

Project	Predicted Temporary Habitat Loss and/or Disturbance (km^2)	Cause of Temporary Habitat Loss and/or Disturbance	Source
Offshore Renewables			
Mona OWF	Construction: 131.07	Jack-up events, cable installation, sand wave clearance, anchoring, and cable removal.	EnBW and BP (2023b)
	Operation and Maintenance: 17.60 km^2 over the entire phase.		
Morgan OWF Generation Assets	Construction: 87.36	Jack-up events, cable installation, sand wave clearance, anchoring, and cable removal.	EnBW and BP (2023c)
	Operation and Maintenance: 11.56 km^2 over the entire phase.		
Morecambe OWF Generations Assets	Construction: 3.5	Jack-up vessel use and installation of cables, turbine and platform foundations.	Morecambe Offshore Wind Limited (2023)
	Operation and Maintenance: 4,500 m^2 per year, for a 35-year life cycle. Therefore, a total of 0.16 km^2 over the entire phase.		

Project	Predicted Temporary Habitat Loss and/or Disturbance (km^2)	Cause of Temporary Habitat Loss and/or Disturbance	Source
Cables and Pipelines			
Morgan and Morecambe OWF Transmission Assets	Not available	Only the Scoping Report is currently available for this project, so no footprint of disturbance is available. However, the construction and operations and maintenance phases of this project overlap with the operations and maintenance phase of the Proposed Development. Therefore, activities such as jack-up events, anchoring, seabed preparation, cable laying, and cable maintenance will result in temporary habitat loss and/or disturbance.	-
Total	**251.25**		

Therefore, the cumulative impact is predicted to be of regional spatial extent (given the larger disturbance footprints than for the Tier 1 assessment), long-term duration (over the operations and maintenance phase), intermittent, and of high reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as described above the Tier 1 assessment and is not repeated here for brevity.

Significance of Effect

Marine Fish

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of most marine fish IEFs is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For sandeel, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For herring, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

Shellfish

For spiny lobster, European lobster and Norway lobster the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For king and queen scallop, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For all other shellfish IEFs, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

Diadromous Fish

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the significance of the effect on the freshwater pearl mussel IEF is also considered to be **minor adverse.**

Decommissioning Phase

Magnitude of Impact

All Species

There is potential for cumulative impacts with four Tier 2 projects in the decommissioning phase:

- Mona OWF;
- Morgan OWF Generation Assets;
- Morecambe OWF Generation Assets; and
- Morgan and Morecambe OWF Transmission Assets.

The decommissioning phase of the Proposed Development will overlap with the operation and maintenance phases of these four Tier 2 projects. Predicted cumulative temporary habitat loss and/or disturbance from each of the Tier 2 plans, projects, and activities during their operation and maintenance phases are presented in Table 7.91 together with a breakdown of the sources of these data. For all four Tier 2 plans, projects, and activities during the decommissioning phase of the Proposed Development, the cumulative temporary habitat loss and/or disturbance is estimated at 29.32 km^2. There are no values available for the decommissioning phase of the Proposed Development, however if it is assumed to be equal or lesser than the construction phase (1.91 km^2), the total cumulative temporary habitat loss and/or disturbance in this phase is 31.23 km^2.

At the time of writing, there was no publicly available information to quantify the footprint of temporary habitat loss and/or disturbance due to the Morgan and Morecambe OWF Transmission Assets. Therefore, these values are not included in the total calculation presented in the paragraph above. As the transmission assets only involves cables, it is likely that the disturbance footprint of temporary habitat loss and/or disturbance will be of a lower extent to that presented for Mona OWF (which includes offshore export cables).

Therefore, the cumulative impact is predicted to be of local spatial extent (given the smaller disturbance footprints than for the operation and maintenance phase), short-term duration (over the decommissioning phase), intermittent, and of high reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as described above the Tier 1 assessment and is not repeated here for brevity.

Significance of Effect

Marine Fish

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of most marine fish IEFs is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For sandeel, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For herring, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

<u>Shellfish</u>

For spiny lobster, European lobster and Norway lobster the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For king and queen scallop, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms

For all other shellfish IEFs, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

<u>Diadromous Fish</u>

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the significance of the effect on the freshwater pearl mussel IEF is also considered to be **minor adverse.**

7.13.10.3 Tier 3

Construction and Operation and Maintenance Phases

Magnitude of Impact

<u>All Species</u>

The only Tier 3 project which has been identified in the CEA with the potential to result in cumulative temporary habitat loss and/or disturbance during the construction and operation and maintenance phases of the Proposed Development was the MaresConnect interconnector cable. There is, however, currently no information on the impact that the MaresConnect interconnector cable will have on fish and shellfish receptors. A planning application is predicted to be submitted in 2024 which will identify and assess these impacts (MaresConnect, 2023).

The activities associated with the MaresConnect interconnector cable which are likely to result in temporary habitat loss and/or disturbance are similar to those expected for the installation of cables for the Proposed Development. Construction is planned to occur in 2025 and the project is anticipated to become operational in 2027 (MaresConnect, 2023), although it should be noted that these timeframes are only indicative at this stage. The construction activities are likely to involve cable installation such as jet trenching, and the installation of cable protection. Operation and maintenance activities are likely to involve the repair and reburial of cables.

The cumulative impact on

predicted to be of local spatial extent, short term duration (for the individual construction and operation and maintenance activities), intermittent, and of high reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as described above the Tier 1 assessment and is not repeated here for brevity.

Significance of Effect

Marine Fish

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of most marine fish IEFs is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For sandeel, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For herring, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

Shellfish

For spiny lobster, European lobster and Norway lobster the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For king and queen scallop, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms

For all other shellfish IEFs, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

Diadromous Fish

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the significance of the effect on the freshwater pearl mussel IEF is also considered to be **minor adverse.**

Decommissioning Phase

There were no Tier 3 plans, projects, or activities identified in the CEA with the potential to result in cumulative temporary habitat loss and/or disturbance during the decommissioning phase of the Proposed Development.

7.13.10.4 Tier 4

Construction and Operation and Maintenance Phases

Magnitude of Impact

Subtidal Habitats and Species

The only Tier 4 project which has been identified in the CEA with the potential to result in cumulative temporary habitat loss and/or disturbance during the construction and operation and maintenance phases of the Proposed Development was the removal of a meteorological mast at Gwynt y Môr OWF. There is, however, currently no information on the impact that this project will have on fish and shellfish receptors.

The activities associated with this project which are likely to result in temporary habitat loss and/or disturbance are anchoring and the use of jack-up vessels for the removal of topside lattice structures, monopiles, and scour protection. There is no timeline for these works currently publicly available, however the marine license was issued for 2022 – 2027. Therefore, while these activities may overlap with the entire construction phase of the Proposed Development, they should be completed shortly after the operation and maintenance phase of the Proposed Development begins (within 2026).

The cumulative impact is predicted to be of local spatial extent, short term duration (for the individual activities), intermittent, and of high reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as described above the Tier 1 assessment and is not repeated here for brevity.

Significance of Effect

<u>Marine Fish</u>

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of most marine fish IEFs is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For sandeel, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For herring, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

<u>Shellfish</u>

For spiny lobster, European lobster and Norway lobster the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For king and queen scallop, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms

For all other shellfish IEFs, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

<u>Diadromous Fish</u>

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the significance of the effect on the freshwater pearl mussel IEF is also considered to be **minor adverse.**

Decommissioning Phase

There were no Tier 4 plans, projects, or activities identified in the CEA with the potential to result in cumulative temporary habitat loss and/or disturbance during the decommissioning phase of the Proposed Development.

7.13.11 Increased SSCs and Associated Deposition

There is the potential for cumulative increased SSCs and associated deposition as a result of activities associated with the Proposed Development and other plans, projects, and activities. Activities include seabed preparation, dredging, aggregate extraction, and cables and pipelines laying. For the purposes of this ES, this additive impact has been assessed within the fish and shellfish ecology CEA study area, using the tiered approach outlined above in section 7.13.1.

All plans, projects, and activities screened into the assessment for cumulative effects from this impact are either on-going activities or projects with sufficient information in the public domain. The plans, projects, and activities within each tier screened into the CEA for each phase of development are illustrated in Table 7.89.

7.13.11.1 Tier 1

Construction Phase

Magnitude of Impact

All Species

There is potential for cumulative impacts with six Tier 1 projects in the construction phase:

- Burbo Bank Extension OWF cable repair and remediation;
- Awel y Môr OWF;
- Mona OWF Suction Bucket Trials;
- Mostyn Energy Park Expansion;
- Hilbre Swash; and
- Burbo Bank Extension OWF Disposal Site IS153.

The construction phase of the Proposed Development coincides with construction activities of the Awel y Môr OWF, such as seabed preparation, drilling, cable installation, and HDD. However, in the PEIR for Awel y Môr, this impact has been determined as localised within one tidal excursion, short-term, intermittent, and reversible upon fish and shellfish receptors (RWE Renewables UK, 2021a). The Awel y Môr OWF also involves the installation of an interlink cable with the Gywnt y Môr Offshore Wind Farm, with the magnitude of suspended sediments likely being of a similar magnitude to offshore export cable installation. Thus, again it can be expected a cumulative effect that may arise would do so within the natural variability of background levels, and only occur if cable installation operations occurred simultaneously. Furthermore, the construction phase of the Proposed Development is between 2024 and 2026, while that of Awel y Môr OWF is currently anticipated as 2026 to 2030 (Table 7.88). Therefore, there may be some overlap between the construction phases of both projects, however it should be noted that it any cumulative impacts will be of a lesser extent than if the two projects overlapped for a longer period of time (i.e. over multiple years).

The construction phase of the Proposed Development also coincides with cable repair and maintenance activities at the Burbo Bank Extension OWF and disposal at site IS153. However, as this only involves intermittent maintenance and disposal work, this impact has been determined as of limited spatial extent, short-term, intermittent, and reversible upon fish and shellfish receptors.

The construction phase of the Proposed Development also encompasses aggregate extraction the Hilbre Swash licensed area, located within the Proposed Development. Resultant plumes from the disposal of dredged material and extraction of aggregate would be advected on the tidal current running in parallel and not coincide with the Proposed Development.

As part of the Mona Offshore Wind Farm application, a series of suction bucket foundation trials were consented to, to validate the suitability of foundation and optimise design. These works occur within the Mona

Array Area at up to 30 locations, using a variety of parameters to best inform final design. At each location, the trial may be undertaken up to 3 times and once all activities at the site are complete the full removal of foundation would occur before moving to the next location to repeat (MarineSpace Ltd., 2023). Although the trials of foundation installation and subsequent removal may mobilise sediment within the Mona Array Area, the small scale nature associated with the installation/removal of one foundation at a time would be expected to produce a small plume with much of the sediment suspended settling in the vicinity of the structures. This, paired with the fact that the Mona Array Area is largely advected on tidal currents and situated approximately 5.60 km north west of the Proposed Development (at its closest point), indicate that if an overlap in SSC or deposition did occur between the projects, that it would do so at background levels. The Mona OWF suction bucket trials have only been assessed for this impact, as the WFD Compliance Assessment concluded that an assessment on ecological impacts was not required, given the low potential for impact.

The construction phase of the Proposed Development is expected to coincide with the construction and operation and maintenance phases of the Mostyn Energy Park Extension and associated maintenance dredging activities. This development, within the Dee Estuary, involves the construction of a 360 m length of new quay wall, the infilling of a 3.5 ha area behind the new quay wall (requiring 600,000 m^3 of infill material, 500,000 m^3 of which will be sourced from dredging activity arisings) (ABPmer, 2022). Alongside the new quay wall a dredged berth pocket will be required to a depth of -11 m CD (400,000 m^3), whilst re-dredging of the existing berth pocket along the existing quay wall to -9 m CD will be required (400,000 m^3) (ABPmer, 2022). The largest dredging operation will take the form of the re-dredging of the main navigation channel to a depth of -4 m CD (3,000,000 m^3) (ABPmer, 2022). Both seabed preparation and cable installation activities produce SSC plumes that extend into the Dee Estuary and overlap with the location of construction activities and dredging at the Port of Mostyn Energy Park Expansion, however, they do so at background levels i.e. < 3 mg/l. It can therefore be judged that although a cumulative impact may arise, the change in SSC would be of negligible significance and recoverable.

The largest overlap in SSC would occur if the disposal of dredged material within the Mostyn Deep disposal site occurred simultaneously with cable installation activities or seabed preparation across West Hoyle Bank, however even in this case, overlapping plumes in the vicinity of West Hoyle Bank and within the Dee Estuary would be of limited magnitude due to the decreases in SSC and deposition observed with distance from respective works. Noting also that sediment plumes would be traversing in parallel and not towards one another as they are advected on the same tidal current. Maximum SSC values in the area of overlap can be up to 100 mg/l for both plumes combined, however, the more representative average plumes are expected to have SSC values of negligible difference to background levels when they coincide. Likewise, sedimentation over the bank can be considered minor and the overall cumulative impact between the disposal of dredged material and the Proposed Development can be considered to be negligible, of local extent and short-term duration. The cumulative impact relating to overlap between operation and maintenance activities from the Mostyn Energy Park Extension and construction activities related to the Proposed Development are expected to be of a similar magnitude to the dredging/disposal activities described above, only of a smaller scale in line with reduced dredge volumes associated with maintenance works rather than construction works.

Proposed Developmenti.e.The cumulative impact on the benthic subtidal and intertidal IEFs is predicted to be of local spatial extent, short term duration (for the individual activities), intermittent, and of high reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as described above for the Proposed Development alone (see section 7.12.12).

Marine Fish

Overall, all marine fish IEFs, except herring, are deemed to be of low vulnerability, high recoverability and local to national importance. The sensitivity of these IEFs is therefore considered to be low.

Based on the increase in sensitivity of herring eggs to the smothering effects of increased sediment deposition, herring is deemed to be of medium vulnerability, high recoverability and of national importance. Therefore, the sensitivity of this receptor is considered to be medium.

Shellfish

Overall, all shellfish IEFs are deemed to be of low to medium vulnerability, high recoverability and local to national importance. The sensitivity of these IEFs is therefore considered to be low.

Diadromous Fish

Overall, this impact is not expected to create any significant barrier to migration to rivers or estuaries used by these diadromous species within the CEA fish and shellfish ecology study area. Diadromous fish IEFs in the regional fish and shellfish ecology study area are deemed to be of low vulnerability, high recoverability and national to international importance. The sensitivity of the receptors is therefore, considered to be low.

Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the sensitivity of the freshwater pearl mussel IEF is also considered to be low.

Significance of Effect

Marine Fish

Overall, for all marine fish IEFs except herring, the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be low. The effect will, therefore, be of **negligible adverse** significance, which is **not significant** in EIA terms.

For herring, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

Shellfish

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be low. The effect will, therefore, be of **negligible adverse** significance, which is **not significant** in EIA terms.

Diadromous Fish

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be low. The effect will, therefore, be of **negligible adverse** significance, which is **not significant** in EIA terms. Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the significance of the effect upon the freshwater pearl mussel IEF is also considered to be **negligible adverse.**

Decommissioning Phase

Magnitude of Impact

All Species

The decommissioning phase of the Proposed Development coincides with operation and maintenance and decommissioning activities of the Awel y Môr OWF, such as cable maintenance, cable removal, and foundation removal. However, in the PEIR for Awel y Môr, this impact has been determined as localised within one tidal excursion, short-term, intermittent, and reversible upon benthic subtidal and intertidal receptors (RWE Renewables UK, 2021a).

The cumulative impact on the benthic subtidal and intertidal IEFs is predicted to be of local spatial extent, short term duration (for the individual activities), intermittent, and of high reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as described above the construction phase and is not repeated here for brevity.

Significance of Effect

Marine Fish

Overall, for all marine fish IEFs except herring, the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be low. The effect will, therefore, be of **negligible adverse** significance, which is **not significant** in EIA terms.

For herring, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

Shellfish

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be low. The effect will, therefore, be of **negligible adverse** significance, which is **not significant** in EIA terms.

Diadromous Fish

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be low. The effect will, therefore, be of **negligible adverse** significance, which is **not significant** in EIA terms. Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the significance of the effect upon the freshwater pearl mussel IEF is also considered to be **negligible adverse.**

7.13.11.2 Tier 2

Construction Phase

Magnitude of Impact

All Species

There is potential for cumulative impacts with three Tier 2 projects in the construction phase: Mona OWF, Morgan OWF Generation Assets, and Morecambe OWF Generation Assets.

For the Mona OWF, modelling suggested that average SSCs during the course of the construction activities was expected to be <300 mg/l with a plume envelope width of approximately 20 km, which corresponds to the local tidal excursion (EnBW and BP, 2023b). Sediments deposited on slack tide in the north-east of the Mona Array Area are expected to be resuspended on subsequent tides. Typically, this plume concentration will be <10 mg/l, and this reduces as distance from the site increases due to natural sediment dispersal. Three days after installation of foundations, sediment concentrations are expected to reduce, with sedimentation and resuspension occurring dependent on the current speed and tidal cycle. Peak concentrations in a resuspension event at this point are likely to reach a maximum of <30mg/l, compared to average concentrations of a maximum of 3mg/l in the area normally (EnBW and BP, 2023b).

For the Morgan OFW Generation Assets, sedimentation one day after the cessation of the sand wave clearance activities was modelled to result in up to 0.5 mm of deposited material at the site of release. In the wider area (approximately 100 m from the release) deposited material reaches depths of typically 0.3 mm, still detectable above background levels of <0.01mm but are expected to decrease on subsequent tidal cycles (EnBW and BP, 2023c). This modelling also found that SSCs would increase by up to 50 mg/l in the area immediately surrounding piling, with a rapid reduction back to background levels of sedimentation as time and distance from the piling activity increased (EnBW and BP, 2023c).

For the Morecambe OWF Generation Assets, finer sediment is expected to exist as a passive plume, and extend to a maximum of 10 km. Other sediments are expected to settle quickly in proximity to their release, within a few hundred metres and up to approximately a kilometre from any construction activity (Morecambe Offshore Wind Limited, 2023).

The increased SSCs from construction activities in the three Tier 2 projects would be of limited spatial extent and intermittent in frequency and unlikely to interact with sediment plumes from the Proposed Development. As described in section 7.12.2, modelling for the Proposed Development suggested that material was retained in the sediment cell and would be subsequently assimilated into the existing sediment transport regime.

The cumulative effect is predicted to be of local spatial extent, short term duration (over the two-year construction phase), intermittent (due to the construction activities), and high reversibility. Therefore, the magnitude of impact is considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as described above the Tier 1 assessment and is not repeated here for brevity.

Significance of Effect

Marine Fish

Overall, for all marine fish IEFs except herring, the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be low. The effect will, therefore, be of **negligible adverse** significance, which is **not significant** in EIA terms.

For herring, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

Shellfish

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be low. The effect will, therefore, be of **negligible adverse** significance, which is **not significant** in EIA terms.

Diadromous Fish

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be low. The effect will, therefore, be of **negligible adverse** significance, which is **not significant** in EIA terms.

Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the significance of the effect upon the freshwater pearl mussel IEF is also considered to be **negligible adverse.**

Decommissioning Phase

Magnitude of Impact

All Species

There is potential for cumulative impacts with four Tier 2 projects in the decommissioning phase:

- Mona OWF;
- Morgan OWF Generation Assets;
- Morecambe OWF Generation Assets; and
- Morgan and Morecambe OWF Transmission Assets.

The operation and maintenance phases of the first three projects will occur during the decommissioning phase of the Proposed Development. For the Morgan and Morecambe OWF Transmission Assets, both the construction and operation and maintenance phases will overlap with the decommissioning phase of the Proposed Development. During their operations and maintenance phases, cable repair and reburial has the potential to result in increased SSCs. These activities would be of limited spatial extent, intermittent in frequency, and unlikely to interact with sediment plumes from the Proposed Development. As described in section 7.12.2, increased SSCs in the decommissioning phase of the Proposed Development are expected to be similar or lower to those of the construction phase, which was assessed as having a low magnitude of impact.

At the time of writing, there was no publicly available information to quantify the increased SSCs and associated deposition due to the Morgan and Morecambe OWF Transmission Assets. As the transmission assets only involves cables, it is likely sedimentation will be of a lower extent to that of Mona OWF (which includes offshore export cables).

Overall, the cumulative effect is predicted to be of local spatial extent, short term duration (over the two-year decommissioning phase), intermittent (due to the individual activities), and high reversibility. Therefore, the magnitude of impact is considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as described above the Tier 1 assessment and is not repeated here for brevity.

Significance of Effect

Marine Fish

Overall, for all marine fish IEFs except herring, the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be low. The effect will, therefore, be of **negligible adverse** significance, which is **not significant** in EIA terms.

For herring, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

Shellfish

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be low. The effect will, therefore, be of **negligible adverse** significance, which is **not significant** in EIA terms.

Diadromous Fish

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be low. The effect will, therefore, be of **negligible adverse** significance, which is **not significant** in EIA terms.

Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the significance of the effect upon the freshwater pearl mussel IEF is also considered to be **negligible adverse.**

7.13.11.3 Tier 3

Construction and Operation and Maintenance Phases

Magnitude of Impact

All Species

The only Tier 3 project which has been identified in the CEA with the potential to result in increased SSCs and associate deposition during the construction and operation and maintenance phases of the Proposed Development was the MaresConnect interconnector cable. There is, however, currently no information on the impact that the MaresConnect interconnector cable will have on fish and shellfish receptors. A planning application is predicted to be submitted in 2024 which will identify and assess these impacts (MaresConnect, 2023).

The activities associated with the MaresConnect interconnector cable which are likely to result in increased SSCs and associated deposition are similar to those expected for the installation of cables for the Proposed Development. Construction is planned to occur in 2025 and the project is anticipated to become operational in 2027 (MaresConnect, 2023), although it should be noted that these timeframes are only indicative at this stage. The construction activities are likely to involve cable installation such as jet trenching, and the installation of cable protection. Operation and maintenance activities are likely to involve the repair and reburial of cables.

The cumulative impact is predicted to be of local spatial extent, short term duration (for the individual construction and operation and maintenance activities), intermittent, and of high reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as described above the Tier 1 assessment and is not repeated here for brevity.

Significance of Effect

<u>Marine Fish</u>

Overall, for all marine fish IEFs except herring, the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be low. The effect will, therefore, be of **negligible adverse** significance, which is **not significant** in EIA terms.

For herring, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

<u>Shellfish</u>

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be low. The effect will, therefore, be of **negligible adverse** significance, which is **not significant** in EIA terms.

<u>Diadromous Fish</u>

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be low. The effect will, therefore, be of **negligible adverse** significance, which is **not significant** in EIA terms.

Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the significance of the effect upon the freshwater pearl mussel IEF is also considered to be **negligible adverse.**

Decommissioning Phase

There were no Tier 3 plans, projects, or activities identified in the CEA with the potential to result in cumulative increased SSCs and associated deposition during the decommissioning phases of the Proposed Development.

7.13.11.4 Tier 4

Construction and Operation and Maintenance Phases

Magnitude of Impact

<u>All Species</u>

The only Tier 4 project which has been identified in the CEA with the potential to result in cumulative increased SSCs and associated deposition during the construction and operation and maintenance phases of the

Proposed Development was the removal of a meteorological mast at Gwynt y Môr OWF. There is, however, currently no information on the impact that this project will have on fish and shellfish receptors.

The activities associated with this project which are likely to result in increased SSCs and associated deposition are anchoring and the use of jack-up vessels for the removal of topside lattice structures, monopiles, and scour protection. There is no timeline for these works currently publicly available, however the marine license was issued for 2022 – 2027. Therefore, while these activities may overlap with the entire construction phase of the Proposed Development, they should be completed shortly after the operation and maintenance phase of the Proposed Development begins (within 2026).

The cumulative impact is predicted to be of local spatial extent, short term duration (for the individual activities), intermittent, and of high reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as described above the Tier 1 assessment and is not repeated here for brevity.

Significance of Effect

Marine Fish

Overall, for all marine fish IEFs except herring, the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be low. The effect will, therefore, be of **negligible adverse** significance, which is **not significant** in EIA terms.

For herring, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

Shellfish

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be low. The effect will, therefore, be of **negligible adverse** significance, which is **not significant** in EIA terms.

Diadromous Fish

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be low. The effect will, therefore, be of **negligible adverse** significance, which is **not significant** in EIA terms.

Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the significance of the effect upon the freshwater pearl mussel IEF is also considered to be **negligible adverse.**

Decommissioning Phase

There were no Tier 4 plans, projects, or activities identified in the CEA with the potential to result in cumulative increased SSCs and associated deposition during the decommissioning phases of the Proposed Development.

7.13.12 Long-Term Subtidal Habitat Loss

Long-term subtidal habitat loss may result from the physical presence of foundations, cable crossing protection, and rock placement. For the purposes of this ES, this additive impact has been assessed within the fish and shellfish ecology CEA study area, using the tiered approach outlined above in section 7.13.1.

All plans, projects, and activities screened into the CEA for this impact are either on-going activities or projects with sufficient information in the public domain. The plans, projects, and activities within each tier screened into the CEA for each phase of development are illustrated in Table 7.89.

7.13.12.1 Tier 1

Construction and Operation and Maintenance Phases

Magnitude of Impact

All Species

There is the potential for cumulative impacts with two Tier 1 projects in the construction and operation and maintenance phases: Awel y Môr OWF and the Mostyn Energy Park Expansion. The MDS for Awel y Môr OWF assumes up to 1.61 km^2 of long-term subtidal habitat loss due to the footprint of turbines, foundations, meteorological mast, and cable protection (RWE Renewables UK, 2021a). The MDS for this impact for the Mostyn Energy Park Expansion accounts for loss of up to 34,900 m^2 of habitat (ABPmer, 2022). Therefore, there is potential for a total of up to 1.71 km^2 of long-term subtidal habitat loss (including the values assumed in the MDS for the Proposed Development; Table 7.21).

Overall, the cumulative effect is predicted to be of local spatial extent (given the low footprint of disturbance), long term duration, continuous, and low reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude is considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as described above for the Proposed Development alone (see section 7.12.10).

Marine Fish

Overall, sandeel are deemed to be of high vulnerability, high recoverability, and of regional importance. The sensitivity of sandeel is therefore considered to be medium.

Herring are deemed to be of high vulnerability, medium recoverability, and of national importance. The sensitivity of herring is therefore considered to be medium.

Overall, most marine fish IEFs in the regional fish and shellfish ecology study area (with the exception of herring and sandeel) are deemed to be of low vulnerability, high recoverability and local to national importance. The sensitivity of the receptor is therefore considered to be low.

Shellfish

Spiny lobster are deemed to be of high vulnerability, low recoverability, and of regional importance. The sensitivity of spiny lobster is therefore considered to be high.

Norway lobster and European lobster are deemed to be of high vulnerability, medium to high recoverability and of local importance. The sensitivity of these fish and shellfish IEFs is therefore considered to be medium.

King and queen scallop are deemed to be of medium vulnerability, high recoverability, and of local importance. The sensitivity of the receptor is therefore considered to be low.

All other shellfish IEFs are deemed to be of medium vulnerability, high recoverability, and of local importance. The sensitivity of the receptor is therefore considered to be low.

Diadromous Fish

Overall, diadromous fish species are deemed to be of low vulnerability, high recoverability and national to international importance. The sensitivity of the receptor is therefore considered to be low.

Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the sensitivity of the freshwater pearl mussel IEF is also considered to be low.

Significance of Effect

Marine Fish

Overall, the magnitude of impact is deemed to be low, and the sensitivity of most marine fish IEFs (with the exception of herring and sandeel) is considered to be low. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

For herring and sandeel, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Shellfish

For spiny lobster, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be high. As per Table 7.31, this yields a 'minor or moderate' significance. The effect will be of **minor adverse** significance (which is **not significant** in EIA terms) due to the small proportion of the CEA fish and shellfish ecology study area that may be impacted by long-term subtidal habitat loss.

For Norway lobster and European lobster, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

For king and queen scallop, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

For all other shellfish IEFs, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Diadromous Fish

Overall, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the significance of the effect on the freshwater pearl mussel IEF is also considered to be **minor adverse.**

Decommissioning Phase

Magnitude of Impact

All Species

There is the potential for cumulative impacts with one Tier 1 project in the decommissioning phase: Awel y Môr OWF. The MDS for Awel y Môr OWF assumes up to 1.61 km^2 of long-term subtidal habitat loss due to the removal of infrastructure installed in the construction phase (RWE Renewables UK, 2021a). Therefore, there is potential for a total of up to 1.67 km^2 of long-term subtidal habitat loss (including the footprint of infrastructure that will be removed from the Proposed Development; Table 7.21).

Overall, the cumulative effect is predicted to be of local spatial extent (given the low footprint of disturbance), long term duration, continuous, and low reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude is considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as described above for the construction and operation and maintenance phases and is not repeated here for brevity.

Significance of Effect

Marine Fish

Overall, the magnitude of impact is deemed to be low, and the sensitivity of most marine fish IEFs (with the exception of herring and sandeel) is considered to be low. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

For herring and sandeel, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Shellfish

For spiny lobster, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be high. As per Table 7.31, this yields a 'minor or moderate' significance. The effect will be of **minor adverse** significance (which is **not significant** in EIA terms) due to the small proportion of the CEA fish and shellfish ecology study area that may be impacted by long-term subtidal habitat loss.

For Norway lobster and European lobster, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

For king and queen scallop, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

For all other shellfish IEFs, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Diadromous Fish

Overall, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the significance of the effect on the freshwater pearl mussel IEF is also considered to be **minor adverse.**

7.13.12.2 Tier 2

Construction and Operation and Maintenance Phases

Magnitude of Impact

All Species

The construction and operations and maintenance phases of the Proposed Development may interact cumulatively with those of three Tier 2 projects: Mona OWF, Morgan OWF Generation Assets, and Morecambe Generation Assets. They also coincide with the operations and maintenance phase of the Morgan and Morecambe OWF Transmission Assets. Predicted cumulative long-term subtidal habitat loss from all the Tier 2 plans, projects, and activities during the construction and operation and maintenance phases of the Proposed Development are presented in Table 7.92, together with a breakdown of the sources of this data and any assumptions made where necessary information was not presented.

For both the Tier 2 plans, projects, and activities during the construction and operations and maintenance phases of the Proposed Development, the cumulative long-term subtidal habitat loss is estimated at 4.38 km^2 (including the values for the Proposed Development provided in Table 7.21). There was no publicly available figure of predicted long-term subtidal habitat loss available for the Morgan and Morecambe OWF Transmission Assets, however given the nature of this project, these are likely to be similar or lower than those presented for the Mona OWF in Table 7.92.

Table 7.92: Cumulative Long-Term Subtidal Habitat Loss For The Construction And Operation And Maintenance Phases Of Tier 2 Plans, Projects, And Activities Identified

Project	Predicted Long-Term Subtidal Habitat Loss (km^2)	Cause of Long-Term Subtidal Habitat Loss	Source
Offshore Renewables			
Mona OWF	2.36	Presence of foundations and protection for cables, cable crossing, and scour.	EnBW and BP (2023b)
Morgan OWF Generation Assets	1.52		
Morecambe OWF Generation Assets	0.45		
Cables and Pipelines			
Morgan and Morecambe OWF Transmission Assets	Not available	Only the Scoping Report is currently available for this project, so no footprint of disturbance is available. However, installation of foundations and protection for cables, cable crossing, and scour will result in long-term subtidal habitat loss.	-
Total	**4.33**		

Overall, the cumulative effect is predicted to be of local spatial extent (given the low footprint of disturbance), long term duration, continuous, and low reversibility. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude is considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as described above the Tier 1 assessment and is not repeated here for brevity.

Significance of Effect

Marine Fish

Overall, the magnitude of impact is deemed to be low, and the sensitivity of most marine fish IEFs (with the exception of herring and sandeel) is considered to be low. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

For herring and sandeel, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Shellfish

For spiny lobster, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be high. As per Table 7.31, this yields a 'minor or moderate' significance. The effect will be of **minor adverse** significance (which is **not significant** in EIA terms) due to the small proportion of the CEA fish and shellfish ecology study area that may be impacted by long-term subtidal habitat loss.

For Norway lobster and European lobster, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

For king and queen scallop, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

For all other shellfish IEFs, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Diadromous Fish

Overall, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the significance of the effect on the freshwater pearl mussel IEF is also considered to be **minor adverse.**

Decommissioning Phase

Magnitude of Impact

All Species

The decommissioning phase of the Proposed Development may interact cumulatively with the operations and maintenance phases of four Tier 2 projects:

- Mona OWF;
- Morgan OWF Generation Assets;
- Morecambe OWF Generation Assets; and
- Morgan and Morecambe OWF Transmission Assets.

Predicted cumulative long-term subtidal habitat loss from each of the Tier 2 plans, projects, and activities during their operation and maintenance phases are presented in Table 7.92, together with a breakdown of the sources of this data and any assumptions made where necessary information was not presented. This is estimated as 4.33 km^2. This impact is likely to be of a lower extent than in the construction and operation and maintenance phase, as the MDS for the Proposed Development assumes that all infrastructure will be removed (with only some rock placement remaining *in situ*).

There was no publicly available figure of predicted long-term subtidal habitat loss available for the Morgan and Morecambe OWF Transmission Assets, however given the nature of this project, these are likely to be similar or lower than that presented for Mona OWF in Table 7.92.

Overall, the cumulative effect is predicted to be of local spatial extent (given the low footprints for disturbance), long term duration, continuous, and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as described above the Tier 1 assessment and is not repeated here for brevity.

Significance of Effect

Marine Fish

Overall, the magnitude of impact is deemed to be low, and the sensitivity of most marine fish IEFs (with the exception of herring and sandeel) is considered to be low. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

For herring and sandeel, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Shellfish

For spiny lobster, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be high. As per Table 7.31, this yields a 'minor or moderate' significance. The effect will be of **minor adverse** significance (which is **not significant** in EIA terms) due to the small proportion of the CEA fish and shellfish ecology study area that may be impacted by long-term subtidal habitat loss.

For Norway lobster and European lobster, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

For king and queen scallop, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

For all other shellfish IEFs, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Diadromous Fish

Overall, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the significance of the effect on the freshwater pearl mussel IEF is also considered to be **minor adverse.**

7.13.12.3 Tier 3

Construction and Operation and Maintenance Phases

Magnitude of Impact

All Species

There was one Tier 3 project identified in the CEA with the potential to result in cumulative long-term subtidal habitat loss during the construction and operation and maintenance phases of the Proposed Development: The MaresConnect interconnector cable. However, there is currently no information on the impact that this project will have on fish and shellfish ecology. A planning application is predicted to be submitted in 2024 which will identify these impacts (MaresConnect, 2023).

Cable protection associated with the MaresConnect interconnector cable is likely to result in long-term subtidal habitat loss, similar to those expected for the cables of the Tier 1 and 2 projects. Construction is likely to occur in 2025 and the protection is anticipated to become operational in 2027 (MaresConnect 2023), although it should be noted that these timeframes are only indicative at this stage.

The cumulative effect is predicted to be of regional spatial extent (as the cable runs between Wales and Ireland), long-term duration, continuous and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as described above the Tier 1 assessment and is not repeated here for brevity.

Significance of Effect

Marine Fish

Overall, the magnitude of impact is deemed to be low, and the sensitivity of most marine fish IEFs (with the exception of herring and sandeel) is considered to be low. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

For herring and sandeel, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Shellfish

For spiny lobster, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be high. As per Table 7.31, this yields a 'minor or moderate' significance. The effect will be of **minor adverse** significance (which is **not significant** in EIA terms) due to the small proportion of the CEA fish and shellfish ecology study area that may be impacted by long-term subtidal habitat loss.

For Norway lobster and European lobster, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

For king and queen scallop, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

For all other shellfish IEFs, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Diadromous Fish

Overall, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the significance of the effect on the freshwater pearl mussel IEF is also considered to be **minor adverse.**

Decommissioning Phase

There were no Tier 3 plans, projects, or activities identified in the CEA with the potential to result in cumulative long-term subtidal habitat loss during the decommissioning phases of the Proposed Development.

7.13.12.4 Tier 4

There were no Tier 4 plans, projects, or activities identified in the CEA with the potential to result in cumulative long-term subtidal habitat loss during the construction, operations and maintenance, and decommissioning phases of the Proposed Development.

7.13.13 Underwater Noise Impacting Fish and Shellfish Receptors

Underwater noise may be generated in the construction phase of the Proposed Development during piling, UXO clearance, site investigation surveys, and various construction activities, such as cable laying. For the purposes of this ES, this additive impact has been assessed within the fish and shellfish ecology CEA study area for underwater noise, using the tiered approach outlined above in section 7.13.1. Due to the higher levels of sound associated with percussive and explosive underwater noise, this section will focus upon the impacts of piling and UXO clearance which have the greatest potential for cumulative effects.

All plans, projects, and activities screened into the CEA for this impact are either on-going activities or projects with sufficient information in the public domain. The plans, projects, and activities within each tier screened into the CEA for each phase of development are illustrated in Table 7.89.

7.13.13.1 Tier 1

Construction Phases

Magnitude of Impact

<u>All Species</u>

There is the potential for cumulative impacts with one Tier 1 project in the construction phase of the Proposed Development: Awel y Môr OWF. The construction phase of the Proposed Development is between 2024 and 2026, while that of Awel y Môr OWF is currently anticipated as 2026 to 2030 (Table 7.88). Therefore, there may be some overlap between the construction phases of both projects, however it should be noted that it any cumulative impacts will be of a lesser extent than if the two projects overlapped for a longer period of time (i.e. over multiple years). The MDS for Awel y Môr OWF assumes the instillation of monopiles for the foundations of 91 turbines and two platforms, with a maximum hammer energy of 5,000 kJ (RWE Renewables UK, 2021d). Furthermore, this MDS also encompasses HDD cofferdam piling with a maximum hammer energy of 300 kJ, clearance of up to 10 UXOs (RWE Renewables UK, 2021d).

Underwater noise modelling undertaken for the Awel y Môr OWF indicated injury and mortality to ranges of up to 1,300 m for Group 1 fish, 6,300 m for Group 2 fish, and 8,600 m for Group 3 fish, if modelled as static receptors (RWE, 2021d). In all cases, modelling the fish as fleeing receptors highly significantly reduced mortality distances, down to <100 m even for Group 3 fish. Injury distances were calculated to reach out to up to 12,000 m for Group 3 static receptors, with this again reducing to up to 120 m when fish were modelled as fleeing receptors, with similar patterns for all other groups of fish (RWE Renewables UK, 2021d). In general, all these values exceeded those modelled for the Proposed Development (see section 7.12.11).

As with the Proposed Development, embedded mitigation including soft starts will reduce the risk of injury and mortality to many fish and shellfish. With respect to behavioural effects, the Awel y Môr OWF indicated behavioural effects in the tens of kilometres, similar to those modelled for the Proposed Development (33 km; see section 7.12.11).

Overall, the cumulative impact is predicted to be of regional spatial extent, short-term duration, intermittent throughout the two-year construction phase, and high reversibility (due to TTS and recoverable injury). It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as described above for the Proposed Development alone (see section 7.12.11).

Marine Fish

Overall, most marine fish IEFs, including elasmobranchs, are deemed to be of low vulnerability, high recoverability, and local to international importance. The sensitivity of these receptors is therefore, considered to be low.

Sprat (Group 4) are deemed to be of medium vulnerability, high recoverability, and regional to national importance. The sensitivity of these receptors is therefore, considered to be medium.

Cod (Group 3) and herring (Group 4) are deemed to be of high vulnerability, high recoverability, and national importance. The sensitivity of the receptor is therefore, considered to be high.

Shellfish

Overall, all shellfish IEFs identified in this assessment are deemed to be of low vulnerability, high recoverability and local to national importance. The sensitivity of these receptors is therefore, considered to be low.

Diadromous Fish

Overall, most diadromous fish species IEFs are deemed to be of low vulnerability, high recoverability and national to international importance. The sensitivity of these receptors is therefore, considered to be low.

As Group 4 species, Allis shad and twaite shad are deemed to be of high vulnerability, high recoverability, and national importance. The sensitivity of these receptors is therefore considered to be high.

Significance of Effect

Marine Fish

Overall, for most marine fish IEFs (including elasmobranchs), the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For Group 4 sprat, the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be medium. The effect will, therefore be **minor adverse**, which is **not significant** in EIA terms.

For cod and herring the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be high The effect will, therefore be either minor adverse or moderate adverse according to the matrix provided in Table 7.31. Based upon the short duration of the project construction phase overlaps, particularly with respect to pile driving (approximately 13 hours of piling for the Proposed Development) and UXO clearance (a duration of days), the significance of the effect is considered **minor adverse**, which is **not significant** in EIA terms.

Shellfish

Overall, for all shellfish IEFs, the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

Diadromous Fish

Overall, for most diadromous IEFs, the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For Group 4 diadromous IEFs (Allis and twaite shad), the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be high. The effect will, therefore, be either minor adverse or moderate adverse according to the matrix provided in Table 7.31. Based upon the short duration of the project construction phase overlaps, particularly with respect to pile driving (approximately 13 hours of piling for the

Proposed Development) and UXO clearance (a duration of days), the significance of the effect is considered **minor adverse**, which is **not significant** in EIA terms.

7.13.13.2 Tier 2

Construction Phases

Magnitude of Impact

All Species

There is potential for cumulative impacts with three Tier 2 projects in the construction phase: Mona OWF, Morgan OWF Generation Assets, and Morecambe OWF Generation Assets. The construction phase of the Proposed Development is between 2024 and 2026, while that of these three Tier 2 projects is currently anticipated as 2026 to 2028 (Table 7.88). Therefore, there may be some overlap between the construction phases of the Tier 2 projects, however it should be noted that it any cumulative impacts will be of a lesser extent than if the three projects overlapped for a longer period of time (i.e. over multiple years). Although the Mooir Vannin OWF is located within the 100 km screening buffer used to identify other plans and projects with potential cumulative impact with regards to underwater noise (63 km away), its construction phase is anticipated to be between 2030 – 2032 (Table 7.88). Therefore, it will not overlap with that of the Proposed Development (2024 - 2026) and is therefore not considered further in this Tier 2 assessment.

The MDS for the Mona OWF includes monopile and pin pile installation with a maximum hammer energy of 5,500 kJ and 2,800 kJ, respectively (EnBW and BP, 2023d). Underwater noise modelling indicated mortality ranges of up to 670 m for Groups 2 to 4 fish during maximum hammer energy, with 420 m modelled for Group 1 fish. If modelled as static receptors, mortality ranges were modelled as 780 m for Group 1 fish, 2,090 m for Group 2 and eggs and larvae, and 2,880 m for Group 3 and 4 fish (EnBW and BP, 2023d). If modelled as fleeing receptors, these values decreased to 11 m for Group 3 and 4 fish, with the threshold not exceeded for Groups 1 and 2. As static receptors, injury ranges were calculated to reach out to 1,085 m for Group 1, 4,440 for Group 2, and 4,400 for Groups 3 and 4. Again, these were reduced to 67 m for Groups 2 to 4 when modelled as fleeing receptors, with the threshold not exceeded for Group 1 (EnBW and BP, 2023d). In general, all these values exceeded those modelled for the Proposed Development (see section 7.12.11).

The MDS for the Morgan OWF Generation Assets includes monopile and pin pile installation with a maximum hammer energy of 5,500 kJ and 3,700 kJ, respectively, and clearance of up to 13 UXOs (EnBW and BP, 2023c). For the Morgan OWF Generation Assets, underwater noise modelling indicated mortality ranges of up to 745 m for Group 1 fish, 2,120 m for Group 2 fish, and 2,980 m for Group 3 and 4 fish, if modelled as static receptors (EnBW and BP, 2023c). In all cases, modelling the fish as fleeing receptors highly reduced mortality ranges, down to <100 m. As static receptors, injury distances were calculated to reach out to up to 4,760 m for Groups 2 to 4, with this again reducing to <100 m in all cases when fish were modelled as fleeing receptors, with similar patterns for all other groups of fish. In general, all these values exceeded those modelled for the Proposed Development (see section 7.12.11).

The MDS for the Morecambe OWF Generation Assets includes monopile and pin pile installation with a with a maximum hammer energy of 5,000 kJ and 2,500 kJ, respectively (Morecambe Offshore Wind Limited, 2023). For the Morecambe OWF Generation Assets, underwater noise modelling indicated mortality ranges of up to 1,600 m for Group 1 fish, 5,000 m for Group 2 fish, and 3,3000 m for Group 3 and 4 fish, if modelled as static receptors (Morecambe Offshore Wind Limited, 2023). In all cases, modelling the fish as fleeing receptors highly reduced mortality ranges, down to100 m for Group 1 fish and to 250 m for Groups 2 to 4. All these values exceeded those modelled for the Proposed Development (see section 7.12.11).

The cumulative effect is predicted to be of regional spatial extent, short-term duration (over the two-year construction phase), intermittent (in terms of noise producing activities), and high reversibility (due to TTS and recoverable injury). It is predicted that the impact will affect the receptor directly. The magnitude is, therefore, considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as described above for the Tier 1 assessment and is not repeated here for brevity.

Significance of Effect

Marine Fish

Overall, for most marine IEFS (including elasmobranchs), the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For Group 4 sprat, the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be medium. The effect will, therefore be **minor adverse**, which is **not significant** in EIA terms.

For cod and herring, the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be high. The effect will, therefore be either minor adverse or moderate adverse according to the matrix provided in Table 7.31. Based upon the short duration of the project construction phase overlaps, particularly with respect to pile driving (approximately 13 hours of piling for the Proposed Development) and UXO clearance (a duration of days), the significance of the effect is considered **minor adverse**, which is **not significant** in EIA terms.

Shellfish

Overall, for all shellfish IEFs, the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

Diadromous Fish

Overall, for most diadromous IEFs, the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be low. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

For Group 4 diadromous IEFs (Allis and twaite shad), the magnitude of the impact is deemed to be low, and the sensitivity of the receptors is considered to be high. The effect will, therefore be either minor adverse or moderate adverse according to the matrix provided in Table 7.31. Based upon the short duration of the project construction phase overlaps, particularly with respect to pile driving (approximately 13 hours of piling for the Proposed Development) and UXO clearance (a duration of days), the significance of the effect is considered **minor adverse**, which is **not significant** in EIA terms.

7.13.13.3 Tier 3 and 4

There were no Tier 3 or 4 plans, projects, or activities identified in the CEA with the potential to result in increased underwater noise during the construction phase of the Proposed Development.

7.13.14 Conclusion

Overall, there were no significant cumulative effects identified for any tiers in the CEA for fish and shellfish ecology.

7.13.15 Marine Mammals and Marine Turtles

The CEA study area for this topic was defined as the regional marine mammal and marine turtle study area (Figure 7.14). All plans, projects, and activities identified within this area were assessed and sorted into tiers using the methodology described in section 7.13.1 above.

The specific plans, projects, and activities scoped into the CEA for marine mammals and marine turtles are outlined in Table 7.93 and in Figure 7.14.

Effects on marine mammals and marine turtles due to changes in prey availability has been assessed for the Proposed Development alone (section 7.12.19). However, this impact has not been presented here in the CEA to avoid repetition of the CEA presented above for fish and shellfish (i.e. prey species). As there were no significant cumulative effects presented for fish and shellfish (section 7.13.14), it can be concluded that there will be no cumulative effect on marine mammals and marine turtles due to changes in prey availability.

7.13.15.1 Maximum Design Scenario

The MDS presented in Table 7.94 has been selected as those with the potential to result in the greatest effect on marine mammal and marine turtle receptors. The potential cumulative effects presented and assessed in this section were based on the PDE provided in volume 1, chapter 3, as well as the information available on other plans, projects, and activities. Effects of adverse significance are not expected to arise should another a different development scenario to that assessed here be taken forward to the final design scheme.

Table 7.93: List Of Other Plans, Projects, And Activities Considered Within The CEA For Marine Mammals And Marine Turtle

Project/Plan/Activity	Status	Distance from Proposed Development (km)	Description	Construction Period (if applicable)	Operation Period (if applicable)	Overlap with the Proposed Development
Tier 1						
Offshore Renewables						
Awel y Môr OWF	Application submitted	1.10	Proposed renewable energy project, 10.50 km off the coast of North Wales, of up to 1.1 GW.	2026 – 2030	2030 – 2055	This project will overlap with all three phases of the Proposed Development.
Project Erebus	Application submitted	252.25	Floating energy demonstration projects.	2025	2026 - 2051	This project overlaps with the construction and operations and maintenance phases of the Proposed Development.
Construction						
Mostyn Energy Park Extension (MEPE) Project	Application submitted	4.00	Extension of quay wall at the Port of Mostyn.	Q2 2023 – Q1 2025	2025 - unknown	This project overlaps with the construction and operations and maintenance phases of the Proposed Development.
Construction and deposit						
Mona OWF Suction Bucket foundation trials	Application submitted	8.80	Trialling of suction bucket foundations to validate their viability within the Mona OWF array area.	July 2023 – July 2024	July 2023 – July 2024	This project overlaps with the construction and operations and maintenance phases of the Proposed Development.
Tier 2						

Project/Plan/Activity	Status	Distance from Proposed Development (km)	Description	Construction Period (if applicable)	Operation Period (if applicable)	Overlap with the Proposed Development
Offshore Renewables						
Mona OWF	Pre-application	5.53	Proposed renewable energy project, 28.20 km off the coast of North Wales, of up to 350 MW.	2026 - 2028	2029 - 2089	This project will overlap with all three phases of the Proposed Development.
Morgan OWF Generation Assets	Pre-application	7.53	The generation assets for the Morgan OWF, which has a capacity of 1.5 GW.	2026 - 2028	2029 - 2089	This project will overlap with all three phases of the Proposed Development.
Morecambe OWF Generation Assets	Pre-application	30.00	The generation assets for the Morgan OWF, which has a capacity of 480 MW.	2026 - 2028	2029 - 2089	This project will overlap with all three phases of the Proposed Development.
Mooir Vannin OWF	Planning	63.00	OWF located approximately 11 km east of the Manx coast, with up to 100 turbines and a capacity of 80-100 MW.	2030 – 2032	2032 - 2067	This project will overlap with all three phases of the Proposed Development.
North Irish Sea Array (NISA) OWF	Pre-application	143.68	OWF located approximately 12.5 km off the coast of Dublin, with between 34 turbines and 46 turbines.	2024 – 2026	2027 - 2059	This project will overlap with all three phases of the Proposed Development.

Project/Plan/Activity	Status	Distance from Proposed Development (km)	Description	Construction Period (if applicable)	Operation Period (if applicable)	Overlap with the Proposed Development
Codling Offshore Wind Park	Pre-application	145.46	OWF in the Irish Sea with a maximum capacity of 1.45 GW.	2025 – 2027	2028 - 2063	This project will overlap with all three phases of the Proposed Development.
Dublin Array OWF	Pre-application	151.88	OWF located approximately 10 km off the coast of Dublin and Wicklow counties, with a maximum capacity of 900 MW.	2025 – 2026	2027 - 2062	This project will overlap with all three phases of the Proposed Development.
Oriel OWF	Pre-application	161.42	OWF in the Irish Sea with a maximum capacity of 375 MW.	2025 – 2026	2026 – unknown	This project will overlap with the construction and operations and maintenance phase of the Proposed Development. It may also overlap with the decommissioning phase, but the lifespan of this project is currently not available.
Arklow Bank Wind Park Phase 2	Pre-application	164.25	OWF located approximately 15 km off the coast of Arklow, with a maximum capacity of 800 MW.	Unknown	2028 – unknown	This project will overlap with the operations and maintenance phase of the Proposed Development. It may also overlap with the construction and decommissioning phases, but these

Project/Plan/Activity	Status	Distance from Proposed Development (km)	Description	Construction Period (if applicable)	Operation Period (if applicable)	Overlap with the Proposed Development
						dates are not currently available.
Llŷr 2 Floating OWF	Pre-application	252.38	Floating offshore wind demonstration project of up to 100 MW.	2024 – 2025	2026 – 2051	This project will overlap with all three phases of the Proposed Development.
Llŷr 1 Floating OWF	Pre-application	258.08	Floating offshore wind demonstration project of up to 100 MW.	2024 – 2025	2026 – 2051	This project will overlap with all three phases of the Proposed Development.
White Cross OWF	Pre-application	276.39	Floating OWF with a capacity of up to 100MW	2025 – 2026	2026 – unknown	This project will overlap with the construction and operations and maintenance phase of the Proposed Development. It may also overlap with the decommissioning phase, but the lifespan of this project is currently not available.
Construction and Deposit						
Bombora WavePower mWave Pembrokeshire Project	Consented (EIA not publicly available)	218.42	Wave energy demonstration site off the coast of south Pembrokeshire with a capacity of 1.5 MW	2024 (installation)	2024-2025	This project will operate for 6-12 months, after which it will be removed from the seabed. This will overlap with the construction phase of the Proposed Development.
Cables and Pipelines						

Project/Plan/Activity	Status	Distance from Proposed Development (km)	Description	Construction Period (if applicable)	Operation Period (if applicable)	Overlap with the Proposed Development
Morgan and Morecambe OWF Transmission Assets	Pre-application	3.00	The transmission assets for the Morgan and Morecambe OWF	2028 - 2029	2030 - 2065	This project will overlap with the operations and maintenance and decommissioning phases of the Proposed Development.
Tier 3						
Cables and Pipelines						
MaresConnect – Wales – Ireland Interconnector Cable	Planning application not yet submitted	10.00	A proposed 750 MW subsea and underground electricity interconnector system, linking the electricity grids in the UK and Ireland.	2025	2027 - 2037	This project will overlap with the construction and operations and maintenance phases of the Proposed Development.

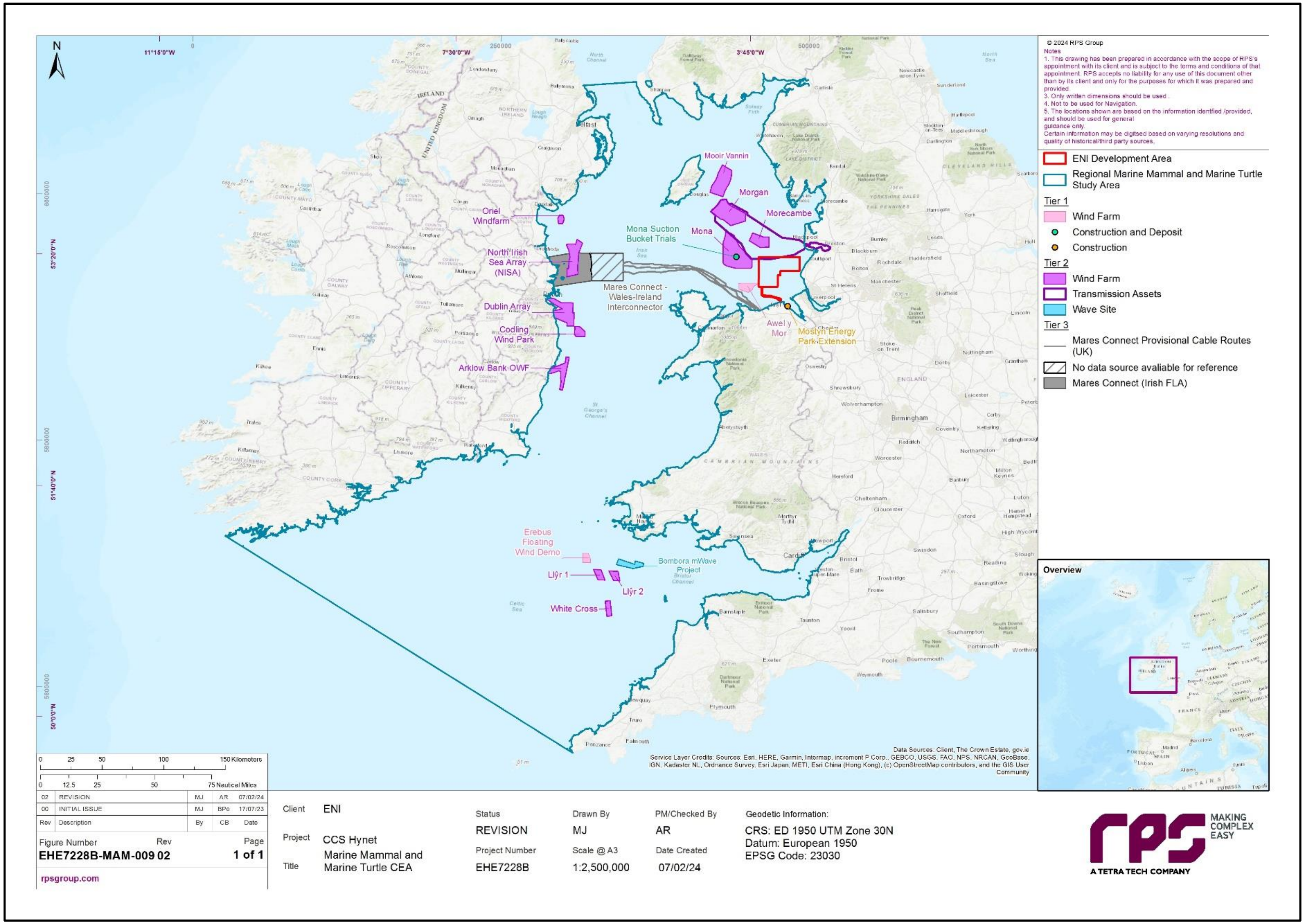

Figure 7.14: Plans, Projects, And Activities Screened Into The CEA For Marine Mammals and Marine Turtles

Table 7.94: MDS Considered For The Assessment Of Potential Cumulative Effects On Marine Mammals And Marine Turtles

Potential Cumulative Effect	Phase	MDS	Justification
Injury, Disturbance, and Displacement from Underwater Noise Generated during Piling	C	The MDS is as described for the Proposed Development (Table 7.23) and assessed cumulatively with the following plans, projects, and activities: **Tier 1:** Offshore Renewables: • Awel y Môr OWF; and • Project Erebus. Construction Projects: • Mostyn Energy Park Extension. **Tier 2:** Offshore Renewables: • Mona OWF; • Morgan OWF Generation Assets; • Morecambe OWF Generation Assets; • Arklow Bank Wind Park Phase 2; • Dublin Array OWF; • NISA OWF; • Oriel OWF; • Codling Offshore Wind Park; • Llŷr 1 Floating OWF; • Llŷr 2 Floating OWF; and • White Cross OWF.	The ZoI for piling can extend over kilometres, therefore by adopting a precautionary approach, projects within the marine mammal and marine turtle CEA study area with construction phases that overlap temporally with the construction phase for the Proposed Development were included. Specifically, piling for the Proposed Development is anticipated for April 2026. Therefore, projects whose construction phase finishes in 2025 were screened in as the sequential piling could lead to a longer duration of impact.
Injury, Disturbance, and Displacement from Underwater Noise Generated during UXO Clearance	C	The MDS is as described for the Proposed Development (Table 7.23) and assessed cumulatively with the following plans, projects, and activities: **Tier 1:** Offshore Renewables: • Awel y Môr OWF; and • Project Erebus.	The ZoI for UXO clearance can extend beyond the boundaries of a project. Therefore, projects within the marine mammal and marine turtle CEA study area whose construction phases overlap temporally with the construction phase of the Proposed Development were included. The construction phases of these projects would include pre-construction UXO clearance.

Potential Cumulative Effect	Phase	MDS	Justification
		Tier 2: Offshore Renewables: • Mona OWF; • Morgan OWF Generation Assets; • Morecambe OWF Generation Assets; • Arklow Bank Wind Park Phase 2; • Dublin Array OWF; • NISA OWF; • Oriel OWF; • Codling Offshore Wind Park; • Llŷr 1 Floating OWF; • Llŷr 2 Floating OWF; and • White Cross OWF.	
Injury, Disturbance, and Displacement from Underwater Noise Generated during Geophysical and Seismic Site Investigation Surveys	C	The MDS is as described for the Proposed Development (Table 7.23) and assessed cumulatively with the following plans, projects, and activities: **Tier 1:** Offshore Renewables: • Awel y Môr OWF. **Tier 2:** Offshore Renewables: • Mona OWF; and • Morgan OWF Generation Assets.	It is anticipated that the magnitude of the impacts will be of a similar scale to that described for the Proposed Development (maximum disturbance value of 13 km for VSP; Table 7.77). Therefore, the screening exercise has screened in projects within 13 km from the Proposed Development whose construction phases (which would include pre-construction site investigation surveys) and operation and maintenance phases overlap temporally with those of the Proposed Development.
	O	The MDS is as described for the Proposed Development (Table 7.23) and assessed cumulatively with the following plans, projects, and activities: **Tier 1:** Offshore Renewables: • Awel y Môr OWF. **Tier 2:**	

Potential Cumulative Effect	Phase	MDS	Justification
		Offshore Renewables: • Mona OWF; • Morgan OWF Generation Assets; and • Mooir Vannin OWF. Cables and Pipelines: • Morgan and Morecambe OWF Transmission Assets.	
Injury, Disturbance, and Displacement from Vessel Activity and other Noise Producing Activities	C	The MDS is as described for the Proposed Development (Table 7.23) and assessed cumulatively with the following plans, projects, and activities: **Tier 1:** Offshore Renewables: • Awel y Môr OWF. Construction and deposit: • Mona OWF Suction Bucket Trials **Tier 2:** Offshore Renewables: • Mona OWF; and • Morgan OWF Generation Assets. **Tier 3:** Cables and Pipelines: MaresConnect Wales – Ireland Interconnector Cable.	It is expected that projects contribute to increased vessel traffic and hence to the amount of noise produced in the environment during the construction, operations and maintenance, and decommissioning phases. However, given the large scale of the marine mammal and marine turtle CEA study area (Figure 7.14), only projects within the maximum disturbance range modelled for the Proposed Development have been included. As per Table 7.79, the maximum disturbance range of vessel activity and other noise producing activities was modelled at 20 km for survey vessels. Therefore, the screening exercise has screened in projects within 20 km from the Proposed Development.
	O	The MDS is as described for the Proposed Development (Table 7.23) and assessed cumulatively with the following plans, projects, and activities: **Tier 1:** Offshore Renewables: • Awel y Môr OWF. **Tier 2:** Offshore Renewables: • Mona OWF; and	

Potential Cumulative Effect	Phase	MDS	Justification
		• Morgan OWF Generation Assets. Cables and Pipelines: • Morgan and Morecambe OWF Transmission Assets. **Tier 3:** Cables and Pipelines: MaresConnect Wales – Ireland Interconnector Cable.	
	D	The MDS is as described for the Proposed Development (Table 7.23) and assessed cumulatively with the following plans, projects, and activities: **Tier 1:** Offshore Renewables: • Awel y Môr OWF. **Tier 2:** Offshore Renewables: • Mona OWF; and • Morgan OWF Generation Assets. Cables and Pipelines: • Morgan and Morecambe OWF Transmission Assets.	
Injury due to Collision with Marine Vessels	C	The MDS is as described for the Proposed Development (Table 7.23) and assessed cumulatively with the following plans, projects, and activities: **Tier 1:** Offshore Renewables: • Awel y Môr OWF. Construction and deposit: • Mona OWF Suction Bucket Trials **Tier 2:** Offshore Renewables: • Mona OWF; and • Morgan OWF Generation Assets.	It is expected that projects contribute to increased vessel collision risk during the construction, operations and maintenance, and decommissioning phases. However, given the large scale of the marine mammal and marine turtle CEA study area (Figure 7.14), only projects within Liverpool Bay have been included. This is because vessel use associated with projects at the extremities of the marine mammal and marine turtle CEA study area, such as those along the coast of Ireland or South West England, would not contribute to increased vessel activity in combination with that of the Proposed Development.

Potential Cumulative Effect	Phase	MDS	Justification
		Tier 3: Cables and Pipelines: MaresConnect Wales – Ireland Interconnector Cable.	
	O	The MDS is as described for the Proposed Development (Table 7.23) and assessed cumulatively with the following plans, projects, and activities: **Tier 1:** Offshore Renewables: • Awel y Môr OWF. **Tier 2:** Offshore Renewables: • Mona OWF; and • Morgan OWF Generation Assets. Cables and Pipelines: • Morgan and Morecambe OWF Transmission Assets. **Tier 3:** Cables and Pipelines: • MaresConnect Wales – Ireland Interconnector Cable.	
	D	The MDS is as described for the Proposed Development (Table 7.23) and assessed cumulatively with the following plans, projects, and activities: **Tier 1:** Offshore Renewables: • Awel y Môr OWF. **Tier 2:** Offshore Renewables: • Mona OWF; and • Morgan OWF Generation Assets. Cables and Pipelines:	

Potential Cumulative Effect	Phase	MDS	Justification
		Morgan and Morecambe OWF Transmission Assets.	

7.13.16 Injury, Disturbance, and Displacement from Underwater Noise Generated during Piling

There is the potential for cumulative increased underwater noise as a result of piling activities associated with the construction phases of the Proposed Development and other plans, projects, and activities. For the purposes of this ES, this additive impact has been assessed within the marine mammal and marine turtle CEA study area, using the tiered approach outlined above in section 7.13.1.

As for the assessment of the Proposed Development alone (section 7.12.14), the risk of injury in terms of PTS to most of the marine mammal and marine turtles due to piling is expected to be localised within close vicinity of the respective projects. It is also anticipated that standard mitigation and monitoring methods (which include soft starts and visual and acoustic monitoring as standard) will be applied during construction, thereby reducing the magnitude of impact. Therefore, there is very low potential for significant cumulative impacts for injury from increased underwater noise during pilling, and the CEA focuses on disturbance only.

As outlined in section 7.13.1, the construction phase of the Proposed Development is anticipated to start in 2024, to enable operation to commence during 2026/2027. Piling is currently anticipated to take place over 29 days in April to May 2026, although the total piling duration, based upon 100 minutes piling for each of eight pin piles, is less than 13.5 hours in total. Therefore, as a precaution, plans, projects, and activities with a construction phase commencing in 2026 are included in the CEA for this impact, although it should be noted that cumulative effects will be of a lesser extent due to the reduced temporal overlap.

All plans, projects, and activities screened into the assessment for cumulative effects from this impact are either on-going activities or projects with sufficient information in the public domain. The plans, projects, and activities within each tier screened into the CEA for each phase of development are illustrated in Table 7.94.

7.13.16.1 Tier 1

Construction Phase

Magnitude of Impact

There is potential for cumulative impacts with one Tier 1 project in the construction phase: Project Erebus.

The piling phase of the Proposed Development (April/May 2026) overlaps with the construction phase of another Tier 1 project, Awel y Môr OWF. However, the MDS in the ES for Awel y Môr OWF assumes that there will be up to 201 days of piling over 12 months in 2028, within the project's four-year construction phase (RWE Renewables UK, 2022). Given the almost two-year gap in between piling activities at Awel y Môr OWF and the Proposed Development, the Awel y Môr OWF is not included in this Tier 1 assessment.

Similarly, the piling phase of the Tier 1 Mostyn Energy Park Extension (Q3 2023 to Q2 2024) is expected to overlap temporally with the construction phase of the Proposed Development. However, construction for Mostyn Energy Park Extension is expected to have been completed in Q1 2025, before the piling phase for the Proposed Development has commenced. Given the almost two-year gap between piling at Mostyn Energy Park Extension and piling at the Proposed Development, Mostyn Energy Park Extension has not been included in this Tier 1 assessment.

Project Erebus is anticipated to be constructed in 2025 only (Table 7.93), therefore piling should not overlap with that of the Proposed Development. However, as the construction phase finishes in 2025, Project Erebus was screened into the assessment as the sequential piling of the Proposed Development in 2026 could lead to a longer duration of impact.

Effects on harbour seal and marine turtles were not considered in the ES for Project Erebus. Given, that the CEA for piling is provided on species-by-species basis, harbour seal and marine turtles will not be considered further for the Tier 1 assessment. There were also very few data on Risso's dolphin in the Project Erebus area, and no density estimate was available (Blue Gem Wind, 2020). Therefore, this species was not included in the

Tier 1 assessment, although the spatial scale of the effects was expected to be similar to that of bottlenose dolphin (Blue Gem Wind, 2020).

Where cumulative numbers of animals potentially disturbed are presented for each species below, the calculations take into account the timelines of respective projects. Given that the construction phase of Project Erebus is anticipated to be completed prior to the commencement of piling at the Proposed Development, animals are likely to recover from the disturbance between piling events and therefore the numbers of animals potentially disturbed at respective projects are not added together.

Harbour Porpoise

Project Erebus is a demonstration scale floating OWF, composed of six to ten wind turbines and a range of foundation options, including pile driven anchors. The construction is planned to take place in 2025 with only 18 days over which piling may occur (Blue Gem Wind, 2020). occur. The number of harbour porpoise predicted to be disturbed was based on densities from site-specific surveys at Project Erebus (Blue Gem Wind, 2020; Table 7.95). It should be noted that Project Erebus is located in close proximity to the Bristol Channel Approaches/Dynesfeydd Môr Hafren SAC designated for protection of harbour porpoise. As the piling at Project Erebus is anticipated to be completed in 2025, it will contribute, temporally, to a slightly longer duration of piling within the marine mammal and marine turtle CEA study area.

Cumulatively, the piling at Project Erebus in 2025 would disturb 1,967 harbour porpoise, followed by that of the Proposed Development in 2026 which, based upon estimates derived by application of the recommended dose-response approach (NRW, 2023) would disturb up to 158 animals (Table 7.95).

Table 7.95: Number Of Harbour Porpoise Predicted To Be Disturbed As A Result Of Piling For Tier 1 Projects

Project	Maximum Number of Piles	Piling Duration	Piling Phase	Density (Animals per km^2)	Maximum Number of Animals Disturbed	Percentage of Reference Population (%)	Source
Proposed Development	8	29 days	<1 month	0.086 0.515	158 945	0.25% (Celtic and Irish Seas MU) 1.51% (Celtic and Irish Seas MU)	Section 7.12.14
Project Erebus	35	18 days	8 months	0.04	1,967	3.15% (Celtic and Irish Seas MU)	Blue Gem Wind, 2020

As harbour porpoise can travel over large distances and there is a potential for overlap of disturbance noise contours with SACs designated for this species (see Table 7.19), the cumulative effects on the designated features and conservation objectives of sites designated for harbour porpoise will be considered in RIAA.

Overall, the impact is predicted to be of regional spatial extent, short-term duration (up to 18 and 29 days of piling for both Project Erebus and the Proposed Development) and intermittent (only occurs during piling activities). Furthermore, the effect of behavioural disturbance is reversible, as animals can return to baseline levels within hours/days after piling activities have ceased. It is predicted that the impact will affect the receptor directly. The impact could result in some measurable changes to individuals that are disturbed (i.e. interruption of feeding or breeding and/or displacement to alternative areas), however this is not likely to have large-scale population effects, given the short-term cumulative duration of piling. The magnitude is therefore considered to be low.

Dolphin Species

Data collected by Lohrengel *et al.* (2018) was used to assess bottlenose dolphin disturbance for Project Erebus. Up to 310 bottlenose dolphin (2.8% of the Offshore Channel and Southwest England MU) were predicted to potentially experience disturbance (Blue Gem Wind, 2020; Table 7.96). This short-term and temporary behavioural effects (up to 18 days of piling) were considered unlikely to alter the population trajectory of bottlenose dolphin (Blue Gem Wind, 2020).

For common dolphin, Project Erebus assessed the number of animals potentially disturbed using densities from site-specific surveys and SCANS-III block D (Blue Gem Wind, 2020). Whilst up to 2,067 animals (2.01% of the population) may be behaviourally disturbed, this was not anticipated to lead to changes in the population trajectory due to the short-term nature of the impact (Table 7.96).

Cumulatively, piling at Project Erebus in 2025 would potentially affect up to 310 bottlenose dolphin, and 2,067 common dolphin. Followed by subsequent piling at the Proposed Development in 2026, up to 65 bottlenose dolphin and 33 common dolphin could potentially experience disturbance (Table 7.96). However, this is likely to be an overestimate as highly precautionary densities were used for the respective assessments.

As described above for harbour porpoise, the piling at Project Erebus is anticipated to be completed in 2025, and will contribute, temporally, to a slightly longer duration of piling within the marine mammal and marine turtle CEA study area.

Table 7.96: Number Of Dolphin Species Predicted To Be Disturbed As A Result Of Piling For Tier 1 Projects

Project	Maximum Number of Piles	Piling Duration	Piling Phase	Density (Animals per km^2)	Maximum Number of Animals Disturbed	Percentage of Reference Population	Source
Bottlenose dolphin							
Proposed Development	8	29	<1 month	0.010 0.035	20 65	6.51% (Irish Sea MU) 21.91% (Irish Sea MU)	Section 7.12.14
Project Erebus	35	18 days	8 months	0.063 (array area) 0.3743 (wider area)	310	2.8% (Offshore Channel and Southwest England MU)	Blue Gem Wind, 2020
Common Dolphin							
Proposed Development	8	29	<1 month	0.027	50	0.05% (Celtic and Greater North Seas MU)	Section 7.12.14
Project Erebus	35	18 days	8 months	1.61 (array are) 0.3743 (wider area)	2,067	2.01% (Celtic and Greater North Seas MU)	Blue Gem Wind, 2020

Cardigan Bay, and the Cardigan Bay/Bae Ceredigion SAC in particular, constitute important habitats for bottlenose dolphin, with large numbers of animals present in the summer (Table 7.19). As bottlenose dolphin can travel over large distances, there is a possibility that a small number of individuals from SAC populations may be occasionally present within the disturbance noise contours. As such the cumulative effects on the designated features and conservation objectives of designated sites will be considered in RIAA.

Overall, the impact is predicted to be of regional spatial extent, short-term duration (up to 18 and 29 days of piling for both Project Erebus and the Proposed Development) and intermittent (only occurs during piling activities). Furthermore, the effect of behavioural disturbance is reversible, as animals can return to baseline levels within hours/days after piling activities have ceased. It is predicted that the impact will affect the receptor directly. The impact could result in some measurable changes to individuals that are disturbed (i.e. interruption of feeding or breeding and/or displacement to alternative areas), however this is not likely to have large-scale population effects, given the short-term cumulative duration of piling. The magnitude is therefore considered to be low.

Minke Whale

Project Erebus assessed the number of minke whale predicted to be affected by disturbance during piling using densities from SCANS III block D (Blue Gem Wind, 2020; Hammond *et al.,* 2021). As described above for harbour porpoise, the piling at Project Erebus is anticipated to be completed in 2025, and will contribute, temporally, to a slightly longer duration of piling within the marine mammal and marine turtle CEA study area.

Cumulatively, for piling at Project Erebus in 2025, up to 55 minke whale (0.3% of the Celtic and Irish Seas MU) was assessed as having the potential to experience disturbance (Blue Gem Wind, 2020). Subsequently, piling at the Proposed Development in 2026 has been predicted to affect up to 32 minke whale (0.16% of the Celtic and Irish Seas MU population (Table 7.97).

Table 7.97: Number Of Minke Whale Predicted To Be Disturbed As A Result Of Piling For Tier 1 Projects

Project	Maximum Number of Piles	Piling Duration	Piling Phase	Density (Animals per km^2)	Maximum Number of Animals Disturbed	Percentage of Reference Population (%)	Source
Proposed Development	8	29 days	<1 month	0.009	17	0.08% (Celtic Greater North Seas MU)	Section 7.12.14
Project Erebus	35	18 days	8 months	0.0112	55	0.3% (Celtic Greater North Seas MU)	Blue Gem Wind, 2020

Overall, the impact is predicted to be of regional spatial extent, short-term duration (up to 18 and 29 days of piling for both Project Erebus and the Proposed Development) and intermittent (only occurs during piling activities). Furthermore, the effect of behavioural disturbance is reversible, as animals can return to baseline levels within hours/days after piling activities have ceased. It is predicted that the impact will affect the receptor directly. The impact could result in some measurable changes to individuals that are disturbed (i.e. interruption of feeding or breeding and/or displacement to alternative areas), however this is not likely to have large-scale population effects, given the short-term cumulative duration of piling. The magnitude is therefore considered to be low.

Grey Seal

Project Erebus used specific gridded density estimates from Carter *et al.* (2020) to assess the number of grey seal predicted to be affected by disturbance. The Wales and Southwest England MUs populations of 6,090 individuals were taken forward as the reference population to inform the assessment (Blue Gem Wind, 2020). As described above for harbour porpoise, the piling at Project Erebus is anticipated to be completed in 2025, and will contribute, temporally, to a slightly longer duration of piling within the marine mammal and marine turtle CEA study area. It should be noted that Project Erebus is located in close proximity to the Pembrokeshire Marine/Sir Benfro Forol SAC and Lundy SAC, which are designated for protection of grey seal (Table 7.19). As such the cumulative effects on the designated features and conservation objectives of designated sites will be considered in RIAA.

Cumulatively, for piling at Project Erebus in 2025, up to 18 grey seal (0.3% of the relevant MUs) was assessed as having the potential to experience disturbance (Blue Gem Wind, 2020). Subsequently, piling at the Proposed Development in 2026 has been predicted to affect up to 125 grey seal (0.92% of various seal MUs populations) (Table 7.97).

Table 7.98: Number Of Grey Seal Predicted To Be Disturbed As A Result Of Piling For Tier 1 Projects

Project	Maximum Number of Piles	Piling Duration	Piling Phase	Maximum Number of Animals Disturbed	Density (Animals per km^2)	Percentage of Reference Population (%)	Source
Proposed Development	8	29 days	<1 month	125	0.467	0.92% (various seal MUs, see Table 7.17) 0.21% (OSPAR Region III)	Section 7.12.14
Project Erebus	35	18 days	8 months	18	Not available as grid cell specific	0.3% (Wales and SW England MUs)	Blue Gem Wind, 2020

Overall, the impact is predicted to be of regional spatial extent, short-term duration (up to 18 and 29 days of piling for both Project Erebus and the Proposed Development) and intermittent (only occurs during piling activities). The piling works for the Proposed Development are expected to be undertaken over a number of days, with the total active piling duration expected to be less than 13.5 hours (within the 29 days), therefore any overlap is expected to be minor. Furthermore, the effect of behavioural disturbance is reversible, as animals can return to baseline levels within hours/days after piling activities have ceased. It is predicted that the impact will affect the receptor directly. The impact could result in some measurable changes to individuals that are disturbed (i.e. interruption of feeding or breeding and/or displacement to alternative areas), however this is not likely to have large-scale population effects, given the short-term cumulative duration of piling. The magnitude is therefore considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as described above for the Proposed Development alone (see section 7.12.14).

Harbour porpoise and grey seal are deemed to have some tolerance to behavioural disturbance, medium vulnerability, high recoverability, and international value. Therefore, the sensitivity of harbour porpoise to behavioural disturbance is considered to be medium.

Overall, bottlenose dolphin, common dolphin, and minke whale are deemed to have some tolerance to behavioural disturbance, low vulnerability, high recoverability and international value. Therefore, the sensitivity of these receptors to behavioural disturbance is considered to be medium.

Significance of Effect

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the cumulative effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

7.13.16.2 Tier 2

Construction Phase

Magnitude of Impact

There is potential for cumulative impacts with eleven Tier 2 projects in the construction phase:

- Mona OWF;
- Morgan OWF Generation Assets;
- Morecambe OWF Generation Assets;
- Mooir Vannin OWF;
- Arklow Bank Wind Park Phase 2;
- Dublin Array OWF;
- NISA OWF;
- Oriel OWF;
- Codling Offshore Wind Park;
- Llŷr 1 Floating OWF;
- Llŷr 2 Floating OWF; and
- White Cross OWF.

The construction dates are unknown for Arklow Bank Wind Phase 2; however, it has been conservatively screened into the assessment in the event that a temporal overlap occurs.

For the majority of these Tier 2 projects, only a Scoping Report is available, which does not include detailed information about behavioural disturbance due to piling. However, injury and disturbance due to piling was scoped in for these projects within their respective Scoping Reports (Oriel Wind Farm Ltd., 2019; Codling Wind Park Limited, 2020; Dublin Array, 2020; SSE Renewables, 2020; Arup, 2021; Floventis Energy, 2022; White Cross, 2022; Orsted, 2023). However, PEIRs are available for the Mona OWF, Morgan OWF Generation Assets, and Morecambe OWF Generation Assets, which have been used in this assessment to provide more detailed information on this impact (EnBW and BP, 2023a, 2023e; Morecambe Offshore Wind Limited, 2023). Marine turtles have not been included in any of the three PEIRs, so are not included further in this Tier 2 assessment. The assessment on behavioural disturbance for Morecambe OWF Generation Assets only included harbour porpoise, grey seal, and harbour seal.

Temporally, the construction phases for 11 of the 12 Tier 2 projects are anticipated to occur between 2024 and 2028 (Table 7.93), although refined piling programmes are not currently available for any of the projects considered (the construction phase of Mooir Vannin OWF is expected to commence in 2030, after construction of the Proposed Development is complete). This timescale constitutes a total of four years where piling activities will occur across the marine mammal and marine turtle CEA study area. Piling will occur intermittently over the construction phase of respective projects. Therefore, although this will not result in a continuous risk of disturbance to marine mammals, it may affect multiple breeding seasons. In the context of these species' life cycles, the duration of the impact is classified as medium term, as the exposure to elevated sound levels could occur over a meaningful proportion of their lifespan.

Additionally in spatial terms, animals may be displaced from an area comparable to disturbance noise contours modelled for the Proposed Development alone (Figure 7.11). However, should concurrent piling occur with another project, considerable levels of underwater noise are likely which may potentially result in a larger area of strong disturbance.

Harbour Porpoise

Piling at the Proposed Development is predicted to potentially disturb up to 158 harbour porpoise, based upon application of the dose-response approach, in line with current guidance (NRW, 2023). Subsequently, piling Mona OWF, Morgan OWF Generation Assets, and Morecambe OWF Generation Assets could affect 587, 1,370, and 1,279 harbour porpoise, respectively (Table 7.99). Given that the construction phase for these three projects is anticipated to be between 2026 to 2028, there is potential for temporal overlap in piling activity with that of the Proposed Development (April/May 2026). The piling works for the Proposed Development are expected to be undertaken over a number of days, with the total active piling duration expected to be less than 13.5 hours, therefore any overlap is expected to be minor.

Table 7.99: Number Of Harbour Porpoise Predicted To Be Disturbed As A Result Of Piling For Tier 2 Projects

Project	Density (Animals per km^2)	Maximum Number of Animals Disturbed	Percentage of Reference Population (Celtic and Irish Seas MU)	Source
Proposed Development	0.086 0.515	158 945	0.25% 1.51%	Section 7.12.14
Mona OWF	0.097	587	0.94%	EnBW and BP (2023a)
Morgan OWF Generation Assets	0.247	1,370	2.19%	EnBW and BP (2023e)
Morecambe OWF Generation Assets	0.371	1,279	2.05%	Morecambe Offshore Wind Limited (2023)

Dolphin Species

Piling at the Proposed Development is predicted to potentially disturb up to 65 bottlenose dolphin. Subsequently, piling Mona OWF and Morgan OWF Generation Assets could affect 17 and 16 individuals, respectively (Table 7.100). For common dolphin, the Proposed Development is predicted to potentially disturb up to 33 animals. Subsequently, piling Mona OWF and Morgan OWF Generation Assets could affect 109 and 100 individuals, respectively). For Risso’s dolphin, the Proposed Development is predicted to potentially disturb up to 58 animals. Subsequently, piling Mona OWF and Morgan OWF Generation Assets could affect 105 and 96 individuals, respectively.

Given that the construction phase for these three projects is anticipated to be between 2026 to 2028, there is potential for temporal overlap in piling activity with that of the Proposed Development (April/May 2026). The piling works for the Proposed Development are expected to be undertaken over a number of days, with the total active piling duration expected to be less than 13.5 hours, therefore any overlap is expected to be minor.

Table 7.100: Number Of Dolphin Species Predicted To Be Disturbed As A Result Of Piling For Tier 2 Projects

Project	Density (Animals per km²)	Maximum Number of Animals Disturbed	Percentage of Reference Population	Source
Bottlenose Dolphin				
Proposed Development	0.010 0.035	20 65	6.51% (Irish Sea MU) 21.91% (Irish Sea MU)	Section 7.12.14
Mona OWF	0.035	17	5.69% (Irish Sea MU)	EnBW and BP (2023a)
Morgan OWF Generation Assets	0.035	16	5.28% (Irish Sea MU)	EnBW and BP (2023e)
Common Dolphin				
Proposed Development	0.027	50	0.05% (Celtic and Greater North Seas MU)	Section 7.12.14
Mona OWF	0.018	109	0.11% (Celtic and Greater North Seas MU)	EnBW and BP (2023a)
Morgan OWF Generation Assets	0.018	100	0.10% (Celtic and Greater North Seas MU)	EnBW and BP (2023e)
Risso's Dolphin				
Proposed Development	0.0313	58	0.47% (Celtic and Greater North Seas MU)	Section 7.12.14
Mona OWF Generation Assets	0.0313	189	1.54% (Celtic and Greater North Seas MU)	EnBW and BP (2023a)
Morgan OWF Generation Assets	0.0313	174	1.42% Celtic and Greater North Seas MU)	EnBW and BP (2023e)

Minke Whale

Piling at the Proposed Development is predicted to potentially disturb up to 17 minke whale. Subsequently, piling Mona OWF and Morgan OWF Generation Assets could affect 105 and 96 individuals, respectively (Table 7.101). Given that the construction phase for these three projects is anticipated to be between 2026 to 2028, there is potential for temporal overlap in piling activity with that of the Proposed Development (April/May 2026). The piling works for the Proposed Development are expected to be undertaken over a number of days, with the total active piling duration expected to be less than 13.5 hours, therefore any overlap is expected to be minor.

Table 7.101: Number Of Minke Whale Predicted To Be Disturbed As A Result Of Piling For Tier 2 Projects

Project	Density (Animals per km^2)	Maximum Number of Animals Disturbed	Percentage of Reference Population (Celtic and Greater North Seas MU)	Source
Proposed Development	0.009	17	0.08%	Section 7.12.14
Mona OWF	0.0173	105	0.52%	EnBW and BP (2023a)
Morgan OWF Generation Assets	0.0173	96	0.48%	EnBW and BP (2023e)

Grey Seal and Harbour Seal

For grey seal, piling at the Proposed Development is predicted to potentially disturb up to 125 animals. Subsequently, piling Mona OWF, Morgan OWF Generation Assets, and Morecambe OWF Generation Assets could affect 92, 48, and up to one animal, respectively (Table 7.101). For harbour seal, piling at the Proposed Development is predicted to potentially disturb up to 2 animals. Subsequently, piling Mona OWF, Morgan OWF Generation Assets, and Morecambe OWF Generation Assets could each affect up to one animal (Table 7.101).

Given that the construction phase for these three projects is anticipated to be between 2026 to 2028, there is potential for temporal overlap in piling activity with that of the Proposed Development (April/May 2026). The piling works for the Proposed Development are expected to be undertaken over a number of days, with the total active piling duration expected to be less than 13.5 hours, therefore any overlap is expected to be minor.

Table 7.102: Number Of Grey And Harbour Seal Predicted To Be Disturbed As A Result Of Piling For Tier 2 Projects

Project	Density (Animals per km^2)	Maximum Number of Animals Disturbed	Percentage of Reference Population	Source
Grey Seal				
Proposed Development	0.467	125	0.92% (various seal MUs, see Table 7.17) 0.21% (OSPAR Region III)	Section 7.12.14
Mona OWF	Not available as grid cell specific	92	0.68% (various seal MUs combined) 0.15% (OSPAR Region III)	EnBW and BP (2023a)
Morgan OWF Generation Assets	Not available as grid cell specific	48	0.53% (various seal MUs combined) 0.08% (OSPAR Region III)	EnBW and BP (2023e)
Morecambe OWF Generation Assets	Not available as grid cell specific	<1	0.069% (various seal MUs combined) 0.0069% (OSPAR Region III)	Morecambe Offshore Wind Limited (2023)
Harbour Seal				

Project	Density (Animals per km^2)	Maximum Number of Animals Disturbed	Percentage of Reference Population	Source
Proposed Development	0.0049	2	0.09% (various seal MUs combined)	Section 7.12.14
Mona OWF	Not available as grid cell specific	<1	0.02% (various seal MUs combined)	EnBW and BP (2023a)
Morgan OWF Generation Assets	Not available as grid cell specific	<1	0.009% (various seal MUs combined)	EnBW and BP (2023e)
Morecambe OWF Generation Assets	Not available as grid cell specific	<1	0.00021% (various seal MUs combined)	Morecambe Offshore Wind Limited (2023)

In the context of the wider habitat available within the marine mammal and marine turtle CEA study area, it is not anticipated that it will result in long-term population-level effects on any of the species.

As above for the Tier 1 assessment, the cumulative effects on the designated features and conservation objectives of designated sites relevant to the marine mammal IEFs will be included in the RIAA.

Overall, the impact is predicted to be of regional spatial extent, medium term duration, intermittent, and high reversibility (as the impact itself occurs only during piling and animals can return to baseline levels within hours/days after piling has ceased). It is predicted that the impact will affect the receptor directly. The impact could result in some measurable changes to individuals that are disturbed (i.e. interruption of feeding or breeding and/or displacement to alternative areas). There are no long-term population-level consequences of disturbance anticipated for any species, and the magnitude is considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as described above for the Proposed Development alone (see section 7.12.14).

Harbour porpoise and grey seal are deemed to have some tolerance to behavioural disturbance, medium vulnerability, high recoverability, and international value. Therefore, the sensitivity of harbour porpoise to behavioural disturbance is considered to be medium.

Overall, bottlenose dolphin, common dolphin, and minke whale are deemed to have some tolerance to behavioural disturbance, low vulnerability, high recoverability and international value. Therefore, the sensitivity of these receptors to behavioural disturbance is considered to be medium.

Significance of Effect

<u>All Species</u>

For all species, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be medium. Cumulative impacts are unlikely to affect the international value of these species in the context of their respective reference populations. The cumulative effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

7.13.16.3 Tier 3 and 4

There were no Tier 3 or 4 plans, projects, or activities identified in the CEA with the potential to result in cumulative impacts regarding underwater noise during piling.

7.13.17 Injury, Disturbance, and Displacement from Underwater Noise Generated during UXO Clearance

There is the potential for cumulative increased underwater noise as a result of UXO clearance activities associated with the construction phases of the Proposed Development and other plans, projects, and activities. For the purposes of this ES, this additive impact has been assessed within the marine mammal and marine turtle CEA study area, using the tiered approach outlined above in section 7.13.1.

As detailed above in section 7.12.15, the duration of increased underwater noise for each UXO detonation is very short (i.e. within seconds), therefore behavioural effects are considered to be negligible in this context. TTS is presented as a metric of temporary auditory injury but also represents a threshold for the onset of a displacement or moving away response in line with recommendations from Southall *et al.* (2007).

All plans, projects, and activities screened into the assessment for cumulative effects from this impact are either on-going activities or projects with sufficient information in the public domain. The plans, projects, and activities within each tier screened into the CEA for each phase of development are illustrated in Table 7.94.

7.13.17.1 Tier 1

Construction Phase

Magnitude of Impact

<u>All Species</u>

There is potential for cumulative impacts with two Tier 1 projects in the construction phase: Awel y Môr OWF and Project Erebus. Effects on harbour seal or marine turtles were not considered in the ES in both Tier 1 projects and are therefore not considered further in this Tier 1 assessment.

The construction phase of the Proposed Development is expected to overlap temporally with the construction phase of the Mostyn Energy Park Extension (Q3 2023 to Q2 2024), and the operations phase of the Mona OWF Suction Bucket foundation trials (July 2023 to July 2024). However, UXO clearance operations will not be undertaken at Mostyn Energy Park Extension or Mona OWF Suction Bucket foundation trials and as such these projects have not been included in this Tier 1 assessment.

The construction of Project Erebus is anticipated for 2025 only, between 2026 to 2030 for Awel y Môr OWF, and between 2024 and 2026 for the Proposed Development. Therefore, it is unlikely that concurrent UXO detonations across these three projects will take place. This is because UXO clearance activities take place before other construction activities commence, at the beginning of the construction phase (i.e. 2024 for the Proposed Development, 2025 for Project Erebus and 2026 for Awel y Môr OWF). Therefore, a sum of the number of animals with the potential to be injured by UXO clearance would not be suitable for this assessment. However, sequential UXO clearance at the respective projects could lead to a longer duration of impact. UXO clearance at each of these projects will occur as a discrete stage within the overall construction phase and therefore will not coincide continuously over the duration of any temporal overlap. In addition, each clearance event results in a very short duration of sound emission (within seconds) so the impact will be short in duration and therefore the temporal overlap is unlikely.

The MDS for Awel y Môr includes 10 UXOs to be cleared, with two clearance events every 24 hours but up to 10 detonations in 10 days (RWE Renewables UK, 2022). Like the Proposed Development high-order detonation was assessed and modelled, although low-order clearance is more likely. The ES for Awel y Môr followed Southall *et al*. (2007) to assess the impacts from UXO detonation on marine mammals. However, the authors highlighted that empirical evidence from UXO detonations using the TTS metric is lacking, in particular the range-dependent characteristics of the peak sounds and discuss whether current propagation models can accurately predict the range at which these thresholds are reached (RWE Renewables UK, 2022). PTS ranges were modelled for a range of expected UXO sizes (5kg TNT NEQ, 15kg TNT NEQ and 164kg TNT NEQ) (RWE Renewables UK, 2022).

For harbour porpoise, the ES for the Awel y Môr OWF assessed the effects of UXO clearance using two densities (0.13 per km^2 (JCP) and 1.0 per km^2 (Sea Watch Foundation (SWF)). The maximum number of harbour porpoise estimated within the ZoI was considered highly conservative. Although, PTS is not recoverable, the magnitude of this impact was considered negligible adverse in the ES, due to the commitment to implement a UXO-specific MMMP to reduce the risk of PTS to negligible (RWE Renewables UK, 2022). Residual impacts for PTS from UXO were therefore considered unlikely for harbour porpoise, minke whale, grey seal and minor adverse significance for bottlenose dolphin, common dolphin and Risso's dolphin (RWE Renewables UK, 2022).

The Awel y Môr OWF ES presented results for various disturbance thresholds, including 26 km Effective Deterrence Ranges (EDR) for high order detonations, 5 km EDR for low order, and TTS-onset thresholds for high-order detonations. However, the authors suggested that there is no evidence of a 5 km EDR being suitable for any marine mammal species for the low order detonation and should be treated with caution as a result. Therefore, they used TTS-onset as a proxy for behavioural disturbance (as per the assessment for the Proposed Development) but caveated that this is likely to overestimate actual behavioural responses. Large TTS ranges were predicted for harbour porpoise (16 km; SPL_{pk}) and minke whale (65 km; SEL_{cum}) for a UXO of 164 kg (RWE Renewables UK, 2022). The authors concluded that the magnitude of the effects of TTS would be low for all species.

The MDS for Project Erebus anticipated one UXO detonation via low-order deflagration but modelled high-order detonations for completeness, highlighting this is not realistic (Blue Gem Wind, 2020). The ES for Project Erebus used densities from site-specific surveys to assess the number of harbour porpoise affected by injury or disturbance, and densities presented in Lohrengel *et al*. (2018), Hammond *et al*. (2021), Carter *et al.* (2022) for bottlenose dolphin, minke whale, and grey seal, respectively.

For Project Erebus, the number of marine mammals predicted to experience PTS was up to one animal for all species and low-order charge sizes, apart from 2kg NEQ, which could result in PTS in up to five harbour porpoise (Blue Gem Wind, 2020). Like Awel y Môr OWF, Project Erebus also used an EDR of 5 km for low order clearance and 26 km for high-order clearance and used TTS-onset as a proxy for disturbance. The maximum predicted TTS range was 103 km for minke whale (Blue Gem Wind, 2020). Project Erebus also emphasised that TTS-onset as a proxy for disturbance is expected to overestimate the actual biological consequences (Blue Gem Wind, 2020). This is supported by the work of Southall *et al*. (2007), which states that "*This approach is expected to be precautionary because TTS at onset levels is unlikely to last a full diel cycle or to have serious biological consequences during the time TTS persists*". Project Erebus concluded that the impact of behavioural disturbance (assessed using TTS-onset as a proxy) was unlikely to significantly affect marine mammal receptors from either low-order or high-order UXO detonation (Blue Gem Wind, 2020).

The maximum number of animals with the potential to experience PTS during UXO clearance for the highest charge size is presented in Table 7.103. For the majority of species, this value is very low (less than five animals). However, for harbour porpoise and grey seal, the number of animals with the potential to be disturbed is in the low hundreds (i.e. a maximum of 212 harbour porpoise at Project Erebus) (Table 7.103). However, this was modelled using high-order UXO clearance for Project Erebus which is very unlikely to occur in practice (the maximum UXO charge weight expected in the area is 331kg, and the project is seeking consent for one low-order detonation with a maximum of 2kg NEQ). Therefore, with measures applied at cumulative projects (i.e. use of low order clearance only for Project Erebus and MMMPs for Awel y Môr and the Proposed Development) the residual risk of injury is likely to be very small.

Table 7.103: Number Of Animals With The Potential To Experience PTS During UXO Clearance For Tier 1 Projects For The Maximum Charge Size (kg)

Project	Species	Maximum Charge Size (kg)	Maximum PTS Range (m)	Maximum Number of Animals Disturbed	Source
Proposed Development	Harbour porpoise	907	15,370	383	Section 7.12.15
	Bottlenose dolphin, common dolphin, Risso’s dolphin		890	<1	
	Minke whale		4,215	<1	
	Grey seal		3,015	115	
Awel y Môr OWF	Harbour porpoise	164	8,600	30	RWE Renewables UK, 2022
	Bottlenose dolphin, common dolphin, Risso’s dolphin		500	<1	
	Minke whale		1.500	<1	
	Grey seal		1,600	3	
Project Erebus	Harbour porpoise	525	13,000	212	Blue Gem Wind, 2020
	Bottlenose dolphin		730	<1	
	Common dolphin		730	3	
	Minke whale		2,200	<1	
	Grey seal		2.500	1	

Increased underwater noise during UXO clearance has the potential to cause TTS (moving away response) in marine mammal receptors, however, this effect will be short-term and reversible. Therefore, the potential for cumulative impact is considered to be very limited, even for multiple projects. Although some ecological functions could be temporarily inhibited due to TTS (e.g. cessation of feeding), these are reversible on recovery of the animal’s hearing and therefore not considered likely to lead to any long-term effects on the individual. Furthermore, the effect of TTS induced by UXO clearance was assessed as of minor adverse significance for all species in the ESs for both Tier 1 projects (Blue Gem Wind, 2020; RWE Renewables UK, 2022), and for the Proposed Development.

<u>Auditory Injury (PTS)</u>

Overall, cumulative impact is predicted to be of local to regional spatial extent, very short-term duration (within seconds), intermittent (throughout the construction phases of the projects), and, although the impact itself is reversible (i.e. during the detonation event only), the effect of PTS is permanent. It that the impact will affect the receptor directly. Assuming standard industry mitigation will be applied for each project (e.g MMMP, low order clearance), it is anticipated that for most species animals would be deterred from the ZoI and therefore the risk of PTS would be reduced. The magnitude is therefore considered to be negligible (for bottlenose dolphin, common dolphin, Risso’s dolphin, minke whale, and grey seal). For harbour porpoise the injury ranges are larger, and there is considered to be a residual risk of PTS to a small number of individuals, therefore the magnitude is considered to be -

Behavioural Disturbance (TTS as a Proxy)

Overall, the cumulative impact is predicted to be of regional spatial extent, short-term duration, intermittent and both the impact itself (i.e. during the detonation event) and effect of behavioural disturbance and TTS are reversible. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low for all species.

Sensitivity of the Receptor

The sensitivity of the receptor is as described above for the Proposed Development alone (see section 7.12.15).

Auditory Injury (PTS)

Overall, all marine mammal IEFs are deemed to have limited tolerance to PTS, high vulnerability, low recoverability, and international value. The sensitivity of the receptor is therefore considered to be high.

Behavioural Disturbance (TTS as a Proxy)

Overall, since TTS is reversible, all marine mammal IEFs are assessed as having some tolerance, medium vulnerability, high recoverability, and international value. The sensitivity of the receptor is therefore considered to be low.

Significance of Effect

Auditory Injury (PTS)

Overall, for all IEFs except harbour porpoise, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Overall, for harbour porpoise, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be high. As per Table 7.31, this results in a 'minor or moderate' significance of effect. However given the low chance of temporal overlap in clearance events or concurrent detonations, based on the low numbers of detonations per day expected during clearance activities the effect is therefore assessed to be of **minor adverse** significance, which is **not significant** in EIA terms.

Behavioural Disturbance (TTS as a Proxy)

Overall, for all IEFs, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, it has been concluded that the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

7.13.17.2 Tier 2

Construction Phase

There is potential for cumulative impacts with 12 Tier 2 projects in the construction phase:

- Mona OWF;
- Morgan OWF Generation Assets;
- Morecambe OWF Generation Assets;
- Mooir Vannin OWF;

- Arklow Bank Wind Park Phase 2;
- Dublin Array OWF;
- NISA OWF;
- Oriel OWF;
- Codling Offshore Wind Park;
- Llŷr 1 Floating OWF;
- Llŷr 2 Floating OWF; and
- White Cross OWF.

The construction dates are unknown for Arklow Bank Wind Phase 2; however, it has been conservatively screened into the assessment in the event that a temporal overlap occurs.

For the majority of the Tier 2 projects, beyond the Scoping Report there was not enough information to conduct a quantitative assessment. Although injury and disturbance due to UXO clearance was scoped in for these projects, their respective Scoping Reports do not provide detailed information about the impact (Oriel Wind Farm Ltd., 2019; Codling Wind Park Limited, 2020; Dublin Array, 2020; SSE Renewables, 2020; Arup, 2021; Floventis Energy, 2022; White Cross, 2022). These projects are likely to have effects similar to the Proposed Development and will likely have similar mitigation (e.g. MMMPs or separate marine licenses) to mitigate harm. However, at this state, a more detailed cumulative assessment cannot be provided for this impact. The indicative programme for construction at Mooir Vannin OWF, including UXO clearance operations, is expected to commence in 2030, after construction (and UXO clearance) at the Proposed Development is complete.

However, PEIRs including PTS ranges for UXO clearance are available for the Mona OWF and Morgan OWF Generation Assets, which have been used in this assessment to provide more detailed information on this impact (EnBW and BP, 2023a, 2023e). Marine turtles have not been included in any either of the PEIRs, so are not included further in this Tier 2 assessment. For both these Tier 2 projects, the construction phases are expected to be from 2026 to 2030 and therefore may have overlap with that of the Proposed Development. Although UXO clearance activities are typically undertaken at the beginning of the construction phase (i.e. in 2024 for the Proposed Development), these timelines are only indicative at this stage and could be subject to change. For a proportionate assessment, these projects are assessed as a precaution.

Both PEIRs assessed PTS and disturbance (TTS/moving away response) resulting during UXO clearance as a potential impact during their construction phases. The same UXO charge sizes as the Proposed Development were modelled for Mona OWF and Morgan OWF Generation Assets (from 25 kg up to 907 kg, with 130 kg the most likely maximum size). Subsequently, the PEIRs predicted the largest injury ranges as a result of high order detonation of a 907 kg UXO size for harbour porpoise of up to 15 km and 28 km for PTS and TTS, respectively (EnBW and BP, 2023a, 2023e). Numbers of animals potentially impacted by PTS due to high-order clearance of the maximum charge size (907 kg) are presented in Table 7.104.

Table 7.104: Number Of Animals With The Potential To Experience PTS Onset Due To High-Order Detonation Of A 907 kg UXO For The Tier 2 Projects

Project	Species	Maximum Charge Size (kg)	Maximum PTS Range (m)	Maximum Number of Animals Disturbed	Source
Proposed Development	Harbour porpoise	907	15,370	383	Section 7.12.15
	Bottlenose dolphin, common		890	<1	

Project	Species	Maximum Charge Size (kg)	Maximum PTS Range (m)	Maximum Number of Animals Disturbed	Source
	dolphin, Risso's dolphin				
	Minke whale		4,215	<1	
	Grey seal		3,015	115	
	Harbour seal		3,015	2	
Mona OWF	Harbour porpoise	907	15,370	72	EnBW and BP (2023a)
	Bottlenose dolphin, common dolphin, Risso's dolphin		890	<1	
	Minke whale		2,720	<1	
	Grey seal		3,015	6	
	Harbour seal		3,015	<1	
Morgan OWF Generation Assets	Harbour porpoise	907	15,370	184	EnBW and BP (2023e)
	Bottlenose dolphin, common dolphin, Risso's dolphin		890	<1	
	Minke whale		2,720	<1	
	Grey seal		3,015	2	
	Harbour seal		3,015	<1	

The construction phases of the other Tier 2 projects range from 2024 to 2027, therefore have possible overlap in UXO clearance activities with the Proposed Development. However, the closest, spatially, to the Proposed Development is the NISA OWF (143.68 km away). Given the PTS and TTS ranges did not exceed tens of kilometres for the Proposed Development, Mona OWF, and Morgan OWF Generation Assets (Table 7.104), there is limited potential for cumulative effects with these other projects.

Auditory Injury (PTS)

Overall, the cumulative impact is predicted to be of local spatial extent, very short-term duration (within seconds), intermittent throughout the construction phases of the projects, and, although the impact itself is reversible (i.e. elevated underwater noise during the detonation event only), the effect of PTS permanent. It is predicted that the impact will affect the receptor directly. In line with UXO guidance, assuming standard industry measures applied for each project, it is anticipated that animals would be deterred from the ZoI, thus reducing the risk of PTS. The magnitude is therefore considered to be negligible (for bottlenose dolphin, common dolphin, Risso's dolphin, minke whale, grey seal and harbour seal). For harbour porpoise the PTS ranges were larger and there is considered to be a residual risk of PTS to a small number of individuals, therefore the magnitude is considered to be low for harbour porpoise.

Behavioural Disturbance (TTS as a Proxy)

The cumulative impact of TTS resulting from a high-order detonation is predicted to be of regional spatial extent, short-term duration, intermittent and both the impact itself (i.e. elevated underwater noise during the detonation event only) and effect of TTS is reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be low for all species.

Sensitivity of the Receptor

The sensitivity of the receptor is as described above for the Proposed Development alone (see section 7.12.15).

Auditory Injury (PTS)

Overall, all marine mammal IEFs are deemed to have limited tolerance to PTS, high vulnerability, low recoverability, and international value. The sensitivity or the receptor is therefore considered to be high.

Behavioural Disturbance (TTS as a Proxy)

Overall, since TTS is reversible, all marine mammal IEFs are assessed as having some tolerance, medium vulnerability, high recoverability, and international value. The sensitivity of the receptor is therefore considered to be low.

Significance of Effect

Auditory Injury (PTS)

Overall, for all IEFs except harbour porpoise, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high. Therefore, the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Overall, for harbour porpoise, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be high. As per Table 7.31, this results in a 'minor or moderate' significance of effect. However given the low chance of temporal overlap in clearance events or concurrent detonations, based on the low numbers of detonations per day expected during clearance activities the effect is therefore assessed to be of **minor adverse** significance, which is **not significant** in EIA terms.

Behavioural Disturbance (TTS as a Proxy)

Overall, for all IEFs, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, it has been concluded that the effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

7.13.17.3 Tier 3 and 4

There were no Tier 3 or 4 plans, projects, or activities identified in the CEA with the potential to result in cumulative impacts regarding underwater noise during UXO clearance.

7.13.18 Injury, Disturbance, and Displacement from Underwater Noise Generated during Geophysical and Seismic Site Investigation Surveys

There is the potential for cumulative increased underwater noise as a result of site investigation survey activities associated with the construction and operation and maintenance phases of the Proposed Development and other plans, projects, and activities. For the purposes of this ES, this additive impact has been assessed, using the tiered approach outlined above in section 7.13.1. Based on the maximum disturbance ranges modelled for this impact for the Proposed Development (13 km), a buffer of 13 km was implemented in the CEA screening exercise.

As detailed in section 7.12.16, there are no thresholds in Popper *et al.* (2014) in relation to HF sonar (>10 kHz) for marine turtles. Thus, marine turtles were not included in the underwater noise modelling for this impact for the Proposed Development alone, and are thus, not included in this cumulative impact either.

The risk of injury to marine mammals in terms of PTS due to site investigation surveys would be expected to be localised to within the close vicinity of respective projects. The assessment for the Proposed Development found that the injury ranges are expected to be small, and the magnitude of the impact has been assessed to be negligible (see section 7.12.16). Therefore, there is very low potential for cumulative impacts for injury from elevated underwater sound due to site investigation surveys and the cumulative assessment provided in the following sections focuses on disturbance only. As animals are likely to recover from this disturbance within hours, surveys that were completed prior to the commencement of construction phase of the Proposed Development (2024-2026) were screened out from further consideration.

All plans, projects, and activities screened into the assessment for cumulative effects from this impact are either on-going activities or projects with sufficient information in the public domain. The plans, projects, and activities within each tier screened into the CEA for each phase of development are illustrated in Table 7.94.

7.13.18.1 Tier 1

Construction and Operation and Maintenance Phases

There is potential for cumulative impacts with one Tier 1 project in the construction and operation and maintenance phases: Awel y Môr OWF. However, this impact was not assessed in the ES for Awel y Môr OWF (RWE Renewables UK, 2022). Therefore, no Tier 1 assessment was conducted.

7.13.18.2 Tier 2

Construction Phase

Magnitude of Impact

There is potential for cumulative impacts with two Tier 2 projects in the construction phase: Mona OWF and Morgan OWF Generation Assets.

For the Mona OWF and Morgan OWF Generation Assets, the MDS includes geophysical survey techniques, such as MBES, SBES, SBP, Side Scan Sonar (SSS), and Ultra High Resolution Seismic (UHRS). It also includes geotechnical activities, such as boreholes, Cone Penetration Tests (CPT), and vibrocores (EnBW and BP, 2023a, 2023e). The underwater noise modelling for the Mona OWF predicted disturbance ranges within hundreds of metres for most activities, with the highest distances of 17.3 km and 31 km presented for SBP and vibrocores, respectively (EnBW and BP, 2023a). A similar pattern was also presented by the modelling for Morgan OWF Generation Assets, and the highest behavioural disturbance ranges were 17 km and 55 km, also for SBP and vibrocores, respectively (EnBW and BP, 2023e). These values exceed those modelled for the Proposed Development, where the highest disturbance range was 13 km for mild disturbance (140 dB re 1 µPa (rms)) due to VSP (Table 7.77).

Overall, the impact of site investigation surveys leading to behavioural disturbance is predicted to be of local spatial extent (i.e. limited to three projects, including the Proposed Development, in close proximity to one another), short-term duration (for the individual surveys), intermittent, and high reversibility (as increased underwater noise only occurs during surveys). The effect of behavioural disturbance is also reversible, as animals returning to baseline levels soon after the surveys have stopped. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as described above for the Proposed Development alone (see section 7.12.16).

It is expected that, to some extent, marine mammals will be able to adapt their behaviour to reduce impacts on survival and reproduction rates and tolerate elevated levels of underwater noise during site investigation surveys. Marine mammals are deemed to have some tolerance, medium vulnerability, high recoverability, and international value. The sensitivity of these receptors to behavioural disturbance from elevated underwater noise during site investigation surveys is therefore considered to be medium.

Significance of Effect

Overall, the magnitude of the impact of behavioural disturbance is deemed to be low and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

Operation and Maintenance Phase

Magnitude of Impact

The operation and maintenance phase of the Proposed Development may interact cumulatively with that of four Tier 2 projects: the Mona OWF, Morgan OWF Generation Assets, the Morgan and Morecambe OWF Transmission Assets and Mooir Vannin OWF.

At the time of writing, there was no publicly available information to quantify this impact at the Morgan and Morecambe OWF Transmission Assets or at Mooir Vannin OWF. In addition, neither of the PEIRs for the Mona OWF and Morgan OWF Generation Assets assessed this impact in their operation and maintenance phases. Therefore, a quantitative Tier 2 assessment was not possible for the operation and maintenance phase. However, it is predicted to be of similar or lesser magnitude than provided above for the construction phase.

Overall, the impact of site investigation surveys leading to behavioural disturbance is predicted to be of local spatial extent (i.e. limited to four projects, including the Proposed Development, in close proximity to one another), short-term duration (for the individual surveys), intermittent throughout the operation and maintenance phase, and high reversibility (as increased underwater noise only occurs during surveys). The effect of behavioural disturbance is also reversible, as animals returning to baseline levels soon after the surveys have stopped. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as described above for the Proposed Development alone (see section 7.12.16).

It is expected that, to some extent, marine mammals will be able to adapt their behaviour to reduce impacts on survival and reproduction rates and tolerate elevated levels of underwater noise during site investigation surveys. Marine mammals are deemed to have some tolerance, medium vulnerability, high recoverability, and international value. The sensitivity of these receptors to behavioural disturbance from elevated underwater noise during site investigation surveys is therefore considered to be medium.

Significance of Effect

Overall, the magnitude of the impact of behavioural disturbance is deemed to be low and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

7.13.18.3 Tier 3 and 4

Construction and Operation and Maintenance Phases

There were no Tier 3 or 4 plans, projects, or activities identified in the CEA with the potential to result in cumulative impacts regarding underwater noise during geophysical and seismic site investigation surveys.

7.13.19 Injury, Disturbance, and Displacement from Vessel Activity and other Noise Producing Activities

There is the potential for cumulative increased underwater noise as a result of vessel activities associated with all three phases of the Proposed Development and other plans, projects, and activities. For the purposes of this ES, this additive impact has been assessed using the tiered approach outlined above in section 7.13.1.

As for the assessment of the Proposed Development alone (section 7.12.17), the risk of injury in terms of PTS as a result of underwater noise produced by vessels and other non-piling activities would be expected to be very low. PTS thresholds unlikely to be exceeded or would be very localised (<10 m) from the source, given that they were not exceeded for any species in the underwater noise modelling of the Proposed Development alone (section 7.12.17). Given the above, there is very low potential for cumulative impacts to cause injury (in terms of PTS) as a result of increased underwater noise from vessels and other (non-piling) noise producing activities. Instead, the cumulative assessment provided below focuses on disturbance only for this impact.

All plans, projects, and activities screened into the assessment for cumulative effects from this impact are either on-going activities or projects with sufficient information in the public domain. The plans, projects, and activities within each tier screened into the CEA for each phase of development are illustrated in Table 7.94.

7.13.19.1 Tier 1

Construction Phase

Magnitude of Impact

<u>All Species</u>

There is potential for cumulative impacts with two Tier 1 project in the construction phase: Awel y Môr OWF and Mostyn Energy Park Extension. It should be noted that the construction phase of Awel y Môr is anticipated to be between 2026 and 2030 (Table 7.93), so will only temporally overlap with that of the Proposed Development for less than a year.

The MDS for Awel y Môr OWF describes up to 101 construction vessels in total, of which 35 may be on site at one time (RWE Renewables UK, 2022). For the Proposed Development, the MDS assumes a total of 236 vessel round trips over the two-year construction phase (Table 7.23).

In the ES for Awel y Môr OWF, impacts associated with underwater noise due to vessel traffic and other construction activities was based on a desktop study. This study stated that using Benhemma-Le Gall *et al.* (2021), harbour porpoise and other cetaceans may be displaced up to 4 km from construction vessels. It also identified localised behavioural disturbance ranges for harbour porpoise and grey seal with avoidance reported up to 5 km from the site during dredging activities. Dredging was predicted to reduce bottlenose dolphin presence of the Awel y Môr OWF for five weeks. Similarly, minke whale presence was adversely correlated with construction related activities, including dredging (RWE Renewables UK, 2022).

It is a standard practice to present estimated ranges over which behavioural disturbance may occur for different vessel types in isolation. For the Proposed Development, disturbance ranges of up to 20 km were predicted for survey vessels, crew transfer vessels, and support vessels (Table 7.79). It is likely that several activities could be potentially consecutively across several offshore developments, and therefore disturbance ranges may extend from several vessels/locations where the activity is carried out.

Therefore, cumulatively across the Proposed Development and Awel y Môr OWF, there may be a noticeable increase in vessel activity from the baseline. Although, it should be noted that the assessments are based on the MDSs and that the number of vessels present at respective projects at any given time is likely to be lower in reality. In addition, vessel movements will be confined to their respective construction areas and will follow existing shipping routes to and from ports. Therefore, it would not be realistic to present a sum of all vessels anticipated within the Proposed Development and Awel y Môr OWF. Introduction of vessels during construction and operations and maintenance phases of the projects will not be a novel impact for marine mammals and marine turtles in the vicinity, and animals, therefore, are anticipated to demonstrate some degree of habituation to this impact.

EIA for the Mostyn Energy Park Extension concluded that there would be no risk of injury or significant disturbance to marine mammals from dredging or vessel activities even if dredging and vessel movements were to take place continuously (i.e. day and night) over the construction phase.

The cumulative impact is predicted to be of local spatial extent, short-term duration (due to the <1 year overlap between construction phase), intermittent (in terms of vessel movements and activities) and both the impact itself (increased underwater noise) and effect of behavioural disturbance are reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as defined above for the Proposed Development alone (section 7.12.17).

Marine Mammal IEFs

Overall, the marine mammal IEFs are deemed to have some tolerance to behavioural disturbance, medium vulnerability, high recoverability and international value. The sensitivity of these receptors is therefore considered to be medium.

Marine Turtle IEFs

Overall, marine turtles are deemed to be of low vulnerability, high tolerance, high recoverability, and international value. The sensitivity of these receptors to behavioural disturbance is therefore considered to be low.

Significance of Effect

Marine Mammal IEFs

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the cumulative effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Marine Turtle IEFs

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the cumulative effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Operation and Maintenance and Decommissioning Phases

Magnitude of Impact

All Species

There is potential for cumulative impacts with one Tier 1 project in both the operation and maintenance and decommissioning phases of the Proposed Development: Awel y Môr OWF. It should be noted that the operation and maintenance phase of Awel y Môr OWF is expected to be between 2030 and 2055, therefore it will still be in operation after cessation of the decommissioning phase of the Proposed Development (Table 7.93). The MDS for Awel y Môr OWF includes up to 1,232 vessel return trips annually over the 25-year operation and maintenance phase (30,800 total) (RWE Renewables UK, 2021a). Only two jack-up vessels and two service operation vessels would be on site at any one time (RWE Renewables UK, 2022). In addition, the MDS for the Proposed Development assumes that there will be up to 750 and 128 vessel round trips over the operation and maintenance and decommissioning phases, respectively (Table 7.23).

As in the construction phase, there may be a noticeable increase in vessel activity from the baseline. Although, it should be noted that the assessments are based on the MDSs and that the number of vessels present at respective projects at any given time is likely to be lower in reality. In addition, vessel movements will be confined to their respective construction areas and will follow existing shipping routes to and from ports. Therefore, it would not be realistic to present a sum of all vessels anticipated within the Proposed Development and Awel y Môr OWF. Introduction of vessels during operations and maintenance and decommissioning phases of the projects will not be a novel impact for marine mammals and marine turtles in the vicinity, and animals, therefore, are anticipated to demonstrate some degree of habituation to this impact.

As for the construction phase, vessel movements at the Mostyn Energy Park Extension are not expected to cause injury, disturbance, or displacement of marine mammals.

The cumulative impact is predicted to be of local spatial extent, long-term duration (temporally over the operation and maintenance and decommissioning phase, but not in terms of individual vessel movements/activities), intermittent (in terms of vessel movements/activities) and both the impact itself (increased underwater noise) and effect of behavioural disturbance are reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as defined above for the Proposed Development alone (section 7.12.17).

Marine Mammal IEFs

Overall, the marine mammal IEFs are deemed to have some tolerance to behavioural disturbance, medium vulnerability, high recoverability and international value. The sensitivity of these receptors is therefore considered to be medium.

Marine Turtle IEFs

Overall, marine turtles are deemed to be of low vulnerability, high tolerance, high recoverability, and international value. The sensitivity of these receptors to behavioural disturbance is therefore considered to be low.

Significance of Effect

Marine Mammal IEFs

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the cumulative effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Marine Turtle IEFs

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the cumulative effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

7.13.19.2 Tier 2

Construction Phase

Magnitude of Impact

<u>All Species</u>

The construction phase of the Proposed Development may interact cumulatively with that of two Tier 2 projects: the Mona OWF and Morgan OWF Generation Assets.

The MDS for the Mona OWF assumes up to 80 vessels on site at any one time and up to 2,004 vessel round trips over the construction phase (EnBW and BP, 2023a). The MDS for Morgan OWF Generation assets assumes up to 63 vessels on site at any one time, with 1,878 total round trips over the construction phase (EnBW and BP, 2023e). In contrast, there will be up to 236 vessel round trips in the construction phase of the Proposed Development (Table 7.23). It should be noted that the construction phases for both these Tier 2 projects are anticipated to be between 2026 and 2028, therefore will only overlap with that of the Proposed Development for <1 year (in 2026).

Both Mona OWF and Morgan OWF Generation Assets also include drilling, cable trenching and laying, and jack-up rig use as other noise producing activities (EnBW and BP, 2023a, 2023e). Like the assessment for the Proposed Development alone, the maximum disturbance ranges modelled for Mona OWF and Morgan OFW Generation Assets were for survey vessel movements, at 22 km and 21 km, respectively (EnBW and BP, 2023a, 2023e).

As above for the Tier 1 assessment, there may be a noticeable increase in vessel activity from the baseline due to these projects. Although, it should be noted that the assessments are based on the MDSs and that the number of vessels present at respective projects at any given time is likely to be lower in reality. In addition, vessel movements will be confined to their respective construction areas and will follow existing shipping routes to and from ports. Introduction of vessels will not be a novel impact for marine mammals and marine turtles in the vicinity, and animals, therefore, are anticipated to demonstrate some degree of habituation to this impact.

The cumulative impact is predicted to be of local spatial extent, short-term duration (over the construction phase), intermittent (in terms of vessel movements/activities) and both the impact itself (increased underwater noise) and effect of behavioural disturbance are reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as defined above for the Proposed Development alone (section 7.12.17).

<u>Marine Mammal IEFs</u>

Overall, the marine mammal IEFs are deemed to have some tolerance to behavioural disturbance, medium vulnerability, high recoverability and international value. The sensitivity of these receptors is therefore considered to be medium.

<u>Marine Turtle IEFs</u>

Overall, marine turtles are deemed to be of low vulnerability, high tolerance, high recoverability, and international value. The sensitivity of these receptors to behavioural disturbance is therefore considered to be low.

Significance of Effect

Marine Mammal IEFs

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the cumulative effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Marine Turtle IEFs

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the cumulative effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Operation and Maintenance and Decommissioning Phases

Magnitude of Impact

All Species

The operation and maintenance and decommissioning phases of the Proposed Development may interact cumulatively with that of three Tier 2 projects: the Mona OWF, Morgan OWF Generation Assets, and the Morgan and Morecambe OWF Transmission Assets. It should be noted that the operation and maintenance phases of Mona OWF and Morgan Generation are expected to be between 2029 and 2089, therefore they will still be in operation after cessation of the decommissioning phase of the Proposed Development (Table 7.93). Similarly, the operation and maintenance phase of the Morgan and Morecambe OWF Transmission Assets is anticipated to be between 2030 and 2065 (Table 7.93), so also encompasses the decommissioning phase of the Proposed Development.

At the time of writing, there was no publicly available information to quantify this impact at the Morgan and Morecambe OWF Transmission Assets. As the transmission assets only involves cables, it is likely that this impact will be of a lower extent to that presented for Mona OWF and Morgan OWF Generation Assets.

The MDS for the Mona OWF assumes up to 21 vessels on site at any one time and up to 2,351 vessel round trips over the construction phase (EnBW and BP, 2023a). This results in 61,126 vessel movements over the 26-year overlap with the operation and maintenance and decommissioning phases of the Proposed Development. The MDS for Morgan OWF Generation assets also assumes up to 21 vessels on site at any one time, with 2,351 total round trips per year (EnBW and BP, 2023e). For the Proposed Development, there will be up to 750 vessel round trips in the operation and maintenance phase and 128 in the decommissioning phase (Table 7.23).

The three Tier 2 projects are also likely to include activities such as cable repair and reburial over their operation and maintenance phases, although values for these were not included in their PEIRs.

As above for the Tier 1 assessment, there may be a noticeable increase in vessel activity from the baseline due to these projects. Although, it should be noted that the assessments are based on the MDSs and that the number of vessels present at respective projects at any given time is likely to be lower in reality. In addition, vessel movements will be confined to their respective construction areas and will follow existing shipping routes to and from ports. Introduction of vessels will not be a novel impact for marine mammals and marine turtles in the vicinity, and animals, therefore, are anticipated to demonstrate some degree of habituation to this impact.

The cumulative impact is predicted to be of local spatial extent, long-term duration (temporally over the operation and maintenance and decommissioning phase), intermittent (in terms of vessel movements/activities) and both the impact itself (increased underwater noise) and effect of behavioural disturbance are reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as defined above for the Proposed Development alone (section 7.12.17).

Marine Mammal IEFs

Overall, the marine mammal IEFs are deemed to have some tolerance to behavioural disturbance, medium vulnerability, high recoverability and international value. The sensitivity of these receptors is therefore considered to be medium.

Marine Turtle IEFs

Overall, marine turtles are deemed to be of low vulnerability, high tolerance, high recoverability, and international value. The sensitivity of these receptors to behavioural disturbance is therefore considered to be low.

Significance of Effect

Marine Mammal IEFs

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the cumulative effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Marine Turtle IEFs

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the cumulative effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

7.13.19.3 Tier 3

Construction Phase

Magnitude of Impact

All Species

There is potential for cumulative impacts with one Tier 3 project in the construction phase of the Proposed Development: The MaresConnect interconnector cable.

There is, however, currently no information on the impact that the MaresConnect interconnector cable will have on marine mammal and marine turtles. A planning application is predicted to be submitted in 2024 which will identify and assess these impacts (MaresConnect, 2023).

As it transects the Proposed Development, the construction of the MaresConnect interconnector cable will result in increased vessel traffic in proximity to the Proposed Development. Non-piling noise producing activities that are likely to occur are cable laying using jet trenching techniques and the installation of cable protection. Construction is planned to occur in 2025 and the project is anticipated to become operational in 2027 (MaresConnect, 2023), although it should be noted that these timeframes are only indicative at this stage.

The cumulative impact is predicted to be of local spatial extent, short term duration (for the individual construction activities), intermittent, and both the impact itself (increased underwater noise) and effect of behavioural disturbance are reversible. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as defined above for the Proposed Development alone (section 7.12.17).

Marine Mammal IEFs

Overall, the marine mammal IEFs are deemed to have some tolerance to behavioural disturbance, medium vulnerability, high recoverability and international value. The sensitivity of these receptors is therefore considered to be medium.

Marine Turtle IEFs

Overall, marine turtles are deemed to be of low vulnerability, high tolerance, high recoverability, and international value. The sensitivity of these receptors to behavioural disturbance is therefore considered to be low.

Significance of Effect

Marine Mammal IEFs

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the cumulative effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Marine Turtle IEFs

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the cumulative effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Operation and Maintenance Phase

Magnitude of Impact

All Species

There is potential for cumulative impacts with one Tier 3 project in the operation and maintenance phase of the Proposed Development: The MaresConnect interconnector cable.

There is, however, currently no information on the impact that the MaresConnect interconnector cable will have on marine mammal and marine turtles. A planning application is predicted to be submitted in 2024 which will identify and assess these impacts (MaresConnect, 2023). The MaresConnect interconnector cable is anticipated to become operational in 2027 (MaresConnect, 2023), although it should be noted that these timeframes are only indicative at this stage.

As it transects the Proposed Development, the operation and maintenance phase of the MaresConnect interconnector cable will result in increased vessel traffic in proximity to the Proposed Development. Non-piling noise producing activities that are likely to occur involve the repair and reburial of cables. The operation and maintenance phase may also potentially result in increased vessel movement, although this will likely be of a lower extent than in the construction phase.

The cumulative impact is predicted to be of local spatial extent, short term duration (for the individual activities), intermittent, and both the impact itself (increased underwater noise) and effect of behavioural disturbance are reversible. It is predicted that the impact will affect the receptor directly. Therefore, the magnitude of impact is considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as defined above for the Proposed Development alone (section 7.12.17).

Marine Mammal IEFs

Overall, the marine mammal IEFs are deemed to have some tolerance to behavioural disturbance, medium vulnerability, high recoverability and international value. The sensitivity of these receptors is therefore considered to be medium.

Marine Turtle IEFs

Overall, marine turtles are deemed to be of low vulnerability, high tolerance, high recoverability, and international value. The sensitivity of these receptors to behavioural disturbance is therefore considered to be low.

Significance of Effect

Marine Mammal IEFs

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the cumulative effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Marine Turtle IEFs

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. Therefore, the cumulative effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Decommissioning Phase

There were no Tier 3 plans, projects, or activities identified in the CEA with the potential to result in cumulative increased underwater noise from vessels and other activities in the decommissioning phase of the Proposed Development.

7.13.19.4 Tier 4

There were no Tier 4 plans, projects, or activities identified in the CEA with the potential to result in cumulative impacts regarding vessel activity and other noise producing activities.

7.13.20 Injury due to Collision with Marine Vessels

There is the potential for cumulative increased risk of vessel collision associated with all three phases of the Proposed Development and other plans, projects, and activities. For the purposes of this ES, this additive impact has been assessed within Liverpool Bay, using the tiered approach outlined above in section 7.13.1.

All plans, projects, and activities screened into the assessment for cumulative effects from this impact are either on-going activities or projects with sufficient information in the public domain. The plans, projects, and activities within each tier screened into the CEA for each phase of development are illustrated in Table 7.94.

7.13.20.1 Tier 1

Construction Phase

Magnitude of Impact

All Species

There is potential for cumulative impacts with two Tier 1 projects in the construction phase: Awel y Môr OWF and Mostyn Energy Park Extension. It should be noted that the construction phase of Awel y Môr OWF is anticipated to be between 2026 and 2030 (Table 7.93), so will only temporally overlap with that of the Proposed Development for less than a year.

The MDS for Awel y Môr OWF project describes up to 101 construction vessels in total, of which 35 may be on site at one time (RWE Renewables UK, 2022). For the Proposed Development, the MDS assumes a total of 236 vessel round trips over the two-year construction phase (Table 7.23).

Furthermore, the ES for the Awel y Môr OWF outlined a commitment to employ a vessel management plan and follow best practice vessel handling protocols to minimise any potential for collision. The Proposed Development also includes similar embedded mitigation in the form of an EMP, which will contain best practice codes of conduct to minimise collision risk (Table 7.32). As for the Proposed Development, it is anticipated that a proportion of vessels during construction of the Awel y Môr OWF will be slow moving or even stationary for periods of time and therefore unlikely to pose a significant collision risk to marine mammals (RWE Renewables UK, 2022). There is also a potential that the sound emissions from vessels will deter animals from the potential zone of impact (see section 7.13.19).

Overall, cumulatively across the Proposed Development and Awel y Môr OWF, there may be a noticeable increase in vessel activity from the baseline. Although, it should be noted that the assessments are based on the MDSs and that the number of vessels present at respective projects at any given time is likely to be lower in reality. In addition, vessel movements will be confined to their respective construction areas and will follow existing shipping routes to and from ports. The risk of collision would likely be localised to these areas and routes, and not extend over a wider area. Introduction of vessels during the construction phase will not be a novel impact for marine mammals and marine turtles in the vicinity, and animals, therefore, are anticipated to demonstrate some degree of habituation to this impact.

EIA for Mostyn Energy Park Extension did not include a quantitative assessment of injury due to collision with marine vessels. However, given the less than two-year construction period and existing vessel traffic associated with the port, the Mostyn Energy Park Extension is not expected to increase the risk of injury due to collision with marine vessels.

With standard industry measures in place to reduce the risk of collision (i.e. vessel management plan, EMP), the impact is predicted to be of limited spatial extent, short-term duration (over the two-year construction phase), intermittent (in terms of vessel movements) and, whilst the risk will only occur during vessel transits, the effect of collision on sensitive receptors is of medium to low reversibility (depending on the extent of injuries). It is predicted that the impact will affect the receptor directly. The magnitude is, conservatively, considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as defined above for the Proposed Development alone (section 7.12.18).

Marine Mammal IEFs

Overall, all marine mammal IEFs are deemed to have some tolerance (largely due to avoidance behaviour), medium recoverability and international value. The sensitivity of the receptor is therefore, considered to be medium.

Marine Turtle IEFs

Overall, marine turtle IEFs are deemed to have low tolerance, medium recoverability, and international value. The sensitivity of the receptor is therefore, considered to be medium.

Significance of Effect

All Species

Overall, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the cumulative effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Operation and Maintenance and Decommissioning Phases

Magnitude of Impact

All Species

There is potential for cumulative impacts with one Tier 1 project in both the operation and maintenance and decommissioning phases of the Proposed Development: Awel y Môr OWF. It should be noted that the operation and maintenance phase of Awel y Môr OWF is expected to be between 2030 and 2055, therefore it will still be in operation after cessation of the decommissioning phase of the Proposed Development (Table 7.93). The MDS for Awel y Môr OWF includes up to 1,232 vessel return trips annually over the 25-year operation and maintenance phase (30,800 total) (RWE Renewables UK, 2021a). Only two jack-up vessels and two service operation vessels would be on site at any one time (RWE Renewables UK, 2022). In addition, the MDS for the Proposed Development assumes that there will be up to 750 and 128 vessel round trips over the operation and maintenance and decommissioning phases, respectively (Table 7.23).

As above for the construction phase, the vessel management plan outlined in the ES for Awel y Môr OWF and the EMP for the Proposed Development will outline best practice vessel handling protocols to minimise any potential for collision. Further, it is anticipated that a proportion of vessels for Awel y Môr OWF and the Proposed Development will be slow moving or even stationary for periods of time and thus unlikely to pose a significant collision risk to marine mammals (RWE Renewables UK, 2022). There is also a potential that the sound emissions from vessels will deter animals from the potential zone of impact (see section 7.13.19).

Overall, cumulatively across the Proposed Development and Awel y Môr OWF, there may be a noticeable increase in vessel activity from the baseline. Although, it should be noted that the assessments are based on the MDSs and that the number of vessels present at respective projects at any given time is likely to be lower in reality. In addition, vessel movements will follow existing shipping routes to and from ports and be contained within localised areas for individual maintenance and decommissioning activities. The risk of collision would likely be localised to these areas and routes, and not extend over a wider area. Introduction of vessels during the operations and maintenance and decommissioning phases will not be a novel impact for marine mammals and marine turtles in the vicinity, and animals, therefore, are anticipated to demonstrate some degree of habituation to this impact.

With standard industry measures in place to reduce the risk of collision (i.e. vessel management plan, EMP), the impact is predicted to be of limited spatial extent, long-term duration, intermittent (in terms of vessel movements) and, whilst the risk will only occur during vessel transits, the effect of collision on sensitive receptors is of medium to low reversibility (depending on the extent of injuries). It is predicted that the impact will affect the receptor directly. The magnitude is, conservatively, considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as defined above for the Proposed Development alone (section 7.12.18).

Marine Mammal IEFs

Overall, all marine mammal IEFs are deemed to have some tolerance (largely due to avoidance behaviour), medium recoverability and international value. The sensitivity of the receptor is therefore, considered to be medium.

Marine Turtle IEFs

Overall, marine turtle IEFs are deemed to have low tolerance, medium recoverability, and international value. The sensitivity of the receptor is therefore, considered to be medium.

Significance of Effect

All Species

Overall, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the cumulative effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

7.13.20.2 Tier 2

Construction Phase

Magnitude of Impact

All Species

The construction phase of the Proposed Development may interact cumulatively with that of two Tier 2 projects: the Mona OWF and Morgan OWF Generation Assets.

The MDS for the Mona OWF assumes up to 80 vessels on site at any one time and up to 2,004 vessel round trips over the construction phase (EnBW and BP, 2023a). The MDS for Morgan OWF Generation assets assumes up to 63 vessels on site at any one time, with 1,878 total round trips over the construction phase (EnBW and BP, 2023e). In contrast, there will be up to 236 vessel round trips in the construction phase of the Proposed Development (Table 7.23). It should be noted that the construction phases for both these Tier 2 projects are anticipated to be between 2026 and 2028, therefore will only overlap with that of the Proposed Development for <1 year (in 2026).

As above for the Tier 1 assessment, both the Tier 2 projects have outlined a commitment to an EMP, which includes measures to minimise collision and disturbance to marine mammals (EnBW and BP, 2023a, 2023e). Further, it is anticipated that a proportion of vessels for the Tier 2 projects and the Proposed Development will be slow moving or even stationary for periods of time and thus unlikely to pose a significant collision risk to marine mammals (EnBW and BP, 2023a, 2023e). There is also a potential that the sound emissions from vessels will deter animals from the potential zone of impact (see section 7.13.19).

As above for the Tier 1 assessment, there may be a noticeable increase in vessel activity from the baseline due to these projects. Although, it should be noted that the assessments are based on the MDSs and that the number of vessels present at respective projects at any given time is likely to be lower in reality. In addition, vessel movements will be confined to their respective construction areas and will follow existing shipping routes to and from ports. Introduction of vessels will not be a novel impact for marine mammals and marine turtles in the vicinity, and animals, therefore, are anticipated to demonstrate some degree of habituation to this impact.

With standard industry measures in place to reduce the risk of collision (i.e. EMPs), the impact is predicted to be of limited spatial extent, short-term duration (over the two-year construction phase), intermittent (in terms of vessel movements) and, whilst the risk will only occur during vessel transits, the effect of collision on sensitive receptors is of medium to low reversibility (depending on the extent of injuries). It is predicted that the impact will affect the receptor directly. The magnitude is, conservatively, considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as defined above for the Proposed Development alone (section 7.12.18).

Marine Mammal IEFs

Overall, all marine mammal IEFs are deemed to have some tolerance (largely due to avoidance behaviour), medium recoverability and international value. The sensitivity of the receptor is therefore, considered to be medium.

Marine Turtle IEFs

Overall, marine turtle IEFs are deemed to have low tolerance, medium recoverability, and international value. The sensitivity of the receptor is therefore, considered to be medium.

Significance of Effect

All Species

Overall, the magnitude of impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. Therefore, the cumulative effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Operation and Maintenance and Decommissioning Phases

Magnitude of Impact

All Species

The operation and maintenance and decommissioning phases of the Proposed Development may interact cumulatively with that of four Tier 2 projects: the Mona OWF, Morgan OWF Generation Assets, the Morgan and Morecambe OWF Transmission Assets and Mooir Vannin OWF. It should be noted that the operation and maintenance phases of Mona OWF and Morgan Generation are expected to be between 2029 and 2089, therefore they will still be in operation after cessation of the decommissioning phase of the Proposed Development (Table 7.93). Similarly, the operation and maintenance phase of the Morgan and Morecambe OWF Transmission Assets is anticipated to be between 2030 and 2065 and the operation and maintenance phase of Mooir Vannin OWF is expected to be between 2032 and 2067 (Table 7.93), so also encompasse the decommissioning phase of the Proposed Development.

At the time of writing, there was no publicly available information to quantify this impact at the Morgan and Morecambe OWF Transmission Assets or at Mooir Vannin OWF. As the transmission assets only involves cables, it is likely that this impact will be of a lower extent to that presented for Mona OWF and Morgan OWF Generation Assets.

The MDS for the Mona OWF assumes up to 21 vessels on site at any one time and up to 2,351 vessel round trips over the construction phase (EnBW and BP, 2023a). This results in 61,126 vessel movements over the 26-year overlap with the operation and maintenance and decommissioning phases of the Proposed Development. The MDS for Morgan OWF Generation assets also assumes up to 21 vessels on site at any one time, with 2,351 total round trips per year (EnBW and BP, 2023e). For the Proposed Development, there will be up to 750 vessel round trips in the operation and maintenance phase and 128 in the decommissioning phase (Table 7.23).

As above for the Tier 1 assessment, there may be a noticeable increase in vessel activity from the baseline due to these projects. Although, it should be noted that the assessments are based on the MDSs and that the number of vessels present at respective projects at any given time is likely to be lower in reality. In addition, vessel movements will be confined to their respective construction areas and will follow existing shipping routes to and from ports. Introduction of vessels will not be a novel impact for marine mammals and marine turtles in the vicinity, and animals, therefore, are anticipated to demonstrate some degree of habituation to this impact.

With standard industry measures in place to reduce the risk of collision (i.e. EMPs), the impact is predicted to be of limited spatial extent, long-term duration, intermittent (in terms of vessel movements) and, whilst the risk will only occur during vessel transits, the effect of collision on sensitive receptors is of medium to low reversibility (depending on the extent of injuries). It is predicted that the impact will affect the receptor directly. The magnitude is, conservatively, considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as defined above for the Proposed Development alone (section 7.12.18).

Marine Mammal IEFs

Overall, all marine mammal IEFs are deemed to have some tolerance (largely due to avoidance behaviour), medium recoverability and international value. The sensitivity of the receptor is therefore, considered to be medium.

Marine Turtle IEFs

Overall, marine turtle IEFs are deemed to have low tolerance, medium recoverability, and international value. The sensitivity of the receptor is therefore, considered to be medium.

Significance of Effect

All Species

Overall, the magnitude of impact is deemed to be low and the sensitivity of the receptor is considered to be medium. Therefore, the cumulative effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

7.13.20.3 Tier 3

Construction Phase

Magnitude of Impact

All Species

There is potential for cumulative impacts with one Tier 3 project in the construction phase of the Proposed Development: The MaresConnect interconnector cable.

There is, however, currently no information on the impact that the MaresConnect interconnector cable will have on marine mammal and marine turtles. A planning application is predicted to be submitted in 2024 which will identify and assess these impacts (MaresConnect, 2023). It is likely that standard industry mitigation, such as an EMP or vessel management plan, will be implemented for the MaresConnect interconnector cable.

As it transects the Proposed Development, the construction of the MaresConnect interconnector cable will result in increased vessel traffic in proximity to the Proposed Development, although it is likely that this will be of a lower extent to the vessel traffic anticipated for the Tier 1 and Tier 2 OWF projects. Construction is planned to occur in 2025 and the project is anticipated to become operational in 2027 (MaresConnect, 2023), although it should be noted that these timeframes are only indicative at this stage.

As above for the Tier 1 and 2 assessments, there may be an increase in vessel activity from the baseline. However, the risk of collision would likely be localised to the areas and routes required for the construction of the MaresConnect interconnector cable, and not extend over a wider area. Introduction of vessels will not be a novel impact for marine mammals and marine turtles in the vicinity, and animals, therefore, are anticipated to demonstrate some degree of habituation to this impact.

With standard industry measures in place to reduce the risk of collision (i.e. EMPs), the impact is predicted to be of local spatial extent, long-term duration, intermittent (in terms of vessel movements) and, whilst the risk will only occur during vessel transits, the effect of collision on sensitive receptors is of medium to low reversibility (depending on the extent of injuries). It is predicted that the impact will affect the receptor directly. The magnitude is, conservatively, considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as defined above for the Proposed Development alone (section 7.12.18).

Marine Mammal IEFs

Overall, all marine mammal IEFs are deemed to have some tolerance (largely due to avoidance behaviour), medium recoverability and international value. The sensitivity of the receptor is therefore, considered to be medium.

Marine Turtle IEFs

Overall, marine turtle IEFs are deemed to have low tolerance, medium recoverability, and international value. The sensitivity of the receptor is therefore, considered to be medium.

Significance of Effect

All Species

Overall, the magnitude of impact is deemed to be low and the sensitivity of the receptor is considered to be medium. Therefore, the cumulative effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Operation and Maintenance Phase

Magnitude of Impact

All Species

There is potential for cumulative impacts with one Tier 3 project in the operation and maintenance phase of the Proposed Development: The MaresConnect interconnector cable.

There is, however, currently no information on the impact that the MaresConnect interconnector cable will have on marine mammal and marine turtles. A planning application is predicted to be submitted in 2024 which will identify and assess these impacts (MaresConnect, 2023). It is likely that standard industry mitigation, such as an EMP or vessel management plan, will be implemented for the MaresConnect interconnector cable.

As it transects the Proposed Development, operation and maintenance activities for MaresConnect interconnector cable will result in increased vessel traffic in proximity to the Proposed Development, although it is likely that this will be of a lower extent to the vessel traffic anticipated for the Tier 1 and Tier 2 OWF projects or for the construction phase. The MaresConnect interconnector cable is anticipated to become operational in 2027 (MaresConnect, 2023), although it should be noted that these timeframes are only indicative at this stage.

As above for the Tier 1 and 2 assessments, there may be an increase in vessel activity from the baseline. However, the risk of collision would likely be localised to the areas and routes required for the construction of the MaresConnect interconnector cable, and not extend over a wider area. Introduction of vessels will not be a novel impact for marine mammals and marine turtles in the vicinity, and animals, therefore, are anticipated to demonstrate some degree of habituation to this impact.

With standard industry measures in place to reduce the risk of collision (i.e. EMPs), the impact is predicted to be of limited spatial extent, long-term duration, intermittent (in terms of vessel movements) and, whilst the risk will only occur during vessel transits, the effect of collision on sensitive receptors is of medium to low reversibility (depending on the extent of injuries). It is predicted that the impact will affect the receptor directly. The magnitude is, conservatively, considered to be low.

Sensitivity of the Receptor

The sensitivity of the receptor is as defined above for the Proposed Development alone (section 7.12.18).

Marine Mammal IEFs

Overall, all marine mammal IEFs are deemed to have some tolerance (largely due to avoidance behaviour), medium recoverability and international value. The sensitivity of the receptor is therefore, considered to be medium.

Marine Turtle IEFs

Overall, marine turtle IEFs are deemed to have low tolerance, medium recoverability, and international value. The sensitivity of the receptor is therefore, considered to be medium.

Significance of Effect

All Species

Overall, the magnitude of impact is deemed to be low and the sensitivity of the receptor is considered to be medium. Therefore, the cumulative effect will be of **minor adverse** significance, which is **not significant** in EIA terms.

Decommissioning Phase

There were no Tier 3 plans, projects, or activities identified in the CEA with the potential to result in cumulative impacts regarding vessel collision in the decommissioning phase of the Proposed Development.

7.13.20.4 Tier 4

There were no Tier 4 plans, projects, or activities identified in the CEA with the potential to result in cumulative impacts regarding vessel collision.

7.13.21 Conclusion

Overall, there were no significant cumulative effects identified for any tiers in the CEA for marine mammals and marine turtles.

7.14 Transboundary Effects

7.14.1 Overview

A screening for transboundary effects was conducted for each marine biodiversity topic and has identified potential for transboundary effects to fish and shellfish ecology and marine mammals and marine turtles (volume 3, RPS Group (2023d)). These are summarised in section 7.14.2 and section 7.14.3 below, respectively. There were no potential transboundary effects identified for benthic subtidal and intertidal ecology, due to the limited extent of the benthic ecology study areas and the reduced mobility of benthic receptors in comparison to fish and shellfish, marine mammals, and marine turtles.

7.14.2 Fish and Shellfish Ecology

As assessed in sections 7.12.9 to 7.12.12 above, potential impacts on fish and shellfish IEFs were:

- Temporary habitat loss and/or disturbance;
- Long-term subtidal habitat loss;
- Underwater noise impacting fish and shellfish receptors; and
- Increased SSCs and associated deposition.

Impacts associated with habitat loss and increased SSCs are likely to be localised to the Proposed Development fish and shellfish ecology study area, which is entirely out with other European Economic Area (EEA) states. However, increased underwater noise has the potential to injure and/or disturb fish and shellfish receptors, including Annex II diadromous fish species. Therefore, there is potential for transboundary effects associated with this impact.

7.14.3 Marine Mammals and Marine Turtles

As assessed in sections 7.12.14 to 7.12.19 above, potential impacts on marine mammal and marine turtle IEFs were:

- Injury, disturbance, and displacement from underwater noise during piling;
- Injury, disturbance, and displacement from underwater noise generated during UXO clearance;
- Injury, disturbance, and displacement from underwater noise during geophysical and seismic survey activities;
- Injury, disturbance, and displacement from vessel activity and other noise producing activities;
- Injury due to collision with marine vessels; and
- Effects on marine mammals and marine turtles due to changes in prey availability.

It is acknowledged that some marine mammals and marine turtles can travel large distances to forage and consequently the marine mammals and marine turtles under the protection of neighbouring EU States may be affected. Therefore, there is the potential for transboundary impacts associated with the Proposed Development to directly affect Annex II marine mammal species. Therefore, there is potential for transboundary effects associated with this impact.

7.15 Inter-related effects

7.15.1 Overview

An inter-related effects assessment has been conducted and is presented in full in volume 2, chapter 14. The inter-related effects assessment is summarised in the following sections.

7.15.2 Benthic Subtidal and Intertidal Ecology

For benthic subtidal and intertidal ecology, the following potential impacts have been considered within the inter-related assessment:

- temporary and long term habitat loss/disturbance;
- increased SSCs and associated sediment deposition;
- increased risk of introduction and spread of INNS; and
- impacts resulting from the release of sediment bound contaminants.

Overall, it was concluded that no inter-related effects would arise for each of these impacts (see volume 2, chapter 14).

7.15.3 Fish and Shellfish Ecology

For fish and shellfish ecology, the following potential impacts have been considered within the inter-related assessment:

- temporary and long term habitat loss/disturbance;
- underwater noise impacting fish and shellfish receptors; and
- increased SSCs and associated sediment deposition.

Overall, it was concluded that no inter-related effects would arise for each of these impacts (see volume 2, chapter 14).

7.15.4 Marine Mammals and Marine Turtles

For marine mammals and marine turtles, the following potential impacts have been considered within the inter-related assessment:

- injury, disturbance, and displacement from underwater noise generated during piling;
- injury, disturbance, and displacement from underwater noise generated during UXO clearance;
- injury, disturbance, and displacement from underwater noise generated during geophysical and seismic site investigation surveys;
- injury, disturbance, and displacement from vessel activity and other noise producing activities;
- injury due to collision with marine vessels; and
- effects on marine mammals and marine turtles due to changes in prey availability.

Overall, it was concluded that no inter-related effects would arise for each of these impacts (see volume 2, chapter 14).

7.16 Conclusion

A summary of the impact assessment on each marine biodiversity topic is presented in Table 7.105, Table 7.106, and Table 7.107 below. For all impacts, significance of effect was assessed as either negligible or of minor adverse significance, neither are significant in EIA terms. Within the CEA, only negligible or minor adverse significance was concluded for all impacts, also not significant in EIA terms.

Table 7.105: Summary Of Impact Assessment For Benthic Subtidal And Intertidal Ecology

Impact	Phase	Magnitude of Impact	Sensitivity of Receptor	Significance of Effect	Significant in EIA Terms?
Temporary subtidal habitat loss and/or disturbance	C O D	Ross worm IEF: negligible All other IEFs: low	All IEFs: medium	Ross worm IEF: **negligible adverse** All other IEFs: **minor adverse**	**No**
Increased SSCs and associated deposition	C D	All IEFs: low	Subtidal habitats and species IEFs: negligible, low, and medium Intertidal habitats and species IEF: low Designated sites IEFs: low	All IEFs: **minor adverse**	**No**
Long-term subtidal habitat loss	C and O D	Subtidal habitats and species IEFs: no change and low Intertidal habitats and species IEF: no change Designated sites IEFs: no change	Subtidal habitats and species IEFs: medium and high Intertidal habitats and species IEF: high Designated sites IEFs: high	All IEFs: **minor adverse**	**No**
Introduction of artificial habitat and colonisation of hard structures	O	Subtidal habitats and species IEFs: no change and low Intertidal habitats and species IEF: no change Designated sites IEFs: no change	All IEFs: high	All IEFs: **minor adverse**	**No**
Increased temperature impacting benthic communities	O	Subtidal habitats and species IEFs: no change and negligible Intertidal habitats and species IEF: negligible Designated sites IEFs: no change	All IEFs: low	All IEFs: **negligible adverse**	**No**
Increased risk of introduction and spread of INNS	C O D	Subtidal habitats and species IEFs: low Intertidal habitats and species IEF and Dee Estuary/Aber Dyfrdwy SAC IEF: assessment not required Fylde MCZ IEF: low	Subtidal habitats and species IEFs: high Fylde MCZ IEF: high	Subtidal habitats and species IEFs: **minor adverse** Fylde MCZ IEF: **minor adverse**	**No**

Impact	Phase	Magnitude of Impact	Sensitivity of Receptor	Significance of Effect	Significant in EIA Terms?
Impacts resulting from the release of sediment bound contaminants	C D	Subtidal habitats and species IEFs: negligible Intertidal habitats and species IEF and Dee Estuary/Aber Dyfrdwy SAC IEF: assessment not required Fylde MCZ IEF: negligible	Subtidal habitats and species IEFs: high Fylde MCZ IEF: high	Subtidal habitats and species IEFs: **minor adverse** Fylde MCZ IEF: **minor adverse**	**No**
Accidental pollution to the surrounding area	C O D	All IEFs: negligible	All IEFs: high	All IEFs: **minor adverse**	**No**

Table 7.106: Summary Of Impact Assessment For Fish And Shellfish Ecology

Impact	Phase	Magnitude of Impact	Sensitivity of Receptor	Significance of Effect	Significant in EIA Terms?
Temporary subtidal habitat loss and/or disturbance	C O D	All IEFs: low	King and queen scallop: low Spiny lobster: medium All other shellfish IEFs: medium Herring: low Sandeel: medium All other marine fish IEFs: low Diadromous IEFs: negligible	All shellfish and marine IEFs: **minor adverse** Diadromous IEFs: **negligible adverse**	**No**
Long-term subtidal habitat loss	C and O D	All IEFs: low	King and queen scallop: low Norway lobster and European lobster: medium Spiny lobster: high All other shellfish IEFs: low Herring: low Sandeel: medium All other marine fish IEFs: low Diadromous IEFs: negligible	All shellfish and marine IEFs: **minor adverse** Diadromous IEFs: **negligible adverse**	**No**
Underwater noise impacting fish and shellfish receptors	C	All IEFs: low	All shellfish IEFs: low Cod, herring, and sprat: high All other marine fish IEFs: low Allis and Twaite shad: high All other diadromous IEFs: low	All IEFs: **minor adverse**	**No**
Increased SSCs and associated deposition	C D	All IEFs: low	All shellfish IEFs: low Herring: medium All other marine fish IEFs: low All diadromous IEFs: low	All shellfish IEFs: **negligible adverse** Herring: **minor adverse** All other marine fish IEFs: **negligible adverse** All diadromous IEFs: **negligible adverse**	**No**

Table 7.107: Summary Of Impact Assessment For Marine Mammals And Marine Turtles

Impact	Phase	Magnitude of Impact	Sensitivity of Receptor	Significance of Effect	Significant in EIA Terms?
Injury, Disturbance, and Displacement from Underwater Noise Generated during Piling	C	Auditory Injury Harbour porpoise and minke whale: low All other IEFs: negligible Behavioural Disturbance All IEFs: low	Auditory Injury All IEFs: high Behavioural Disturbance All marine mammal IEFs: medium Marine turtle IEFs: low	Auditory Injury All IEFs: **minor adverse** Behavioural Disturbance All marine mammal IEFs: **minor adverse** Marine turtle IEFs: **negligible adverse**	**No**
Injury, Disturbance, and Displacement from Underwater Noise Generated during UXO Clearance	C	Auditory Injury (PTS) Harbour porpoise: low All other IEFs: negligible Behavioural Disturbance (TTS as a proxy) All IEFs: negligible	Auditory Injury (PTS) All IEFs: high Behavioural Disturbance (TTS as a proxy) All IEFs: low	Auditory Injury (PTS) All IEFs: **minor adverse** Behavioural Disturbance (TTS as a proxy) All IEFs: **negligible adverse**	**No**
Injury, Disturbance, and Displacement from Underwater Noise Generated during Geophysical and Seismic Site Investigation Surveys	C	Auditory Injury All marine mammal IEFs: negligible Behavioural Disturbance All marine mammal IEFs: low	Auditory Injury All marine mammal IEFs: high Behavioural Disturbance All marine mammal IEFs: medium	Auditory Injury All marine mammal IEFs: **minor adverse** Behavioural Disturbance All marine mammal IEFs: **minor adverse**	**No**
Injury, Disturbance, and Displacement from Vessel Activity and other Noise Producing Activities	C O D	Auditory Injury All IEFs: negligible Behavioural Disturbance All IEFs: low	Auditory Injury All IEFs: high Behavioural Disturbance All marine mammal IEFs: medium Marine turtle IEFs: low	Auditory Injury All IEFs: **minor adverse** Behavioural Disturbance All IEFs: **minor adverse**	**No**
	C	All IEFs: low	All IEFs: medium	All IEFs: **minor adverse**	**No**

Impact	Phase	Magnitude of Impact	Sensitivity of Receptor	Significance of Effect	Significant in EIA Terms?
Injury due to Collision with Marine Vessels	O				
	D				
Effects on Marine Mammals and Marine Turtles due to changes in Prey Availability	C	All IEFs: low	Minke whale: medium All other IEFs: low	All IEFs: **minor adverse**	**No**
	O				
	D				

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Liverpool Bay CCS Ltd

HYNET CARBON DIOXIDE TRANSPORTATION AND STORAGE PROJECT - OFFSHORE

Environmental Statement
Volume 2, chapter 8: Offshore Ornithology

EHE7228B
Liverpool Bay CCS Limited
Final
February 2024
Offshore ES
Offshore Ornithology

Glossary

Term	Meaning
Cumulative effect assessment	Assessment of the likely effects arising from the offshore components of the HyNet CO_2 Transportation and Storage Project – Offshore ('Proposed Development') alongside the likely effects of other development activities in the vicinity of the Proposed Development.
Effect	The consequence of an impact
Environmental Impact Assessment	A statutory process by which certain planned projects must be assessed before a formal decision to proceed can be made. It involves the collection and consideration of environmental information, which fulfils the assessment requirements of the EIA Directive and EIA Regulations, including the publication of an Environmental Impact Assessment (EIA) Report.
Impact	A change that is caused by an action
Magnitude	Size, extent, and duration of an impact.
Maximum Design Scenario	The maximum design parameters of each Proposed Development asset (both on and offshore) considered to be a worst case for any given assessment but within the range of the Project Description Envelope.
Mitigation Measure	Measure which would avoid, reduce, or remediate an impact
Non-statutory stakeholder	Organisations with whom the regulatory authorities may choose to engage who are not designated in law but are likely to have an interest in a proposed development.
Project	The HyNet Carbon Dioxide Transportation and Storage Project.
Project Design Envelope (PDE)	Also known as the Rochdale Envelope, the PDE concept is routinely utilised in both onshore and offshore planning applications to allow for some flexibility in design options, particularly offshore, and more particularly for foundations and turbine type, where the full details of the project are not known at application submission but where sufficient detail is available to enable all environmental impacts to be appropriately considered during the EIA.
Project lifetime effects	Effects that occur throughout more than one phase of the project (construction, operations and maintenance, and decommissioning) interacting to potentially create a more significant effect upon a receptor than if just assessed in isolation in a single phase.
Proposed Development	The offshore components of the Project which are subject of this Environmental Statement, as described in Chapter 3: Proposed Development Description.
Receptor-led effects	Effects that interact spatially and/or temporally resulting in inter-related effects upon a single receptor.
Residual Impact	Residual impacts are the final impacts that occur after the proposed mitigation measures have been put into place, as planned.
Scoping Opinion	Sets out the Secretary of State's response to the Applicants Scoping Report and contains the range of issues that the Secretary of State, in consultation with statutory stakeholders, has identified should be considered within the EIA.
The Applicant	This is Liverpool Bay CCS Ltd.
Transboundary effects	Impacts from a project within one state affect the environment of another state(s).

Acronyms and Initialisations

Acronym/Initialisation	Description
CCS	Carbon Capture and Storage
CEA	Cumulative Effects Assessment
CIEEM	Chartered Institute of Ecology and Environmental Management
DECC	The Department of Energy and Climate Change, merged with the Department for Business, Innovation and Skills, to form the Department for Business, Energy and Industrial Strategy.

Acronym/Initialisation	Description
EcIA	Ecological Impact Assessment
EEA	European Economic Area
EIA	Environmental Impact Assessment
Eni	Eni UK Limited
EPS	European Protected Species
ES	Environmental Statement
HRA	Habitats Regulations Appraisal
JNCC	the Joint Nature Conservation Committee
MDS	Maximum Design Scenario
MHWS	Mean High Water Springs
NPS	National Policy Statement
OP	Offshore Platform
OPRED	Offshore Petroleum Regulator for Environment and Decommissioning
PoA	Point of Ayr
SNCB	Statutory Nature Conservation Body
UK	United Kingdom
UXO	Unexploded ordnance

Units

Unit	Description
%	Percent
km	Kilometres
km^2	Kilometres squared
m	Metres (distance)
m^2	Metres squared (area)
MW	Megawatt

Contents

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8 ORNITHOLOGY

8.1 Introduction

This chapter of the Environmental Impact Assessment (EIA) Environmental Statement (ES) presents the assessment of the potential impact of the Project on offshore ornithology. Specifically, this chapter considers the potential impact of the Proposed Development during the construction, operation and maintenance, and decommissioning phases.

The assessment presented is informed by the following technical reports:

- The Eni Hynet Offshore Ornithology Baseline Technical Report (RPS Group, 2024a).
- The Eni Hynet Offshore Ornithology Displacement Technical Report (RPS Group, 2024b).
- The Eni Hynet EIA Intertidal Ornithology Technical Report (RPS Group, 2023).
- The Eni Hynet EIA Little Tern Foraging Distribution Technical Report (RPS Group, 2024c).

The offshore ornithology chapter deals with any waterbirds that are present at some point in their life cycle in the study area. The overarching term 'waterbird' is used to refer to species that depend on wetland environment for survival at some point in their life cycle. This includes true seabirds, seaducks, and divers and grebes, gulls, terns, skuas, waders and wildfowl.

8.2 Purpose of this chapter

The primary purpose of the ES is outlined in volume 1, chapter 1. In summary, the primary purpose of this Environmental Statement is to support the Marine Licence, and Storage Permit applications for the Proposed Development. The ES sets out the findings of the Environmental Impact Assessment (EIA).

In particular this ES chapter:

- Presents the existing environmental baseline established from desk studies and site-specific surveys.
- Identifies any assumptions and limitations encountered in compiling the environmental information.
- Presents the potential environmental effects on offshore ornithology arising from the Proposed Development, based on the information gathered and the analyses and assessments undertaken
- Highlights any necessary monitoring and/or mitigation measures which could prevent, minimise, reduce or offset the possible environmental effects of the Proposed Development on offshore ornithology.

8.3 Study area

There are three study areas for the offshore ornithology assessment. These are:

- The offshore ornithology study area.
- The intertidal ornithology study area.
- The little tern foraging distribution study area.

Further details on these areas are provided in the following sections.

8.3.1 The offshore ornithology study area

The Offshore Ornithology Study Area is defined as the area encompassing the Proposed Development, which includes the offshore structures, offshore cables and subsea cables, plus an additional 10 km buffer in order to account for the displacement of sensitive divers and seaducks.

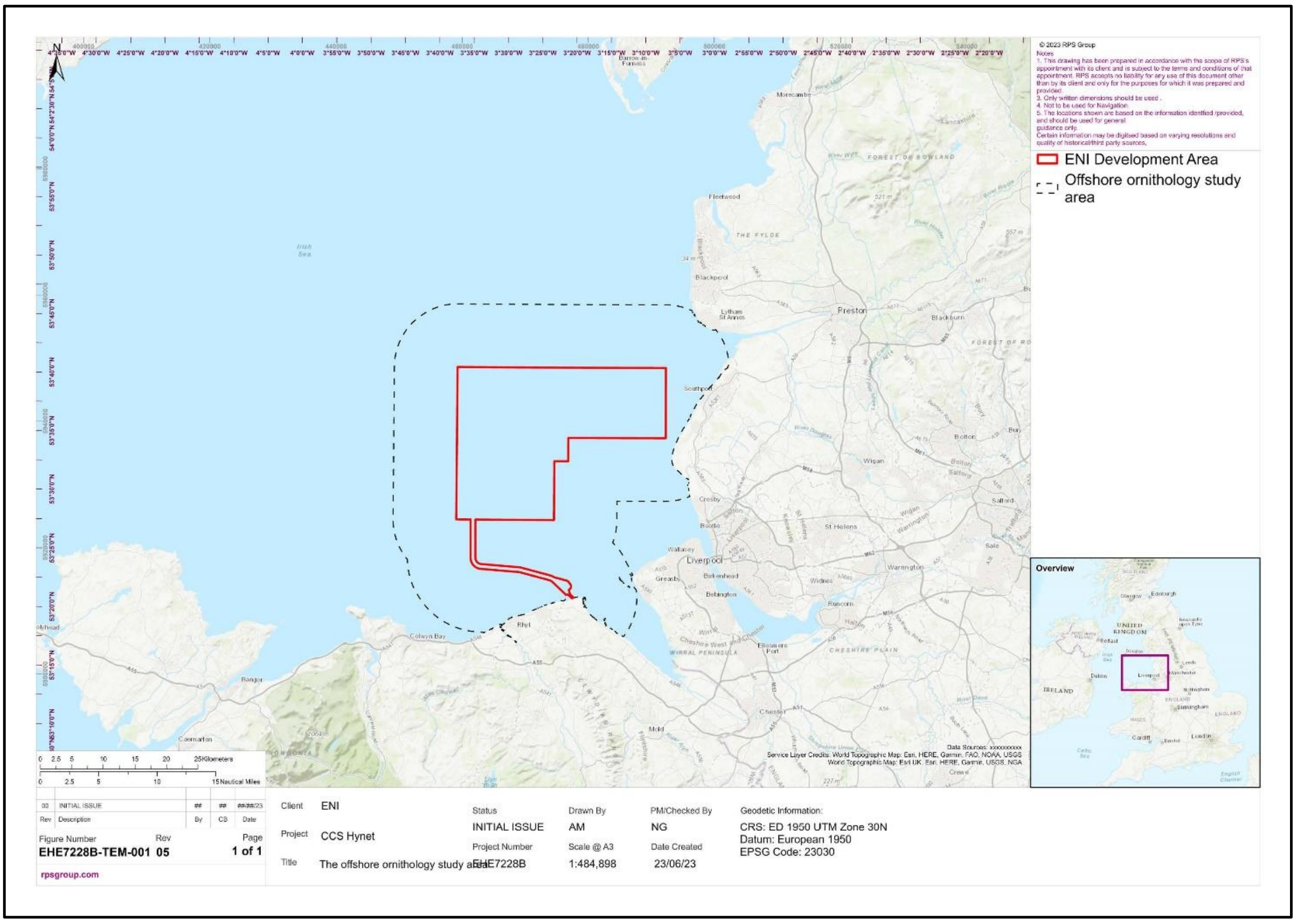

Figure 8-1: The Offshore Ornithology Study Area

Additionally, there are several protected sites designated for marine and coastal waterbirds with connectivity to the Proposed Development area. Figure 8-2 shows the designated sites (international and national) with relevant ornithology features that are within 315 km of the Proposed Development area and given consideration within the assessment. A distance of 315 km was used to assess connectivity to the Proposed Development as this is the mean maximum foraging range for Northern gannet as taken from Woodward, *et. al*. (2014).

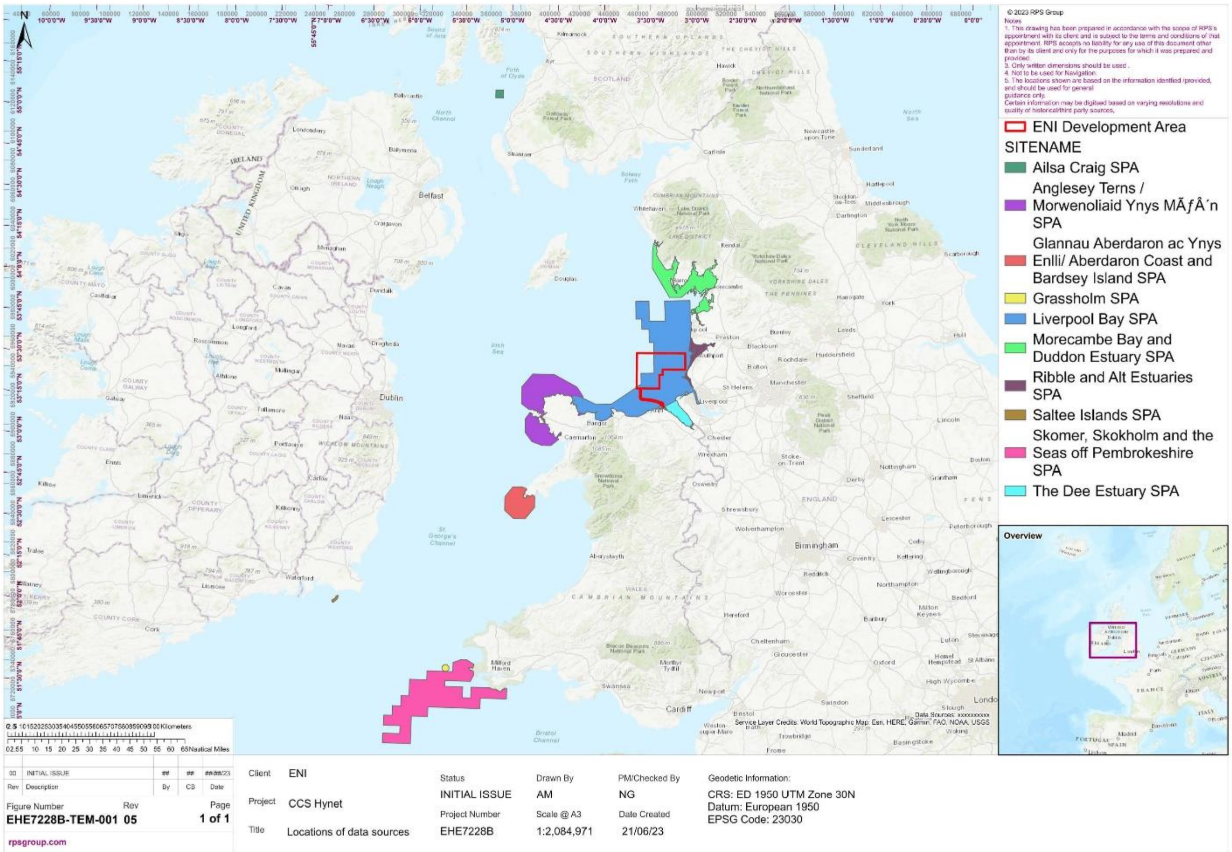

Figure 8-2: Designated Sites Within 315 Km Of The Proposed Development

8.3.2 The intertidal ornithology study area

The intertidal ornithology study area is situated on the outer western edge of the Dee Estuary in Denbighshire, North Wales. It encompasses the proposed landfall plus a 500 m buffer. This 500 m buffer is included to take account of bird interests that may occur adjacent or close to the proposed landfall. The intertidal ornithology study area extends from Mean High Water Spring (MHWS) to up to 2 km seawards (see Figure 8-3).

The intertidal ornithology study area is primarily composed of mud and sand flats, the nearshore waters are shallow and a strong tidal current sweeps outward from the estuary mouth. The gradient of the beach is shallow and large expanses of mud and sandflats can be exposed at low tide. It is of importance to waterbirds that may utilise these habitats for roosting, loafing, or foraging.

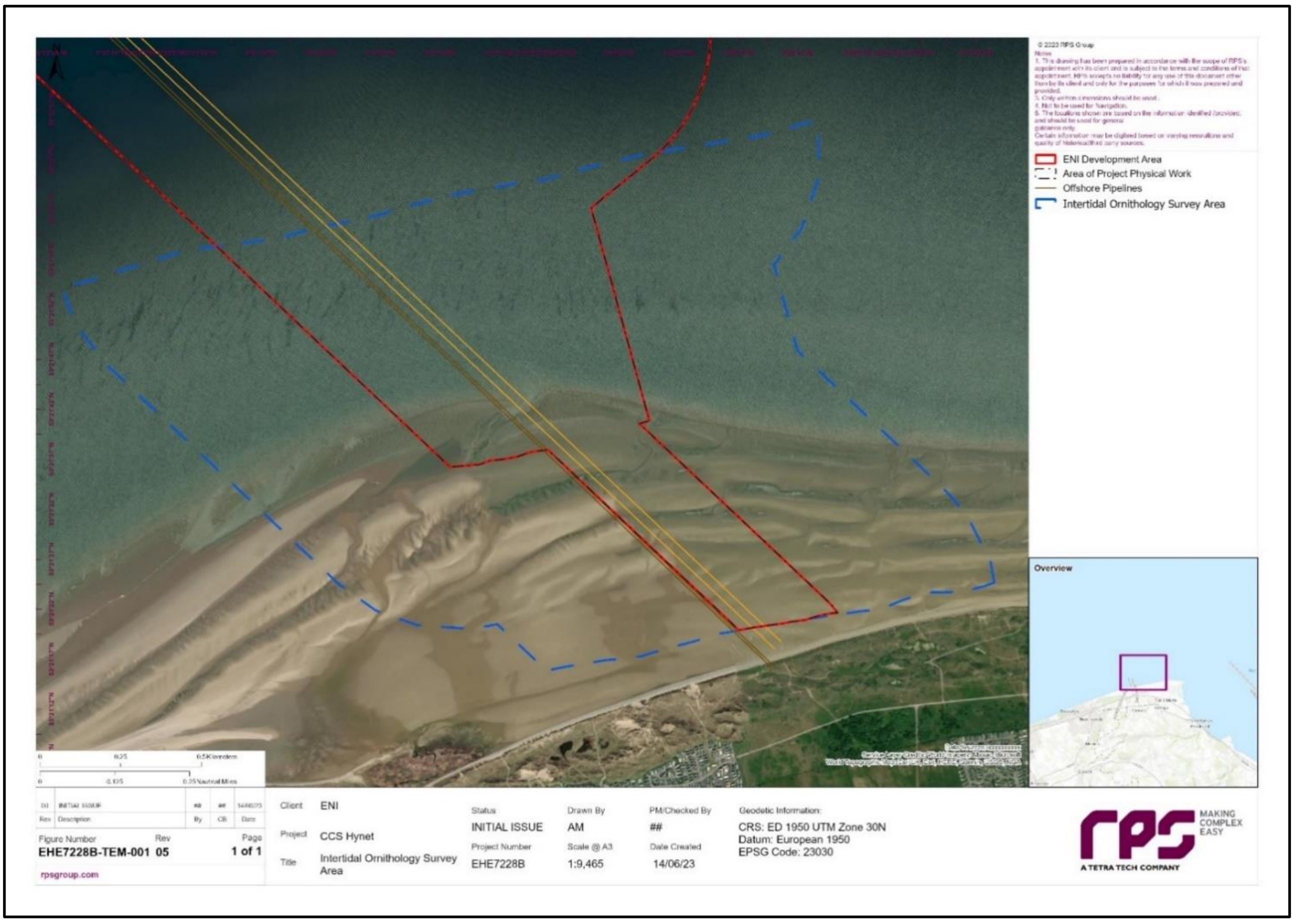

Figure 8-3: The Intertidal Ornithology Study Area

8.3.3 The little tern foraging distribution study area

The little tern foraging distribution study area is situated on the outer western edge of the Dee Estuary in Denbighshire, North Wales. The study area was designed using published evidence on foraging ranges (Parsons et al., 2015; Woodward et al., 2019).

As little tern mostly forage in the nearshore waters within close proximity of their colony, the study area encompasses all of the intertidal and nearshore waters up to 4.5km either side of the main colony at Gronant Dunes and extends to 2km offshore (this was the distance at which land based surveyors could reliably identify little tern using spotting scopes with x 60 magnification as per Joint Nature Conservation Committee guidance (2004)).

Figure 8-4 shows the location and extent of the study area. As little tern use both the intertidal (when it is inundated) and subtidal zones for foraging, the landward extent of the surveys was taken as Mean High Water Spring (MHWS).

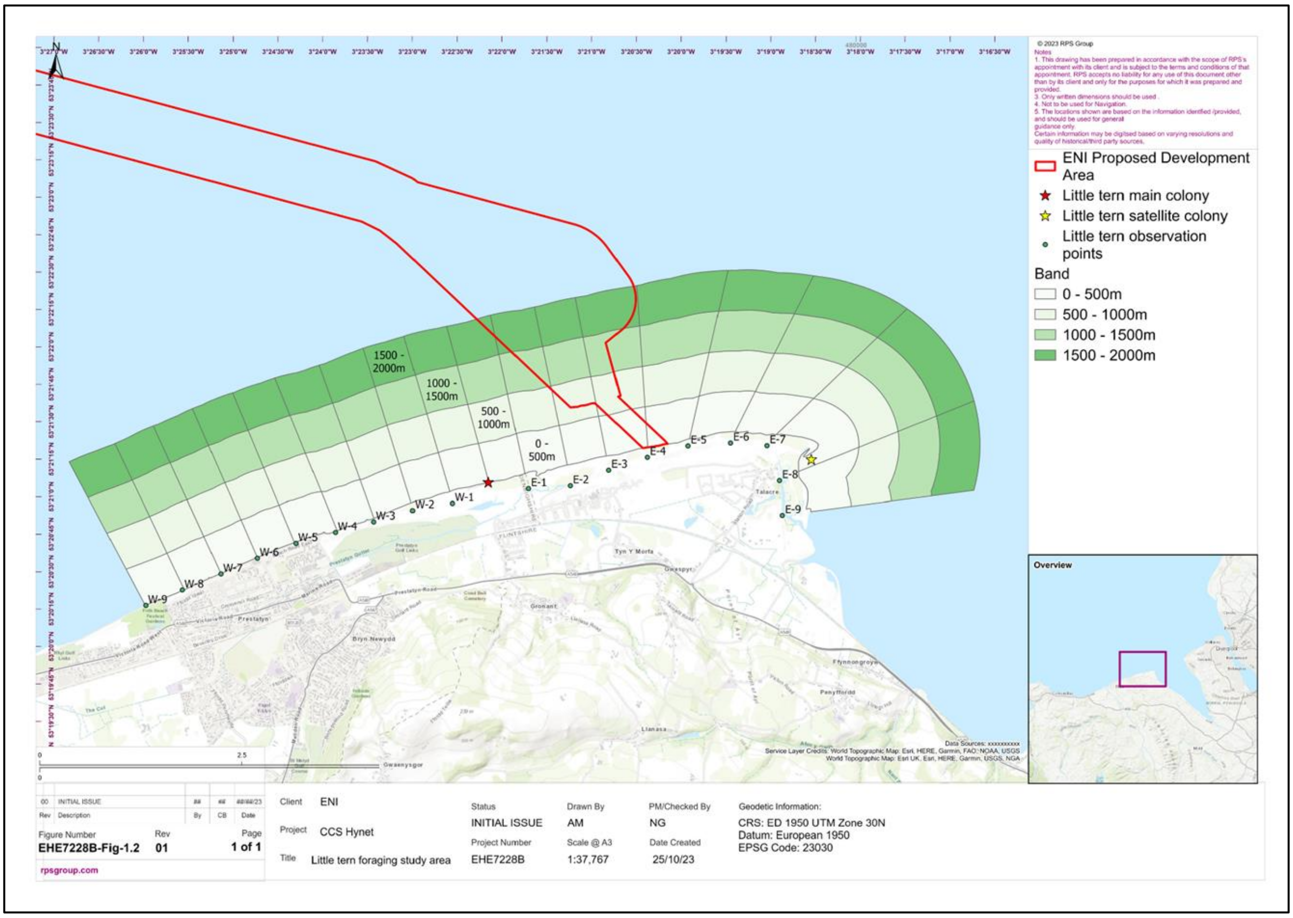

Figure 8-4: The Little Tern Foraging Distribution Study Area

8.4 Policy and legislative context

8.4.1 Legislation

8.4.1.1 Habitats and Species Regulations

The Conservation of Habitats and Species Regulations 2017 (as amended) and the Conservation of Offshore Marine Habitats and Species Regulations 2017 (as amended) require the assessment of significant effects on internationally important nature conservation sites where these may arise as a result of a project.

The international sites relevant to offshore ornithology are Special Protection Areas (SPAs) or potential SPAs (pSPAs), and Ramsar sites. These have been traditionally referred to as European Sites or Natura 2000 sites. Following the UK's departure from the European Union (EU) they are now referred to as the National Site Network.

The Habitats Regulations also provide protection for certain species of plants and animals, referred to as European Protected Species (EPS). These Regulations set out those species that are protected and the activities that are prohibited, such as deliberate disturbance or creating damage to a breeding place.

The Habitat Regulations also provide for licences to be granted for certain operations, such as developments that may affect protected species, subject to:

- there being no satisfactory alternative; and
- the action authorised not being detrimental to the maintenance of the population of the species concerned at a favourable conservation status in their natural range.

With respect to the Project, the species present have been identified and the likely effects assessed. Where possible, effects on protected species have been avoided or minimised.

All wild birds, their nests and their eggs are protected under the Wildlife and Countryside Act (1981), as amended. This legislation makes it an offence to intentionally or recklessly:

- kill, injure or take any wild bird (excluding certain specified game and other licence-controlled species);
- take, damage destroy or otherwise interfere with the nest of any wild bird while it is in use or being built;
- obstruct or prevent any wild bird from using its nest; and
- take or destroy the egg of any wild bird.

8.4.2 The Environment (Wales) Act 2016

The Environment (Wales) Act sets out legislation to plan and manage Wales' natural resources through the Natural Resources Policy (NRP).

The policy sets out three National Priorities:

- Delivering nature-based solutions.
- Increasing renewable energy and resource efficiency.
- Taking a place-based approach.

Section 6 under Part 1 of the Act introduced a duty for public planning authorities to embed the consideration of biodiversity and ecosystems into their policy development, plans and projects.

8.4.3 The Ramsar Convention

The Ramsar Convention on Wetlands of International Importance (referred to as the Ramsar Convention) is an international treaty for the conservation and sustainable use of designated wetland areas, known as Ramsar sites. The Convention came into force in 1976.

Ramsar sites are wetlands of international importance designated under the criteria of the Ramsar Convention (i.e. the wetland supports 20,000 waterbirds and/or supports 1% of the biogeographic population of a species or subspecies (race) of waterbird).

In the UK, Ramsar sites are protected under the National Site Network, in the same way as SPAs and Special Area of Conservation (SACs).

8.4.4 The Convention on Biological Diversity

The Convention on Biological Diversity entered into force in 1993 with three main objectives:

- the conservation of biological diversity;
- the sustainable use of the components of biological diversity; and
- the fair and equitable sharing of the benefits arising out of the utilization of genetic resources.

The overall objective is to encourage actions that will lead to a sustainable future. The Secretariat of the Convention is based in Montreal in Canada and aims to assist governments to implement the Convention and its programmes of work.

8.4.5 Planning policy context

Planning policy is presented in volume 1, chapter 2 of the ES.

8.4.6 National Policy Statements

There are currently six energy National Policy Statements (NPSs), two of which contain policy relevant to the Proposed Development:

- overarching NPS for Energy (NPS EN-1) which sets out the UK Government's policy for the delivery of major energy infrastructure (DECC 2011a); and
- NPS for Renewable Energy Infrastructure (NPS EN-3) (DECC 2011b).

These are currently being updated and draft versions were published for consultation in September 2021.

A summary of the policy and legislation relating to offshore ornithology is presented in Table 8-1.

Table 8-1: Summary Of Planning Consents And Environmental Legislation Relevant To Offshore Ornithology

Summary of Relevant Legislation	How and Where Considered in the offshore ES
NPS EN-1	
Where the proposal is subject to EIA, the applicant should ensure that the ES clearly sets out any effects on the environment, including specific fauna. An assessment is required of any likely significant effects of the proposal on the environment be they direct, indirect, secondary, cumulative, short, medium, long-term, permanent, temporary, positive, or negative at all stages of the project. Methods for avoiding or mitigating adverse effects should be included. (NPS EN-1 paragraph 4.2.1)	Assessment of the potential effects of the Project are considered in sections 8.11, 8.12, and 8.15. The mitigation methodology is considered in section 8.10.
The ES should include an assessment of the effects on the environment arising from the construction of infrastructure once completed but before it is operational. (NPS EN1 paragraph 4.2.3)	Construction, operation and decommissioning effects are identified in Table 8-16 and considered in section 8.11.
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. (NPS EN-1 paragraph 5.3.3)	The baseline ornithological environment is described in section 8.7. Internationally and nationally designated sites are identified in Table 8-8 Important areas for offshore ornithology are described in Offshore Ornithology Baseline Technical Report (RPS Group, 2024a), Offshore Ornithology Displacement Technical Report (RPS Group, 2024b), Intertidal Ornithology Technical Report (RPS Group, 2023) and Little Tern Foraging Distribution Technical Report (RPS Group, 2024c). Assessment of the potential effects on designated sites are considered in section 8.11, 8.12 and 8.15. Assessment of the potential effects on specific species are considered in section 8.11.
The important sites for biodiversity are those identified through international conventions and European Directives that the Habitats Regulations provide protection for. Potential Special Protection Areas (pSPAs) and listed Ramsar sites should be afforded the same protections within development proposals. (NPS EN-1 paragraph 5.3.9)	The importance of these sites is described in Offshore Ornithology Baseline Technical Report (RPS Group, 2024a), Intertidal Ornithology Technical Report (RPS Group, 2023) and Little Tern Foraging Distribution Technical Report (RPS Group, 2024c).
All Sites of Specific Scientific Interest (SSSIs) should be protected as if designated as sites of international importance, including those features of SSSIs not covered by international designation.	All relevant SSSIs are identified in Offshore Ornithology Baseline Technical Report (RPS Group,2023) and Intertidal Ornithology Technical Report (RPS Group, 2023).

Summary of Relevant Legislation	How and Where Considered in the offshore ES
(NPS EN-1 paragraph 5.3.10)	Assessment of the potential effects on designated sites are considered in section 8.11, 8.12 and 8.15.
Many species and habitats have been identified as being of principal importance to biodiversity in addition to wildlife species that receive statutory protection under a range of legislative provisions. These species and habitats require conservation action. (NPS EN-1 paragraph 5.3.17)	Assessment of the potential effects of the Project are considered in sections 8.11, 8.12, and 8.15.
The highest level of biodiversity protection is afforded to sites identified through international conventions. The Habitats Regulations set out sites for which a Habitats Regulations Appraisal (HRA) will assess the implications of a plan or project, including Special Areas of Conservation and Special Protection Areas. As a matter of policy, the following should be given the same protection as sites covered by the Habitats Regulations and an HRA will also be required: (a) potential Special Protection Areas and possible Special Areas of Conservation; (b) listed or proposed Ramsar sites. (NPS-EN1 paragraph 5.4.4 & 5.4.5)	Internationally designated sites are identified in Table 8-8. The importance of these sites is described in Offshore Ornithology Baseline Technical Report (RPS Group, 2024a), Intertidal Ornithology Technical Report (RPS Group, 2023) and Little Tern Foraging Distribution Technical Report (RPS Group, 2024c).
Where the development is subject to EIA the applicant should ensure that the Environmental Statement 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. (NPS EN-1 paragraph 5.4.17)	Internationally and nationally designated sites are identified in Table 8-8. Important areas for offshore ornithology are described in Offshore Ornithology Baseline Technical Report (RPS Group, 2024a), Intertidal Ornithology Technical Report (RPS Group, 2023) and Little Tern Foraging Distribution Technical Report (RPS Group, 2024c).
The design of Energy 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. (NPS EN-1 paragraph 5.4.22)	Important areas for offshore ornithology are described in Offshore Ornithology Baseline Technical Report (RPS Group, 2024a), Offshore Ornithology Displacement Technical Report (RPS Group, 2024b), Intertidal Ornithology Technical Report (RPS Group, 2023) and Little Tern Foraging Distribution Technical Report (RPS Group, 2024c). Assessment of the potential effects on designated sites are considered in section 8.11, 8.12 and 8.15. Assessment of the potential effects on specific species are considered in section 8.11.
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	The mitigation methodology is discussed in section 8.10.

Summary of Relevant Legislation	How and Where Considered in the offshore ES
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. (NPS EN-1 paragraph 5.4.35)	
NPS EN-3	
The applicant should assess the effects of the cable and any associated infrastructure on the marine, coastal and onshore environment. (NPS-EN3 paragraph 3.8.81)	Construction, operation and decommissioning effects are identified in Table 8-16 and considered in section 8.11.
Assessment of environmental effects of cabling infrastructure and any proposed offshore or onshore substations should assess effects both alone and cumulatively with other existing and proposed infrastructure. (NPS-EN3 paragraph 3.8.85)	Assessment of potential stand-alone impacts are considered in section 8.11. Assessment of potential cumulative impacts are considered in section 8.12.
Applicants should include details on how avoidance has been achieved, good design principles have been followed and provide proposals for mitigation, as well as demonstrating that they have considered how their proposals can contribute towards environmental net gain. (NPS-EN3 paragraph 3.8.86)	The mitigation methodology is discussed in section 8.10.
Preparation and installation of the cable route can affect the following elements of the physical offshore environment, which can have knock on impacts on other biodiversity receptors: • water quality – disturbance of the seabed sediments or release of contaminants can result in direct or indirect effects on habitats and biodiversity, as well as on fish stocks thus affecting the fishing industry. (NPS-EN3 paragraph 3.8.125)	Construction, operation and decommissioning effects are identified in Table 8-16 and considered in section 8.11.
There is the potential for the construction and decommissioning phases, including activities occurring both above and below the seabed, to impact fish communities, migration routes, spawning activities and nursery areas of particular species. (NPS-EN3 paragraph 3.8.130)	Construction and decommissioning effects are identified in Table 8-16 and considered in section 8.11.
Export cable routes will cross the intertidal/coastal zone resulting in habitat loss, and temporary disturbance of intertidal flora and fauna. (NPS-EN3 paragraph 3.8.137)	Assessment of the potential effects on specific species are considered in section 8.11.
Applicant assessment of the effects of installing cable across the intertidal/coastal zone should demonstrate compliance with mitigation measures identified by The Crown Estate in any plan-level HRA produced as part of its leasing round and include information, where relevant, about: any alternative landfall sites that have been considered by the applicant during the design phase and an explanation for the final choice; • any alternative cable installation methods that have been considered by the applicant during the design phase and an explanation for the final choice; • potential loss of habitat • disturbance during cable installation, maintenance/repairs and removal (decommissioning); • increased suspended sediment loads in the intertidal zone during installation and maintenance/repairs;	Assessment of the potential effects on specific species are considered in section 8.11. The mitigation methodology is discussed in section 8.10.

Summary of Relevant Legislation	How and Where Considered in the offshore ES
• predicted rates at which the intertidal zone might recover from temporary effects, based on existing monitoring data; and • protected sites. (NPS-EN3 paragraph 3.8.138)	
Landfall and cable installation and decommissioning methods should be designed appropriately to minimise effects on intertidal/coastal habitats, taking into account other constraints. (NPS-EN3 paragraph 3.8.243)	Assessment of the potential effects are considered in section 8.11. Assessment of potential cumulative impacts are considered in section 8.12. The mitigation methodology is discussed in section 8.10.
Applicants should undertake a review of up-to-date research and all potential mitigation options presented. (NPS-EN3 paragraph 3.8.257)	A review of research conducted for other projects in the area is include in Offshore Ornithology Baseline Technical Report (RPs Group, 2024a). The mitigation methodology is discussed in section 8.10.

8.4.7 The Welsh National Marine Plan

The assessment of potential changes to offshore ornithology has also been made with consideration to the specific policies set out in the Welsh National Marine Plan (Welsh Government, 2019).

The Welsh National Marine Plan was published on 12 November 2019 and sets out the policy for the next 20 years for the sustainable use of Welsh seas. It includes sector objectives for renewable energy to support the decarbonisation of the Welsh economy.

Table 8-2: Welsh National Marine Plan And Its Relevance To Offshore Ornithology

Policy	Key provisions	How and where considered in the offshore ES
ENV_01: Resilient marine ecosystems	Proposals should demonstrate how potential impacts on marine ecosystems have been taken into consideration and should, in order of preference: • avoid adverse impacts; and/or • minimise impacts where they cannot be avoided; and/or • 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. Proposals that contribute to the protection, restoration and/or enhancement of marine ecosystems are encouraged.	Assessment of the potential effects are considered in section 8.11. The mitigation methodology is discussed in section 8.10.
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 on designated sites that are not part of the MPA network.	Assessment of potential impacts on designated sites are considered in section 8.11.
ENV_05: Underwater sound.	Proposals should demonstrate that they have considered man-made noise impacts on the marine environment and, in order of preference:	Sources of man-made noise are identified in Table 8-16.

Policy	Key provisions	How and where considered in the offshore ES
	• avoid adverse impacts; and/or • minimise impacts where they cannot be avoided; and/or • 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.	
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: • avoid adverse impacts on those areas; and/or • minimise adverse impacts where they cannot be avoided; and/or • 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	Potential impacts on fish, and therefore prey availability for birds, are identified in Table 8-16 and considered in section 8.11.16.

8.4.8 The North West Inshore and North West Offshore Marine Plan

The assessment of potential changes to offshore ornithology has also been made with consideration to the specific policies set out in the North West Inshore and North West Offshore Marine Plan (HM Government, 2021) in Table 8-3.

The North West Inshore and North West Offshore Marine Plan was published in June 2021 and provides a framework that will shape and inform decisions over how the areas' waters are developed, protected and improved over the next 20 years. It covers an area of around 7,100 square kilometres of inshore and offshore waters stretching from the Solway Firth border with Scotland to the River Dee border with Wales. It is very busy; the low-lying coastlines and diverse marine environments share limited space with a large variety of activities.

Table 8-3: North West Inshore and North West Offshore Marine Plan And Its Relevance To Offshore Ornithology

Policy	Key provisions	How and where considered in the offshore ES
Marine protected areas NW-MPA-1	Proposals that support the objectives of marine protected areas and the ecological coherence of the marine protected area network will be supported. Proposals that may have adverse impacts on the objectives of marine protected areas must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate - adverse impacts so they are no longer significant.	Assessment of potential impacts on designated sites are considered in section 8.11. The mitigation methodology is discussed in section 8.10.
Marine protected areas NW-MPA-2	Proposals that enhance a marine protected area's ability to adapt to climate change, enhancing the resilience of the marine protected area network, will be supported. Proposals that may have	Assessment of potential impacts on designated sites are considered in section 8.11. The mitigation methodology is discussed in section 8.10.

Policy	Key provisions	How and where considered in the offshore ES
	adverse impacts on an individual marine protected area's ability to adapt to the effects of climate change, and so reduce the resilience of the marine protected area network, must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate - adverse impacts so they are no longer significant.	
Disturbance NW-DIST-1	Proposals that may have significant adverse impacts on highly mobile species through disturbance or displacement must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate - adverse impacts so they are no longer significant.	Assessment of the potential effects are considered in section 8.11. The mitigation methodology is discussed in section 8.10.

8.5 Consultation

Table 8-4: A Summary Of The Key Consultations To Date

Date	Consultee and type of response	Issue raised	Response to issue raised and/or where considered in this chapter
27/01/2023	OPRED	The ES should assess the environmental effects of the Project upon features of nature conservation interest. It is recommended that the ES thoroughly assesses the potential for the Project to affect national or international sites of nature conservation importance. This should include a full assessment of the direct and indirect effects of the Project on the features of all important nature conservation sites including, but not limited to, Natural England's Impact Risk Zones, Sites of Special Scientific Interest (SSSI), Marine Conservation Zones (MCZ) and Designated Sites with Fish and Shellfish Qualifying Features. Further website information on these sites and how this may be accessed is provided in Annex 2. In particular, it is noted that the following Welsh sites have been omitted in Table 7-7 (Designated Sites with Fish and Shellfish Qualifying Features) of the ES scoping report: o Dee Estuary SAC, designated for river and sea lamprey. o River Dee and Bala Lake SAC, designated for Atlantic salmon, river and sea lamprey. o Afon Gwyrfai a Llyn Cwellyn SAC, designated for Atlantic salmon. o Afon Eden SAC - Cors Goch Trawsfynydd, designated for Atlantic salmon and Freshwater peal mussel. o River Teifi SAC, designated for Atlantic salmon, river and sea lamprey	This ES assess the impact of the Proposed Development upon features of nature conservation of internationally and nationally designated ornithological sites in 8.11.

Date	Consultee and type of response	Issue raised	Response to issue raised and/or where considered in this chapter
27/01/2023	OPRED	The Developer is advised to ensure that the ES appropriately assesses the impact of all phases of the Project (I.e., construction, operation, maintenance and decommissioning) on protected species including, for example: pinnipeds, cetaceans, fish, marine turtles, birds, marine invertebrates, bats etc. Information on the relevant legislation protecting these species can be found at https://www.gov.uk/government/publications/protected-marine-species	All phases of the project that were scoped in for assessment in this Offshore Ornithology chapter have assessed on all species of protected waterbird that are likely to utilise the study areas 8.11.1 to 8.11.22.
27/01/2023	OPRED	It is advised that records of protected species are sought from the appropriate local biological record centres, nature conservation organisations and NBN Atlas (https://nbnatlas.org/). It is also advised that consideration should be given to the wider context of the location of the Project, in terms of habitat linkages and protected species populations in the wider area to assist the impact assessment.	Records were sought for waterbirds from the BTO and the Joint Nature Conservation Committee (JNCC) on breeding, wintering, and passage birds that utilise the habitats within the study areas. These were used to inform the baseline 8.7.
27/01/2023	OPRED	Table 7-20: Mean max foraging ranges with standard deviation (SD) for seabird species. The use of Woodward *et al*., 2019 mean max plus 1 standard deviation foraging ranges is welcomed. It is advised that breeding season foraging ranges for razorbill and guillemot are those within appendix 1 of Woodward *et al*., 2019 which excludes data from Fair Isle where the foraging range may have been unusually high due to reduced prey availability during the study year. Therefore, the foraging range to use for razorbill is 73.8 km + 48.4 km and for guillemot is 55.5 km + 39.7 km.	This has been noted and used where appropriate.
27/01/2023	OPRED	Section 7.5.3 and Section 7.5.4. Consideration should be given as to whether seabird surveys of the platform will be required to ascertain if nesting and/or roosting seabirds are (or have been) using the structures. JNCC have generated an advice note on Seabird Survey Methods for Offshore Installations: Black-legged kittiwakes including example offshore installation seabird survey recording forms and a black-legged kittiwakes information and resources signposting document which may be useful for seabird surveys of offshore platforms. Consideration should also be given to the anthropogenic disturbance and displacement of Red-Throated Diver and Common Scoter which are features of Liverpool Bay SPA, and which are also included as a priority species in Section 7 of the Environment (Wales) Act 2016. Both species are sensitive to anthropogenic disturbance and displacement. Details of where further information can be found on this is provided in Annex 2.	Nesting bird surveys of the offshore platforms have already been undertaken by RSK Biocensus (RSK) between 8th and 13th June 2022. Nesting black-legged kittiwake were present on four of the six platforms and a nesting bird strategy (also authored by (RSK) in December 2022) was created following these surveys. The effects of anthropogenic disturbance and displacement on red-throated diver and common scoter have also been considered in the Offshore Ornithology Displacement Technical Report and both species have been carried forward for assessment in 8.11.1.
27/01/2023	OPRED	Table 7-22: Impacts Proposed to be Scoped into the Assessment for Offshore Ornithology.	This has been scoped in and is considered within section 8.11.7.

Date	Consultee and type of response	Issue raised	Response to issue raised and/or where considered in this chapter
		In addition to the vessel movements in the construction and decommissioning phases of the Project, the maintenance and repair vessel movements also have the potential to impact on ornithology receptors during the operational phase and so should be factored into the assessment.	
27/01/2023	OPRED	Should work be undertaken during the non-breeding season, this would be likely to coincide with the presence of red-throated diver and common scoter in the Liverpool Bay SPA. The number of boat movements associated with the works should therefore be included within the ES. The significance of any increase in vessel movements, in particular those that transit the Liverpool Bay SPA should be presented in relation to the disturbance to the red-throated diver and common scoter, covering any vessel transit routes taken. Interim advice of the treatment of displacement for red-throated diver is available at Joint Statutory Nature Conservation Body (SNCB) Interim Displacement Advice Note | JNCC Resource Hub (https://hub.jncc.gov.uk/assets/9aecb87c-80c5-4cfb-9102-39f0228dcc9a).	The number of vessels has been included in the Maximum Design Scenario (MDS) presented in section 8.8.1.

8.6 Methodology to inform the baseline

8.6.1 Offshore ornithology

The Offshore Ornithology baseline was compiled solely from desk-top sources. There is a wealth of available data on the density, distribution, and seasonality of marine birds within the study area. The most relevant pieces of literature that were drawn on are HiDef Aerial Surveying Limited (2023), Waggitt, *et al*. (2022), Bradbury *et al*. (2014), Webb, *et. al*. (2006), and Lawson, *et. al*. (2016). A full list of all desk-top sources that were consulted during the derision of the offshore ornithology baseline are available within the Eni Hynet ES Offshore Ornithology Baseline Technical Report (RPS Group, 2024a).

8.6.2 Intertidal ornithology

The methodology used a combination of diurnal and nocturnal intertidal surveys that ran between October 2022 and April 2023, these results were then compared with the most recent relevant WeBS sector counts to derive the baseline.

The RPS surveys were based on WeBS Core Count (high tide) and the Low Tide Count methodologies of the BTO, JNCC, RSPB, Wildfowl and Wetlands Trust (WWT), WeBS scheme as outlined by Gilbert *et al.* (1998).

Surveyors made six hourly counts per survey, and a minimum of two survey visits (reflecting different tidal influences) per month between September 2022 to April 2023. All surveys were carried out by competent and experienced field ornithologists.

The nocturnal element of the intertidal and nearshore bird survey follows the same approach as the diurnal surveys, except that the surveys ran on a reduced intensity (i.e. single survey visit of a half tidal cycle (six-hour period) per month between November 2022 and March 2023 inclusive). The methodology followed best practice guidance as per Bird Survey & Assessment Steering Group (Bird Survey & Assessment Steering Group, 2022). All surveys were carried out by competent and experienced field ornithologists using a combination of thermal imagers and camcorders with infrared capabilities used alongside high powered infrared laser torches.

A detailed methodology for the RPS surveys is included in Intertidal Ornithology Technical Report (RPS Group 2023).

8.6.3 Little tern foraging distribution

The survey methodology was based on Parsons *et al*. (2015).

The little tern foraging distribution survey programme consisted of 8 survey visits spaced throughout the little tern breeding season (May 2023 to July 2023 inclusive; see RPS (2024c) for full details of the survey programme).

- Counts were undertaken from 18 vantage points located on the upper shore above MHWS.
- Survey started at different tidal states, i.e., low, high, ebb, and flood.
- During each survey, two surveyors started at the observation points closest to the little tern colony (W-1 and E-1) and then moved outwards to W-9 and E-9. These were spaced as close to 500m apart as possible, except for between E-6 and E-9 as access was restricted. Therefore, surveyors had to use the inland path and took the best vantage points as close to 500m apart as was possible. Due to the curvature of the estuary mouth the eastern part of the study area has a larger surface area.
- At each observation point the surveyors stopped for a 30min period (this time is based on the mean foraging trip duration for little terns lasting between 16 and 29 minutes according to Perrow *et al*. (2006)) and looked outwards perpendicular to the shore and recorded all little terns within each zone. Little terns that were at their colonies were not recorded. The following details were recorded:
- Number and age of little terns (adult or juvenile).
- Flight direction (only marked as west or east, e.g., if birds heading northeast then marked as east).
- Behaviour (actively foraging, transiting, on sea, etc.).
- Distance from the shoreline (0 m – 500 m, 500 m – 1000 m, 1000 m – 1500 m, 1500 m – 2000 m).
- Notes, e.g., if terns are carrying prey.
- Numbers of common tern and sandwich tern were also recorded as secondary target species.
- Disturbance – Any source of disturbance to the birds across the study area at the time of the count was recorded. The perceived effect of disturbance on abundance and behaviour of birds in the count sector was also scaled according to the following categories (see Table 8-5).

Surveys were carried out by experienced ornithologists using binoculars and spotting scopes with x 60 magnification (RPS, 2024c).

Table 8-5: Disturbance Scale

Effect Notation	Definition
W	Weak e.g. change in behaviour, but birds not excluded
M	Moderate e.g. birds excluded from parts of the recording sector
S	Strong e.g. avoidance of the recording sector

Additional survey data was also collected, including:

- Weather conditions (wind speed using the Beaufort Scale, cloud cover estimated as eighths or octas of the sky, sea state, and visibility.
- Date

- Tidal state range during survey period.

8.7 Existing baseline description

8.7.1 Offshore ornithology

8.7.2 General overview

The offshore ornithology study area is defined as the area encompassing the Eni Development Area, which includes the offshore structures, offshore cables and subsea cables (including intertidal habitats up to MHWS, plus an additional 10 km buffer, or up to Mean Low Water Springs where this is less than 10 km (Figure 8-1). The 10 km distance was applied to account for the displacement of sensitive divers and sea ducks which are highly sensitive to vessel movements (Schwemmer *et al.*, 2011; Burger *et al.*, 2019) and are present in the Liverpool Bay in internationally important numbers.

Offshore Ornithology Baseline Technical Report (RPS Group, 2024a) provides a detailed baseline characterisation of offshore ornithology (which includes only marine and waterbird species) within the Eni Development Area for the Hynet Carbon Dioxide Transportation and Storage Project and wider region. Data was collated through a detailed desktop review of relevant material within the region (Table 8-6). There are several protected sites designated for marine birds with connectivity to the Eni Proposed Development Area. Table 8-7 shows the designated sites with relevant ornithology features that are within 315 km of the Eni Proposed Development Area and given consideration within this assessment. The 315 km distance is the mean maximum foraging range for northern gannet (as taken from Woodward, *et. Al*., 2019) and was the range used to assess connectivity with the proposed development. Supplementary material from HiDef Aerial Surveying Limited (2023), Waggitt *et al.* (2020), Bradbury *et al.* (2014), and Lawson *et. Al.* (2016) was used to produce maps showing the spatial variation in densities of species across seasons in the Offshore Ornithology study area. Species identified and their associated densities in the area were used to assess the predicted displacement in relation to the Eni Development, as presented in Offshore Ornithology Displacement Technical Report (RPS Group, 2024b).

Offshore Ornithology Displacement Technical Report (RPS Group, 2024b) presents the method and results of the Matrix table approach (using 'Disturbance Sensitivity' and 'Habitat Specialization' scores from Bradbury *et al*. (2014) (expanded from Furness *et al*., 2013) as recommended by the Joint SNCB Interim Displacement Advice Note (SNCB 2022)), to assess seabird displacement resulting from the Eni Development Project during the construction, operations and maintenance, and decommissioning phases. The report considered the most sensitive species found within the Proposed Development area. The displacement was assessed on the installation of new power cables and cable protection, construction of the new Douglas platform and associated construction activities and on the operation and maintenance of the new Douglas platform. For the purposes of displacement assessment therefore, peak densities of seabirds were identified within:

- the Area of Project Physical Work plus a 2 km buffer which overlaps with the Liverpool Bay/Bae Lerpwl SPA and the Area of Project Physical Work plus a 4 km buffer which overlaps with the Liverpool Bay/Bae Lerpwl SPA work (if appropriate for the species i.e. common scoter and red-throated diver);
- the Area of Project Physical Work plus a 2 km buffer; and
- the Douglas platform plus a 2 km buffer.

Potential displacement and mortality rates were calculated for each sensitive species in the area: little tern, common tern, common scoter, red-throated diver, little gull, sandwich tern, Manx shearwater, northern gannet, northern fulmar, and European storm petrel; as well as the likelihood of predicted mortalities surpassing the 1% baseline mortality threshold.

Table 8-6: Summary Of Key Desktop Reports Used To Inform Offshore Ornithology Baseline Technical Report

Title	Source	Year	Author
Densities of qualifying species within Liverpool Bay/Bae Lerpwl SPA: 2015 to 2020 (NECR440)	Natural England	2023	HiDef Aerial Surveying Limited
Awel Y Môr OWF Offshore Ornithology Baseline Characterisation Report	APEM Ltd.	2022	Boa, *et al.*
LBA CCS Transport and Storage Project Feasibility Study Pre-EN	Eni Progetti	2021	ENI
Seabird Monitoring Programme Report 1986-2019	JNCC	2021	JNCC
Distribution maps of cetacean and seabird populations in the North-East Atlantic	Journal of Applied Ecology	2020	Waggitt *et al.*
Desk-based revision of seabird foraging ranges used for HRA screening	BTO Research Report	2019	Woodward *et al.*
Gwynt Y Môr OWF Post-construction Aerial Surveys 2016 to 2019	APEM Ltd.	2017 – 2019	Goddard *et al.,* 2017, 2018, Goulding *et al.,* 2019
UK Offshore Energy Strategic Environmental Assessment OESEA3	Department of Energy and Climate Change (DECC)	2016	DECC
An Assessment of the Numbers and Distributions of Wintering Waterbirds and Seabirds in Liverpool Bay	JNCC	2016	Lawson *et al.*
Mapping Seabird Sensitivity to Offshore Wind Farms	PlosOne	2014	Bradbury *et al.*
SEA678 Data Report for Offshore Seabird Populations	University College Cork	2006	Mackey and Giménez
North Hoyle Offshore Wind Farm, Annual FEPA Monitoring Report 2004-2005	Npower Renewables	2005	RWE Group

8.7.3 Desktop study results

8.7.3.1 Designated sites

There are three designated sites that directly overlap with the Offshore Ornithology Study Area: Liverpool Bay/Bae Lerpwl SPA, Dee Estuary SPA and Ribble and Alt Estuaries SPA. In addition, the potential for offshore interaction of birds from breeding colonies with the Eni Development Area has been assessed based on the most extensive and prevalent seabird foraging ranges. In order to identify designated sites with potentially connectivity to the Proposed Development, a foraging range distance of 315 km (mean-max foraging range of northern gannet, Woodward *et al.,* 2019) was used. The list of SPAs within range of the Eni Development Area are shown in **Table 8-7**.

Table 8-7 Spa Colonies (Qualifying As An Individual Species And/Or Assemblage Of Species) Within Individual Species Range (Mean-Max Foraging Range) From The Eni Development Area

Site Name and Code	Distance to nearest point of Eni Development Area (km)	Relevant Qualifying Feature
Liverpool Bay/Bae Lerpwl SPA (UK9020294A)	0.00	• Red-throated diver *Gavia stellata* (non-breeding) • Little gull *Hydrocoloeus minutus* (non-breeding) • Common scoter *Melanitta nigra* (non-breeding) • Little tern *Sternula albifrons* (breeding) • Common tern *Sterna hirundo* (breeding)
Dee Estuary SPA (UK9013011)	0.00	• Sandwich tern *Sterna sandvicensis* (non-breeding) • Common tern *Sterna hirundo* (breeding) • Little tern *Sternula albifrons* (breeding) • Cormorant *Phalacrocorax carbo* • Great crested grebe *Podiceps cristatus*
Ribble and Alt Estuaries SPA (UK9005103)	1.00	• Lesser black-backed gull *Larus fuscus* (breeding) • Common tern (breeding)
Anglesey Terns/Morwenoliaid Ynys Môn SPA (UK9013061)	30.0	• Sandwich Tern *Sterna sandvicesis* (breeding)
Morecambe Bay and Duddon Estuary SPA (UK9020326)	22.0	• Lesser black-backed gull *Larus fuscus* (breeding and non-breeding)
Aberdaron Coast and Bardsey Island/Glannau Aberdaron ac Ynys Enlli SPA (UK9013121)	98.0	• Manx Shearwater *Puffinus puffinus* (breeding)
Ailsa Craig SPA (UK9003091)	196.0	• Gannet *Morus bassanus* (breeding)
Skomer, Skokholm and the Seas off Pembrokeshire/Sgomer, Sgogwm a Moroedd Penfro SPA (UK9014051)	213.0	• Storm Petrel *Hydrobates pelagicus* (breeding) • Manx Shearwater (breeding)
Grassholm SPA (UK9014041)	224.0	• Gannet *Morus bassanus* (breeding)
Saltee Islands SPA (IE0004002)	246.0	• Fulmar *Fulmarus glacialis* (breeding) • Gannet *Morus bassanus* (breeding)

8.7.3.2 Species accounts

Table 8-8 shows the population and density of species recorded in the Eni Development Area which are qualifying features of SPAs within 315 km. Peak density estimates were generated from supplementary material from Waggitt *et al.* (2020), Bradbury *et al.* (2014), and Lawson *et. Al.* (2016). Waggitt *et al.* (2020) shows little tern and common tern are likely absent from the Liverpool Bay/Bae Lerpwl SPA area, however, both the Dee Estuary and Liverpool Bay SPAs are designated in part for supporting both species. Therefore, the approach taken for characterising little tern and common tern utilisation of the Proposed Development is based upon the foraging ranges from known colonies adjacent to the Liverpool Bay SPA. For little tern, a 5 km mean max foraging range was used (Woodward *et. Al.,* 2019). A total of 8.6% of the area available to little tern within their foraging range is located within the Proposed Development area. For common tern, an 18 km mean max foraging range was used (Woodward *et. Al.,* 2019). A total of 2.5% of the area available to common tern within their foraging range is located within the Proposed Development area. Regional populations were calculated for each species assessed in Offshore Ornithology Displacement Technical Report (RPS Group, 2024b), using data from JNCC 2023; Lawson *et al.* 2016; and Furness 2015. Great cormorant and lesser black-backed gull were not assessed for displacement and so regional population was not estimated.

Table 8-8: Spa With Connectivity To The Proposed Development

Species	Regional Population (within species' mean-max foraging range* of Eni Development Area)
Common scoter	141,801 (non-breeding)[1]
Red-throated diver	1,657 (non-breeding)[1]
Great cormorant	Unreported
Northern fulmar	343,042 (breeding)[1]
Manx Shearwater	967,552 (breeding)[1]
European storm petrel	179,093 (breeding)[1]
Northern gannet	449,233 (breeding)[1]
Little gull	319 (non-breeding)[1]
Lesser black-backed gull	Unreported
Sandwich tern	4,159 (breeding)[1]
Little tern	742 (breeding)[1]
Common tern	26,707 (breeding)[1]

[1]The Offshore Ornithology Displacement Technical Report (data collated from HiDef Aerial Surveying Limited (2023); JNCC 2023; Lawson *et al.,* 2016; and Furness 2015)

8.7.4 Displacement results

8.7.4.1 Background

The construction, operations and maintenance, and decommissioning of the Eni development may lead to disturbance and displacement of birds caused by airborne noise, underwater sound, and presence of vessels and infrastructure. In relation to offshore developments, displacement is defined as a reduction in the number of seabirds occurring within or immediately adjacent to an offshore development (Furness *et al.,* 2013). A high level of disturbance has the potential to displace seabirds from an area of sea in which the development activity is occurring. As a result, displaced birds may move to areas already occupied by other birds and thus face higher intra or inter-specific competition due to a higher density of individuals competing for the same resource. Alternatively, displaced birds may be forced to move into areas of lower habitat quality (e.g. areas of lower prey availability). Such disturbance and resulting displacement could ultimately affect their demographic fitness (i.e. survival rates and breeding productivity) as well as potentially impacting on other birds in areas that displaced birds move to.

There is the potential for disturbance and displacement from airborne noise, underwater sound, and presence of vessels within the Proposed Development as the result of site preparation activities in advance of installation activities, cable installation activities placements and decommissioning activities such as export cable removal. Construction activities can result in a point source of disturbance, for example when construction vessels are at a location to undertake piling and install foundations or cables. During the operations and maintenance phase, the presence of the new Douglas platform has the potential to directly disturb seabirds leading to displacement from the Proposed Development area including an area of variable size or buffer around it where the birds would usually reside. Additionally, activities associated with the operations and maintenance of the platform (e.g. vessel, helicopter and inspection drone activity) may disturb and displace species within the Proposed Development area.

The displacement assessment for the Proposed Development is based on the use of the SNCB Matrix table approach. As sensitivity to displacement differs considerably between seabird species, species were screened and progressed for the Matrix table approach using 'Disturbance Sensitivity' and 'Habitat Specialization' scores from Bradbury *et al.* (2014) and Wade *et al.* (2016) as recommended by the Joint SNCB Interim Displacement Advice Note (JNCC, 2017). In addition to the species' sensitivity rating, the abundance of birds in the Eni development area was considered as to whether species were progressed to the matrix stage. For each of the species assessed (presented in Table 8-9), displacement impacts were quantified for the population derived within the area of physical works plus 2 km buffer, as recommended by SNCBs. However, a 4 km buffer was used for common scoter and red-throated diver due to being more sensitive to disturbance from noise, boat and helicopter traffic, and can be affected up to this distance (Natural England 2021).

The Maximum Design Scenario (MDS) is represented by the maximum density of vessels and structures across the Eni development area that would cause the greatest extent of disturbance and displacement to birds for the greatest duration of impact. The MDS also represents the maximum underwater sound impacts from impact piling for each of the relevant infrastructure foundation options and the maximum number of vessel and helicopter movements that would cause greatest visual and noise disturbance and displacement to birds from the array area and offshore cable corridor. The MDS is summarised in Table 8-16.

The full approach of the displacement assessment is detailed in Offshore Ornithology Displacement Technical Report (RPS Group, 2024b).

Table 8-9: Identification Of Species Taken Forward To The Displacement Assessment

Species	Why displacement analysis is required	Stage of Eni Development displacement analysis is required for
Little tern	Species recorded within development area, qualifying feature of nearby SPA within foraging range, high uncertainty level associated with displacement vulnerability score	Installation of cable route
Common tern	Species recorded within development area, qualifying feature of nearby SPA within foraging range	Installation of cable route
Common Scoter	Species recorded within development area, qualifying feature of nearby SPA within foraging range, very high vulnerability to displacement, low uncertainty level associated with displacement vulnerability score	Installation of cable route
Red-throated diver	Species recorded within development area, qualifying feature of nearby SPA within foraging range, very high vulnerability to displacement, low uncertainty level associated with displacement vulnerability score	Installation of cable route
Little gull	Species recorded within development area, qualifying feature of nearby SPA within foraging range, moderate uncertainty level associated with displacement vulnerability score	Installation of cable route
Sandwich tern	Species recorded within development area, qualifying feature of nearby SPA within foraging range, moderate uncertainty level associated with displacement vulnerability score	Construction and decommissioning Operational phase (Douglas platform)
Manx Shearwater	Species recorded within development area, qualifying feature of nearby SPA within foraging range, high	Construction and decommissioning Operational phase (Douglas platform)

Species	Why displacement analysis is required	Stage of Eni Development displacement analysis is required for
	uncertainty level associated with displacement vulnerability score	
Northern gannet	Species recorded within development area, qualifying feature of nearby SPA within foraging range	Construction and decommissioning Operational phase (Douglas platform)
European storm petrel	Species recorded within development area, qualifying feature of nearby SPA within foraging range, high uncertainty level associated with displacement vulnerability score	Construction and decommissioning Operational phase (Douglas platform)

8.7.4.2 Displacement from construction

As the impacts relating to disturbance from the presence of vessels during construction is temporary it is considered appropriate that a mortality rate of 0.5 to 1% is used. Table 8-10 outlines the predicted mortalities resulting from cable laying activities during the construction phase and within the most disruptive season (relative to species). For full results from all bio seasons, see Offshore Ornithology Displacement Technical Report (RPS Group, 2024b). In addition, the number of birds potentially displaced is calculated based on the potential total area occupied by vessels at any one time. These rates are still regarded precautionary for assessment of the displacement impacts, further backed up by the fact that construction is both temporally and spatially restricted to a very small area of sea at any one time.

Table 8-10: A Summary Of Mortality Estimates Based Upon The Construction Project Phase And During The Most Disruptive Season (Relative To Species)

Species	Season	Peak Density (birds per km²)	Regional Baseline Population (individuals)		Mortality Rate used for assessment (%)	Number of individuals subject to mortality (%)	Increase in baseline mortality (%)
			Population	Baseline Mortality			
Common scoter	Non-breeding	** 33,080 – 4 year mean peak abundance (within Area of Project Physical Works + 4 km buffer)	141,801	33,080	0.5 – 1.0	165.4 – 330.8	0.49 – 0.98
Red-throated diver	Return migration	** 407.2 – 4 year mean peak abundance (within Area of Project Physical Works + 4 km buffer)	1,171	407.2	0.5 – 1.0	2.04 – 4.07	0.2 – 0.89
Great cormorant	Non-breeding	1.66 birds per km²	9,602	3,197	0.5 – 1.0	0.105 – 0.211	0.02 – 0.04
Manx shearwater	Breeding	5	1,580,895	207,097	1 – 5	0	0.000

Species	Season	Peak Density (birds per km²)	Regional Baseline Population (individuals)		Mortality Rate used for assessment (%)	Number of individuals subject to mortality (%)	Increase in baseline mortality (%)
			Population	Baseline Mortality			
Northern fulmar	Breeding	67.2	828,194	149,903	1 – 5	0 – 1	0.000 – 0.001
European storm petrel	Breeding	0.1	834,500	118,499	1 – 5	0	0.000
Northern gannet	Breeding	36.7	661,888	123,773	1 – 5	0 – 1	0.000 – 0.001
Little gull	Non-breeding	0.328 (within Area of Project Physical Works + 2 km buffer)	319	50	0.5-1.0	0.010-0.020	0.020-0.040
Sandwich tern	Passage	115.5	10,761	3,583	10-30	6 – 30	0.167 – 0.837
Little tern	Breeding	N/A	742	N/A	N/A	N/A	0.04 – 0.06
Common tern	Non-breeding	N/A	26,707	N/A	N/A	N/A	0.003 – 0.006

* During the operation and maintenance phase all species had increases in baseline mortality of **less than 0.00%.** ** Estimated 4 year mean peak abundance taken from HiDef Aerial Surveying Limited (2023).

Little Tern*

The Dee Estuary and Liverpool Bay/Bae Lerpwl SPA support breeding little tern, with the coastal waters being a key foraging ground for this species. It is therefore appropriate to consider the potential temporary habitat loss due to cable laying activities, with a high percentage of habitat loss likely to cause increased mortality. As shown in Offshore Ornithology Baseline Technical Report (RPS Group, 2024a), the little tern foraging range at Gronant Dunes and Point of Ayr overlap with the Proposed Development area by 8.6%.

As no known reported disturbance distances for foraging birds has been stated, a precautionary distance of 50 m is considered appropriate. Consequently, the area of impact from a single vessel at any one time could be up to 0.05 km². During construction, there is potential for up to 12 vessels to be present within the area. On this basis a theoretical maximum area of disturbance of up to 0.6 km² could occur.

Using the theoretical maximum area of disturbance of up to 0.6 km², approximately 0.8% of the foraging area of little terns is considered to be affected by displacement resulting from cable laying and increased vessel activity.

A breeding season abundance of 5.9 little tern could be displaced from within the 0.8% affected area. When considering a mortality rate of 0.5 to 1%, this would result in approximately 0.03 to 0.06 little tern being subject to mortality.

The breeding population estimate for little tern in the Liverpool Bay SPA is recorded as 742 individuals (Table 1.9) and, using the average baseline mortality rate of 0.2 (Table 1.10), the natural predicted mortality in the winter bio-season is 148.4 individuals per annum. The addition of 0.03 to 0.06 mortalities would increase the mortality relative to the baseline mortality rate by 0.02 to 0.04%.

In the breeding bio-season and assessed against the little tern population the predicted mortalities did not surpass a 1% baseline mortality threshold.

Common Tern*

Both the Dee Estuary and Liverpool Bay SPAs are designated in part for supporting breeding common tern. It is therefore appropriate to consider the potential temporary habitat loss due to cable laying activities, with a high percentage of habitat loss likely to cause increased mortality.

Burger (1998) suggests that common tern are disturbed by vessels at a minimum distance of 100 m. The area of impact from a single vessel at any one time could be up to a maximum distance of 0.1 km^2. During construction, there is potential for up to 12 vessels to be present within the area. On this basis a theoretical maximum area of disturbance of up to 1.2 km^2 could occur. However, during construction vessel activity will be clustered around the area of cable laying and therefore the areas of potential disturbance from each vessel will overlap and the overall area of disturbance will be considerably smaller.

As shown in Offshore Ornithology Baseline Technical Report (RPS Group, 2024a), part of the Proposed Development area overlaps with the foraging area by 2.5%. In order to incorporate the displacement resulting from cable laying and increased vessel activity, the potential impacts on common terns are considered within a radius of 1.2 km^2. As a result, approximately 0.16% of the foraging area could be affected.

A breeding season abundance of 42.7 common tern could be displaced from within the 0.16% affected area. When considering a mortality rate of 0.5 to 1%, this would result in approximately 0.21 to 0.42 little tern being subject to mortality.

The breeding population estimate for little tern in the Liverpool Bay SPA is recorded as 26,707 individuals (Table 1.9) and, using the average baseline mortality rate of 0.268 (Table 1.10), the natural predicted mortality in the winter bio-season is 7,157 individuals per annum. The addition of 0.21 to 0.42 mortalities would increase the mortality relative to the baseline mortality rate by 0.003 to 0.006%.

In the breeding bio-season and assessed against the little tern population the predicted mortalities did not surpass a 1% baseline mortality threshold.

All other seabirds

The displacement scores for all other species come in below the critical 1% threshold of excess mortality. Both common scoter and red-throated diver are near the 1% threshold however the effects are predicted to be very temporary in nature only lasting one season. Therefore, no cumulative mortality will be caused year on year.

Sandwich tern are also close to the 1% threshold. However, these are mostly composed of passage birds which are less tied to discreet areas of habitat and therefore more mobile and flexible in their use of foraging areas.

8.7.4.3 Permanent displacement from operation of Douglas platform

Although most studies have documented attraction effects of offshore platforms in both seabirds and land birds, the presence of platforms can also displace birds from otherwise suitable foraging habitat (Ronconi *et al*., 2015). In some studies, it has been shown that shearwaters, storm petrels, and Northern fulmar occurred in lower densities close to offshore platforms compared to regions 10 km – 50 km away (AMEC, 2011). With the lack of known consequences and rates at which birds avoid offshore structures, it is assumed therefore that for certain species, complete avoidance of the offshore platform occurs.

Table 8-11 summarises the predicted annual (BDMPS) increase in baseline mortality for the seabird species assessed as being at risk. In all bio-seasons and assessed against the regional populations, the predicted mortalities of each species did not exceed a 1% increase in baseline mortality threshold caused by the operation of the Douglas platform.

Table 8-11: Annual (BDMPS) Permanent Displacement Estimates For The Eni Development Douglas Platform Plus 2 Km Buffer During Operation Of Platform Estimates For The Eni Development Douglas Platform Plus 2 Km Buffer During Operation Of Platform

Species	Douglas platform + 2 km buffer Peak Abundance	Regional Baseline Population		Displacement Rate resulting from Eni Development (%)	Mortality Rate resulting from Eni Development (%)	Number of individuals subject to mortality	Increase in baseline mortality (%)
		Population	Baseline Mortality				
Sandwich tern	0	10,761	3,583	50-100	30-50	0	0.000
Manx shearwater	5	1,580,895	207,097	50-100	1-10	0-0	0.000
Northern gannet	32.2	661,888	123,773	50-100	1-10	0-3	0.000-0.002
Northern fulmar	54.2	828,194	149,903	50-100	1-10	0-5	0.000-0.003
European storm petrel	0.1	834,500	118,499	50-100	1-10	0	0.000

8.7.5 Intertidal ornithology

8.7.5.1 General overview

The Intertidal Ornithology Study Area sits at the mouth of the Dee Estuary, which is an important stop-off for many species of wintering and passage waders and wildfowl, in addition to providing nesting habitat for the UK's largest colony of breeding little tern.

The Intertidal Ornithology Study Area is mostly composed of sand and mudflats and/or nearshore waters. The area is mostly used by gulls, waders, and waterfowl, with small numbers of common scoter and red-throated diver utilising the nearshore waters. The nearshore waters also provide the foraging ground for breeding and passage terns.

8.7.5.2 Designated sites

There are three internationally designated sites with intertidal waterbird features within 20 km, two of these are also Ramsar sites.

Table 8-12: The Internationally Designated Sites Within 20 Km Of The Landfall Of The Proposed Developments

Sites	Distance from site	Features
The Dee Estuary SPA and Ramsar	0 km	**Non-breeding** – cormorant (*Phalacrocorax carbo*), shelduck (*Tadorna tadorna*), teal (*Anas crecca*), pintail (*Anas acuta*), wigeon (*Anas* pprox.), great crested grebe (*Podiceps cristatus*), oystercatcher (*Haematopus ostralega*), grey plover (*Pluvalis squatarola*), knot (*Calidris canuta*), dunlin (*Calidris alpina*), black-tailed godwit (*Limosa limosa*), bar-tailed godwit (*Limosa lapponica*), curlew (*Numenius arquata*), redshank (*Tringa* pprox.), sanderling (Calidris alba), **Breeding** – common tern (*Sterna hirundo*), little tern (*Sternula albifrons*), redshank (*Tringa* pprox.) **Passage** – ringed plover (*Charadrius hiaticula*), sandwich tern (*Sterna sandvicensis*)
Liverpool Bay SPA	0 km	**Non-breeding** – red-throated diver (*Gavia stellata),* common scoter (*Melanitta nigra),* little gull (*Hydrocoloeus minutus)* **Breeding** – little tern (*Sternula albifrons*), common tern (*Sterna hirundo*)
Mersey Narrows and North Wirral Foreshore SPA and Ramsar	7.9 km	**Non breeding** – cormorant (*Phalacrocorax carbo*), oystercatcher (Haematopus ostralegus), grey plover (*Pluvialis squatarola*), sanderling (Calidris alba), dunlin (*Calidris alpina alpina*), knot (*Calidris canuta*), bar-tailed godwit (*Limosa lapponica*), redshank (*Tringa* pprox.), little gull (*Hydrcoloeus minutus*) **Breeding** – common tern (*Sterna hirundo*)

There are also four SSSIs with intertidal waterbird features within 20 km of the landfall of the proposed development. One underpins the Mersey narrows and north Wirral foreshore SPA whilst the other three underpin the Dee Estuary SPA. Only species of interest that are not named as designated features of the internationally designated sites that they underpin are named below.

Table 8-13: The Nationally Designated Sites Within 20 Km Of The Landfall Of The Proposed Development

SSSIs	Distance from site	Features
North Wirral Foreshore SSSI	7.9 km	**Non-breeding** – greater scaup (*Anthya marila*), common scoter (*Melanita nigra*), goldeneye (*Bucephala clangula*), red-throated diver (*Gavia stellata*), great crested grebe (*Podiceps cristatus*), turnstone (*Arenaria interpres*), black-tailed godwit (*Limosa limosa*)
Dee Estuary SSSI England	4.4 km	As SPA and Ramsar
Dee Estuary/Aber Afon Dyfrdwy SSSI Wales	0 km	As SPA and Ramsar
Gronant Dunes and Talacre Warren SSSI	0 km	As Dee Estuary SPA and Ramsar

8.7.5.3 Survey results

The full findings of the diurnal and nocturnal intertidal surveys undertaken are presented in detail in Intertidal Ornithology Technical Report (RPS Group, 2023).

A total of 51 waterbird species were identified to species level during the diurnal and nocturnal surveys. These species belonged to nine taxonomic groups:

- wildfowl (11 species);
- seaducks, divers and grebes (5 species);
- seabirds and auks (4 species);
- cormorants (1 species);
- herons (2 species);
- rails (2 species);
- waders (16 species);
- gulls (7 species); and
- terns (3 species).

Table 8-14 contains a summary of the intertidal survey results and the conservation status of each species recorded. The conservation status of each species has been used to determine whether it is carried through for assessment as a Valued Ornithological Receptor (VOR). All species that are SPA, Ramsar, or SSSI features have been taken through in addition to those species named on – annex 1 of the birds directive, schedule 1 of the Wildlife and Countryside Act, as amended (1981), section 7 of the Environment Act (Wales) 2016, and any species named under the red and amber lists of the Birds of Conservation Concern (BOCC 5 UK) (Stanbury *et al*., 2021) and BOCC 4 Wales (Johnstone *et al*., 2022).

Table 8-14: Summary Of Peak Counts From Either Diurnal Or Nocturnal Intertidal Survey Results

Taxonomic group	Species	Peak Count	SPA feature	Ramsar feature	SSSI feature	Annex 1	Schedule 1	Section 7	UK BoCC 5	BoCC 4 Wales
	Mute swan	2	×	×	×	×	×	×	Green	Green
	Canada goose	208	×	×	×	×	×	×	Green	Green
	Greylag goose	2	×	×	×	×	×	×	Amber	Amber
	Pink-footed goose	330	✓	✓	✓	×	×	×	Amber	Green
	Brent goose	321	×	×	×	×	×	✓	Amber	Green
	Shelduck	77	✓	✓	✓	×	×	×	Amber	Red
	Gadwall	2	×	×	×	×	×	×	Amber	Green
	Mallard	14	×	×	×	×	×	×	Amber	Green
	Teal	29	✓	✓	✓	×	×	×	Amber	Amber
	Wigeon	1	✓	✓	✓	×	×	×	Amber	Amber
	Pintail	2	✓	✓	✓	×	×	×	Amber	Amber
Seaducks, divers and grebes	Common scoter	185	✓	×	×	×	✓	✓	Red	Amber
	Great northern diver	1	×	×	×	✓	×	×	Amber	Green

Taxonomic group	Species	Peak Count	SPA feature	Ramsar feature	SSSI feature	Annex 1	Schedule 1	Section 7	UK BoCC 5	BoCC 4 Wales
	Red-throated diver	2	✓	×	×	✓	×	×	Green	Amber
	Goosander	1	×	×	×	×	×	×	Green	Green
	Great crested grebe	7	×	×	✓	×	×	×	Green	Green
True seabirds	Gannet	3	✓	×	×	×	×	×	Amber	Amber
	Kittiwake	12	✓	×	×	×	×	×	Red	Red
	Guillemot	3	✓	×	×	×	×	×	Amber	Amber
	Razorbill	2	✓	×	×	×	×	×	Amber	Amber
Cormorants	Cormorant	388	✓	✓	✓	×	×	×	Green	Green
Herons	Grey heron	2	×	×	×	×	×	×	Green	Amber
	Little egret	2	✓	×	×	✓	×	×	Green	Green
Rails	Moorhen	2	×	×	×	×	×	×	Amber	Green
	Water rail	2	×	×	×	×	×	×	Green	Amber
Waders	Oystercatcher	188	✓	✓	✓	×	×	×	Amber	Amber
	Ringed plover	59	✓	✓	✓	×	×	✓	Red	Red
	Lapwing	112	×	×	×	×	×	✓	Red	Red
	Golden plover	45	✓	×	✓	✓	×	✓	Green	Red
	Grey plover	52	✓	✓	✓	×	×	×	Amber	Red
	Knot	2	✓	✓	✓	×	×	×	Amber	Amber
	Dunlin	449	✓	✓	✓	×	×	×	Red	Red
	Sanderling	229	✓	✓	✓	×	×	×	Amber	Green
	Turnstone	1	✓	×	×	×	×	×	Amber	Amber
	Common sandpiper	7	×	×	×	×	×	×	Amber	Amber
	Redshank	4	✓	✓	✓	×	×	×	Amber	Red
	Black-tailed godwit	32	✓	✓	✓	×	✓	×	Red	Amber
	Curlew	60	✓	✓	✓	×	×	✓	Red	Red
	Whimbrel	3	×	×	×	×	✓	×	Red	Amber
	Snipe	105	×	×	×	×	×	×	Amber	Amber
	Jack snipe	1	×	×	×	×	×	×	Green	Amber
Gulls	Black-headed gull	465	×	×	✓	×	×	✓	Amber	Red
	Mediterranean gull	1	✓	×	×	✓	✓	×	Amber	Amber
	Common gull	2,852	×	×	×	×	×	×	Amber	Amber
	Great black-backed gull	43	×	×	×	×	×	×	Amber	Amber
	Herring gull	516	✓	×	×	×	×	✓	Red	Red
	Yellow-legged gull	1	×	×	×	×	×	×	Amber	Amber
	Lesser black-backed gull	21	✓	✓	×	×	×	×	Amber	Red
Terns	Common tern	3	✓	✓	✓	✓	×	×	Amber	Amber

Taxonomic group	Species	Peak Count	SPA feature	Ramsar feature	SSSI feature	Annex 1	Schedule 1	Section 7	UK BoCC 5	BoCC 4 Wales
	Little tern	44	✓	×	✓	✓	✓	×	Amber	Red
	Sandwich tern	1,043	✓	×	✓	✓	×	×	Amber	Amber

8.7.6 Little tern foraging distribution

8.7.6.1 General overview

The Gronant Dunes little tern colony is situated on the upper beach at the Gronant Dunes approx. 1.2 km from the Proposed Development. Whilst the UK has seen a decline of 42% in little tern abundance since the 1980s (SMP, 2019), the colony at Gronant has quadrupled in size over the same period. It held 211 and 212 Apparently Occupied Nests (AONs) in 2022 and 2023 (RSPB) respectively making it one of the UKs largest colonies. In addition to the main colony a satellite colony has formed to the east at Point of Ayr. This hosted 39 AONs in 2022 and 30 in 2023 (RSPB). These two colonies combined, contain all the Welsh breeding population of little tern and circa. 10% of the UK breeding population. The threshold for international importance for little tern is 190 individuals, so this site is internationally important for this species.

8.7.6.2 Designated sites

The Proposed Development passes directly through the Liverpool Bay Special Protection Area (SPA), Dee Estuary SPA, Ramsar and Site of Special Scientific Interest (SSSI), and Gronant Dunes and Talacre Warren SSSI. These sites are of national and international importance for breeding little tern and common tern (*Sterna hirundo*) and for passage sandwich tern (*Sterna sandvicensis*), see Table 8-12 and Table 8-13.

8.7.6.3 Survey results

The results of the site-specific surveys corroborate the findings of other little tern studies with 90% of foraging birds concentrated within 1.5 km offshore from MHWS and 3.5 km alongshore either side of the colony (RPS, 2024c). The highest concentrations of foraging little tern were situated close to the main colony at Gronant Dunes and within the first 1.5 km offshore (see Figure 8-5).

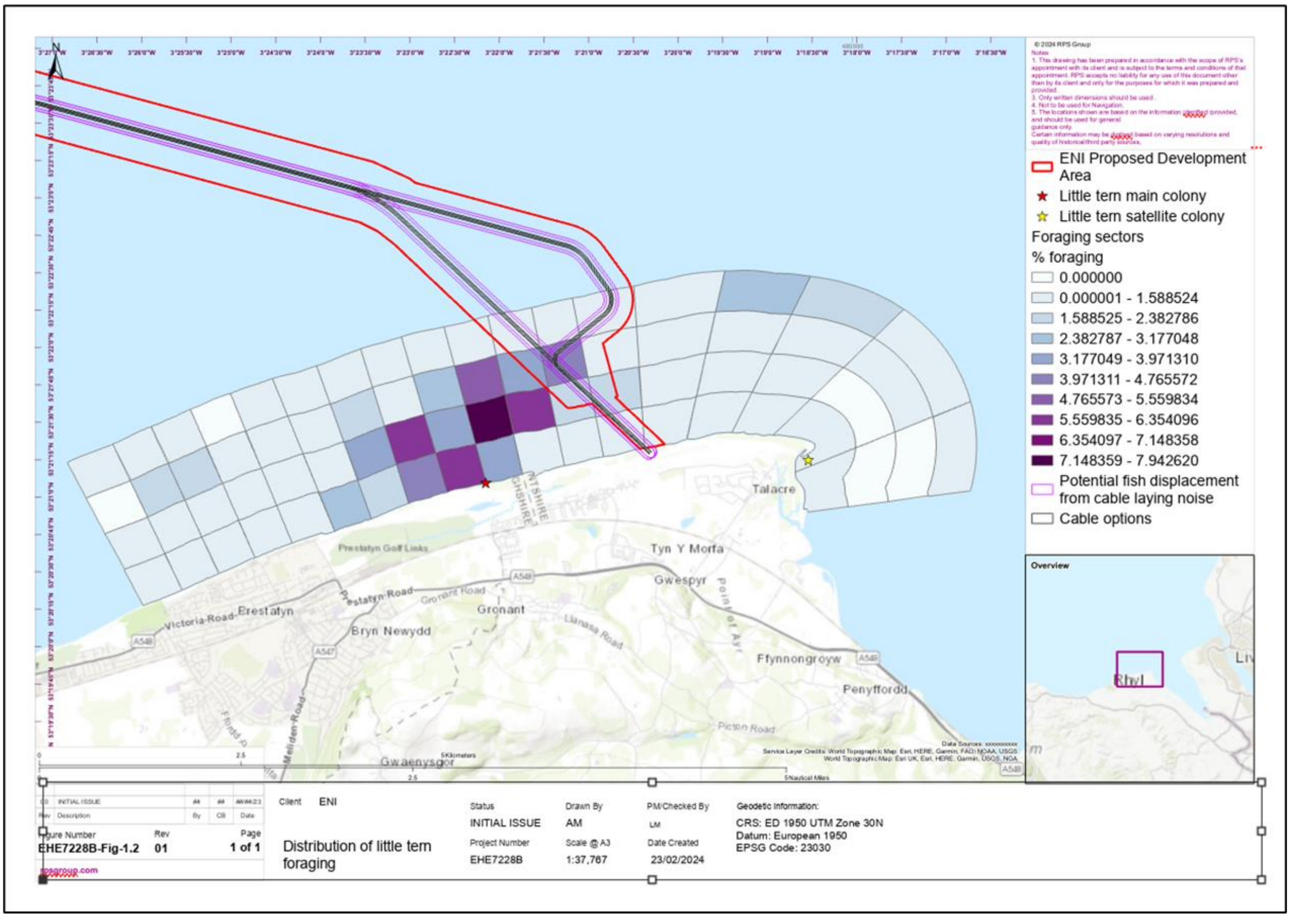

Figure 8-5: Distribution Of Foraging Little Tern Split By Count Sectors And Distance Bands

Based upon the 2023 breeding season data, between 2.4% and 2.9% of the Gronant Dunes and Point of Ayr little terns foraging distribution may be affected by changes in prey availability caused by underwater noise during cable laying activities (Table 8-15) .

There is no available data on thresholds of suspended sediment loads that may alter fish behaviour therefore this potential impact cannot be quantified. However, suspended sediments above 1,000 mg/l may cause injury or mortality of adult fish and lower levels may cause mortality of juvenile fish and eggs. Sediment loads are expected to surpass the 1,000 mg/l level in the nearshore waters.

Table 8-15: Calculations To Determine What Percentage Of Little Tern Foraging Is Located Within The Area Where Prey Availability May Be Affected By Underwater Noise

			Weighted % of overlap with 68m fish displacement zone			
			Through West Hoyle Bank		Around West Hoyle Bank	
Observation point	Distance band	% foraging per sector	Option 1.1	Option 1.2	Option 2.1	Option 2.2
E-3	1000 - 1500m	4.654	1.406	1.507	1.898	1.917
E-3	500 - 1000m	2.344	0.491	0.405	0.491	0.405
E-4	500 - 1000m	1.819	0.235	0.291	0.235	0.291
E-2	1000 - 1500m	3.324	0.145	0.075	0.000	0.000
E-2	1500 - 2000m	0.385	0.128	0.123	0.000	0.000

			Weighted % of overlap with 68m fish displacement zone			
			Through West Hoyle Bank		Around West Hoyle Bank	
Observation point	Distance band	% foraging per sector	Option 1.1	Option 1.2	Option 2.1	Option 2.2
E-4	0 - 500m	0.070	0.022	0.021	0.022	0.021
E-3	1500 - 2000m	0.385	0.003	0.009	0.028	0.016
E-5	0 - 500m	0.070	0.001	0.002	0.001	0.002
E-4	1500 - 2000m	0.735	0.000	0.000	0.207	0.216
E-4	1000 - 1500m	1.015	0.000	0.000	0.002	0.010
Total foraging overlap with the 68m underwater noise fish displacement zone			**2.431**	**2.432**	**2.884**	**2.877**

8.8 Key parameters for assessment

8.8.1 Maximum Design Scenario

The maximum design scenarios (MDSs) identified in Table 8-16 have been selected as those having the potential to results in the greatest effect on an identified receptor or receptor group.

Effects of greater adverse significance are not predicted to arise should any other development scenario, based on details within the Project Design Envelope (e.g. different infrastructure layout), to that assessed here be taken forward in the final design scheme.

Table 8-16: Maximum Design Scenario Considered For The Assessment Of Potential Impacts

a C=construction, O=operation and maintenance, D=decommissioning

Potential Impact	Phase[a] C	O	D	Maximum Design Scenario	Justification
Temporary habitat loss leading to displacement/disturbance of birds	✓	✕	✓	**Construction Phase** **Offshore Inter-OP Cables** Number of cables: 3 Zone of disturbance: 15 m width per trench Maximum burial depth: 3 m Maximum width of trench: 1.5 m Cable length: 12 km (Douglas to Hamilton), 15 km (Douglas to Hamilton North), 35 km (Douglas to Lennox) **PoA Terminal-Douglas Cable** Number of cables: 2 Distance between cables: 30 m minimum Zone of disturbance: 15 m width per trench Maximum width of trench: 1.5 m Total length: 34 km per cable **Injection Wells – Hamilton** Number of wells: 4 Days to completion: 35 per well Distance to coastline: 23 km **Injection Wells – Hamilton North**	**Construction Phase** The MDS includes the maximum construction corridor width, within which the cables will be located – this represents the largest physical impact and greatest area of habitat loss. Open cut trenching generally represents the worst case in relation to habitat loss, compared to Horizontal Directional Drilling beneath a feature. The MDS includes the maximum number of wells to be drilled or altered. The works associated with this represent largest physical and disturbance impact. **Decommissioning Phase** Decommissioning is likely to operate within the parameters identified for construction.

Potential Impact	Phase[a] C	O	D	Maximum Design Scenario	Justification
				Number of wells: 2 Days to completion: 35 per well Distance to coastline: 26 km **Injection Wells – Lennox** Number of wells: 2 targets Days to completion: 45 per well Distance to coastline: 11 km **Monitoring Wells – Hamilton Main** Number of wells: 1 Days to completion: 55 Distance to coastline: 23 km **Monitoring Wells – Hamilton North** Number of wells: 1 Days to completion: 55 Distance to coastline: 26 km **Monitoring Wells – Lennox** Number of wells: 1 Days to completion: 45 Distance to coastline: 26 km **Sentinel Wells – Hamilton North** Number of wells: 1 Days to completion: 20 Distance to coastline: 26 km **Sentinel Wells – Lennox** Number of wells: 1 Days to completion: 20 Distance to coastline: 11 km **Decommissioning Phase** Decommissioning activities are anticipated to occur within the areas affected by the construction phase. Temporary habitat loss will be limited to temporary works areas no greater in size than the construction works areas	
Disturbance and displacement from airborne sound and presence of vessels and infrastructure	✓	✓	✓	**Construction Phase** **OP and Wells** Maximum number of installation and support vessels: 3 Maximum number of tugs/anchor handlers: 7 Maximum number of cargo barges: 5 Maximum number of support vessels: 2 Maximum number of survey vessels: 2 Maximum number of seabed preparation vessels: 2 Maximum number of crew transfer vessels: 2 **Cables and Pipeline** Preferred burial technique: plough Maximum number of cable lay installation and support vessels: 4	**Construction Phase** The MDS includes the maximum number of vessels to be present on site in relation to topside installation at any given time and the extent of impact is based on this. These vessels will be present across the whole site, including each platform and well location. The preferred method for laying cables using a plough will contribute to sound levels. Magnetometer surveys have not indicated a high potential for UXO to be found however if located may be detonated *in situ*. **Operation and Maintenance Phase** The MDS includes the maximum number of vessels to be present on

Potential Impact	Phase[a] C	O	D	Maximum Design Scenario	Justification
				Maximum number of jack-up vessels: 2 Maximum number of multicat vessels: 2 Maximum number of working boats: 3 Maximum number of support vessels for trenching: 1 Maximum number of DSV/LCV for cable pull in: 1 Maximum number of survey vessels: 1 Maximum number of seabed preparation vessels: 1 Maximum number of crew transfer vessels: 1 Maximum number of cable protection installation vessels: 1 Maximum number of cable burial installation vessels: 1 **UXO** Possibility of finding unexploded ordnance (UXO) **Operation and Maintenance Phase** Maximum number of jack-up vessels: 1 Maximum number of other vessels: 3 Maximum number of helicopters: 1 **Decommissioning Phase** Maximum number of main decommissioning and support vessels: 2 Maximum number of tug/anchor handlers: 6 Maximum number of number of barges: 4 Maximum number of cable decommissioning and support vessels: 2 Maximum number of survey vessels: 1 Maximum number of crew transfe2 vessels: 2	site in relation to the operation and maintenance of the project. These vessels will be present across the whole site, including each platform and well location. **Decommissioning Phase** The MDS includes the maximum number of vessels to be present on site in relation to the decommissioning of the project. These vessels will be present across the whole site, including each platform and well location.
Collision with static offshore infrastructure	✗	✓	✗	**Operation and Maintenance Phase** Number of platforms: 4 Heights below taken at lowest astronomical tide (LAT). **Douglas OP** Height of main structure: 38.5 m Height of helideck: 46.5 m Height of crane: 62.7 m Length: 76.7 m Width: 45.6 m	**Operation and Maintenance Phase** The MDS includes the maximum heights of the operating platforms in relation to the operation and maintenance of the project. These structures present the greatest risk of collision across the site. A reduced number of vessels operating in the area compared to during the construction and decommissioning phases may reduce disturbance levels and

Potential Impact	Phase[a] C	O	D	Maximum Design Scenario	Justification
				Hamilton Main OP Height: 33.5 m Length: 27.8 m Width: 23.9 m **Hamilton North OP** Height: 33.5 m Length: 27.8 m Width: 23.9 m **Lennox OP** Height: 35.7 m Length: 33.9 m Width: 29.6 m	increase the number of birds in the area.
Indirect impacts to birds from changes in prey availability	✓	✓	✓	**Construction Phase** Disturbance to fish and shellfish from underwater sound and sedimentation leading to possible displacement of prey. Underwater noise caused by cable laying activities may impact prey up to 68 m from activities. Piling activities associated with platform construction have the potential to displace prey. The dredging of West Hoyle Bank to install a cable route will involve dredging a trench 1 km long, 60 m wide and 7 m deep and the Suspended Sediment Concentration (SSC) may lead to possible displacement of prey. The cable laying plough and associated SSCs may lead to possible displacement of prey. **Operation and Maintenance Phase** Disturbance to fish and shellfish from underwater sound leading to possible displacement of prey. **Decommissioning Phase** Disturbance to fish and shellfish from underwater sound and sedimentation leading to possible displacement of prey.	**Construction Phase** The preferred method of laying cables is via plough, likely to generate high vibration levels. The presence of surface vessels and below water construction activity will impact the distribution of prey in the area. Dredging of the West Hoyle Bank and cable route may increase sedimentation **Operation and Maintenance Phase** Routine maintenance and operation will impact prey distribution and many present an injury risk to fish/shellfish through the presence of vessels. Activities such as the removal of marine growth from subsea structures will likely give rise to vibration levels, sediment disturbance and noise resulting in an impact on prey distribution. **Decommissioning Phase** Subsea installations on the seabed that are exposed or at a depth of up to 0.6 m will be removed, this will generate vibration and noise disturbance.
Accidental pollution in the surrounding area	✓	✓	✓	**Construction Phase** Drilling of wells (creation of new and re-directing existing). Cutting of trenches for cable laying. Detonation of UXO along cable route. Presence of vessels involved in construction processes. **Operation and Maintenance Phase** Presence of vessels involved in routine operation and maintenance. **Decommissioning Phase**	**Construction Phase** Vessels associated with the construction process present a risk of fuel run-off. **Operation and Maintenance Phase** Vessels associated with the routine operation and maintenance processes present a risk of fuel run-off. **Decommissioning Phase**

Potential Impact	Phase[a] C	O	D	Maximum Design Scenario	Justification
				Presence of vessels involved in decommissioning processes.	Vessels associated with the decommissioning process present a risk of fuel run-off. The cleaning of pipelines during decommissioning present a risk of contamination should leakage occur into the sea.
Creation of roosting and nesting habitats among project infrastructure	×	✓	×	**Operation and Maintenance Phase** Number of platforms: 4 Heights below taken at lowest astronomical tide (LAT). **Douglas OP** Height of main structure: 38.5 m Height of helideck: 46.5 m Height of crane: 62.7 m Length: 76.7 m Width: 45.6 m **Hamilton Main OP** Height: 33.5 m Length: 27.8 m Width: 23.9 m **Hamilton North OP** Height: 33.5 m Length: 27.8 m Width: 23.9 m **Lennox OP** Height: 35.7 m Length: 33.9 m Width: 29.6 m	**Operation and Maintenance Phase** The MDS includes the maximum heights of the operating platforms in relation to the operation and maintenance of the project. These structures provide the only potential for offshore roosting and nesting habitat within the project area.

8.8.2 Impacts scoped out of the assessment

On the basis of the baseline environment and the Proposed Development Description outlined in chapter 3 of the Offshore ES, two impacts are proposed to be scoped out of the assessment for Intertidal and Offshore Ornithology. This was either agreed with key stakeholders through consultation as discussed in chapter 5, or otherwise, the impact was proposed to be scoped out in the HyNet Carbon Dioxide transportation and Storage Project – Offshore Scoping Report (*Eni, 2022*) and no concerns were raised by key consultees. These impacts are outlined, together with a justification for scoping it out, in Table 8-17.

Table 8-17 Impacts Scoped Out Of The Assessment For Intertidal And Offshore Ornithology (Tick Confirms The Impact Is Scoped Out)

Potential Impact	Phase C	O&M	D	Justification
Operational underwater noise	×	✓	×	**Operation and maintenance phase** Underwater noise during the project's ongoing operation is unlikely to result in noise levels that would impact surrounding bird species.
Injury to biodiversity from potential	✓	✓	✓	**All phases**

Potential Impact	Phase			Justification
	C	O&M	D	
collision with marine vessels				The presence of construction, maintenance and decommissioning marine vessels, in addition to increased vessel traffic in the area is unlikely to cause injury to seabirds through vessel strikes and collision risks given the industrialised nature of Liverpool Bay. Shipping and marine traffic is heavily prevalent within Liverpool Bay and seabirds and vessel strikes have not been documented within the area. The majority of seabird strikes is a direct result of attraction and sometimes associated collision with lights (Ronconi *et al*., 2015). Although unpredictable, poor weather, precipitation and cloud cover have been known to exacerbate the effects of nocturnal attraction to lights (Ronconi *et al*., 2015).

8.9 Methodology for assessment of effects

8.9.1 Impact assessment criteria

The offshore ornithology impact assessment has followed the methodology set out in volume 1, chapter 5. Specific to the onshore and intertidal ornithology impact assessment, the following guidance documents have also been considered:

- Guidelines on Ecological Impact Assessment (CIEEM, 2022).

In addition, this chapter has considered the legislative framework as defined by:

- The Conservation of Habitats and Species Regulations 2017 (as amended)
- The Wildlife and Countryside Act 1981 (as amended)
- European Commission (‘EC’) Directive 2009/147/EC (codified version of 79/409/EC) on the Conservation of Wild Birds (the ‘Birds Directive’)
- Ramsar Convention on Wetlands of International Importance 1971
- Section 7 of the Environment (Wales) Act 2016

Consideration was also given to those species featuring on the following:

- Species listed as red or amber on the Birds of Conservation Concern 5 (BOCC 5 UK) (Stanbury *et al*., 2021)
- Species listed as red or amber on the Birds of Conservation Concern Wales 4 (BOCC4 Wales) (Johnstone *et al*., 2022).

The criteria for determining the significance of effects is a two-stage process that involves defining the magnitude of the impacts and the sensitivity of the receptors. This section describes the criteria applied in this chapter to assign values to the magnitude of potential impacts and the sensitivity of the receptors. The terms used to define magnitude and sensitivity are based on those which are described in further detail in volume 1, chapter 5.

The criteria for defining magnitude in this chapter are outlined below. This set of definitions has been determined on the basis of changes to bird populations.

Table 8-18: Definition Of Terms Relating To The Magnitude Of An Impact

Magnitude of impact	Definition
High	A change in the size or extent of distribution of the relevant biogeographic population or the population that is the interest feature of a specific protected site that is predicted to irreversibly alter the population in the short to long term and to alter the long-term viability of the population and/or the integrity of the protected site. Impacts felt long-term. Impacts predicted to be reversed in the long-term (i.e. more than five years) following cessation of the project activity.
Medium	A change in the size or extent of distribution of the relevant biogeographic population or the population that is the interest feature of a specific protected site that occurs in the short and long-term, but which is not predicted to alter the long-term viability of the population and/or the integrity of the protected site. Impacts felt medium to long term. Impacts predicted to be reversed in the medium-term (i.e. no more than five years) following cessation of the project activity.
Low	A change in the size or extent of distribution of the relevant biogeographic population or the population that is the interest feature of a specific protected site that is sufficiently small-scale or of short duration to cause no long-term harm to the feature/population. Impacts present for a short to medium duration. Impacts predicted to be reversed in the short-term (i.e. no more than one year) following cessation of the project activity.
Negligible	Very slight change from the size or extent of distribution of the relevant biogeographic population or the population that is the interest feature of a specific protected site. Impacts present for a short duration Impacts predicted to be reversed rapidly (i.e. no more than circa six months) following cessation of the project related activity.
No change	No loss or alteration of characteristics, features or elements; no observable impact either adverse or beneficial.

The criteria for defining recoverability and sensitivity in this chapter are outlined below. The definition of sensitivity considers the vulnerability and recoverability of a receptor as well as taking into account the conservation importance of each receptor.

It should be noted that high vulnerability and/or low recoverability are not necessarily linked with high conservation value within a particular impact. A receptor could be categorised as being of high conservation value (e.g. an interest feature of a SPA) but have a low or negligible physical/ecological vulnerability to an effect and vice versa. Determination of sensitivity takes these differing aspects into consideration.

Table 8-19: Definition Of Recoverability

Sensitivity	Definition
High	A species with a low to medium reproductive success and a stable or increasing UK trend in breeding abundance and productivity.
Medium	A species with a low reproductive success and a stable or increasing UK long-term trend in breeding abundance and productivity.
Low	A species with a low reproductive success and a declining UK long-term trend in breeding abundance and productivity or uncertainty regarding the long-term trend (due to data availability).

Table 8-20: Definition Of Conservation Values Relating To The Sensitivity Of The Receptor

Conservation importance	Definition
Very High	Species of international/European importance: • Cited interest feature of SPA or Ramsar • Population present within survey area exceeds 1% threshold of international importance.

Conservation importance	Definition
High	Species of national importance: • Species listed on Annex 1 of the EU Birds Directive • Species that contribute to the assemblage of a SSSI • Species listed on Schedule 1 of the Wildlife and Countryside Act (1981) as amended • Population present within survey area exceeds 1% threshold of National Importance. • Species listed in Section 7 of the Environment (Wales) Act, 2016
Medium	Species of regional importance: • Species listed on LBAPs for the local area • Species considered to be of regional significance due to population size or distribution restrictions.
Low	Species of local importance: • Species that are of importance on a very local scale (i.e. within the local borough)
Negligible	• All commonly occurring and widespread species

Table 8-21: Definition Of Sensitivity Of The Receptor

Sensitivity	Definition
Very High	Bird species has high conservation value, very high vulnerability to impact and has no ability to recover.
High	Bird species has high conservation value, medium vulnerability to impact and has low recoverability.
	Bird species has medium conservation value, high vulnerability to impact and has low recoverability.
Medium	Bird species has high conservation value, low vulnerability to impact and has medium recoverability.
	Bird species has high conservation value, low vulnerability to impact and has low recoverability.
	Bird species has medium conservation value, high vulnerability to impact and has medium recoverability.
	Bird species has medium conservation value, medium vulnerability to impact and has medium recoverability.
	Bird species has medium conservation value, low vulnerability to impact and has medium recoverability.
Low	Bird species has medium conservation value, medium vulnerability to impact and high recoverability.
	Bird species has low conservation value, medium to high vulnerability to impact and medium to high recoverability.
Negligible	Bird species has low conservation value, low vulnerability to impact and medium to high recoverability.
	Bird species is not vulnerable to impacts.

The conservation value of ornithological receptors is based on the population from which individuals are predicted to be drawn. This reflects current understanding of the movements of species, with site-based protection (e.g. SPAs) generally limited to specific periods of the year (e.g. the breeding season). Therefore, conservation value can vary through the year depending on the relative sizes of the number of individuals predicted to be at risk of impact and the population from which they are estimated to be drawn. Conservation value therefore corresponds to the degree of connectivity which is predicted between the Proposed

Development and protected populations. Using this approach, the conservation importance of a species seen at different times of year may fall into any of the defined categories. The significance of the effect upon offshore ornithology is determined by correlating the magnitude of the impact and the sensitivity of the receptor. The method employed for this assessment is presented in. Where a range of significance of effect is presented in, the final assessment for each effect is based upon expert judgement.

For the purposes of this assessment, any effects with a significance level of 'Moderate' or 'Major' have been concluded to be significant in terms of Environmental Impact Assessment.

Table 8-22: Matrix Used For The Assessment Of The Significance Of The Effect

Sensitivity of Receptor	Magnitude of Impact				
	No Change	Negligible	Low	Medium	High
Negligible	No change	Negligible	Negligible or Minor	Negligible or Minor	Minor
Low	No change	Negligible or Minor	Negligible or Minor	Minor	Minor or Moderate
Medium	No change	Negligible or Minor	Minor	Moderate	Moderate or Major
High	No change	Minor	Minor or Moderate	Moderate or Major	Major
Very High	No change	Minor	Moderate or Major	Major	Major

8.10 Embedded mitigation

The Applicant is aware of two periods during the year when birds associated with the Dee Estuary SPA and Ramsar site are potentially at their most sensitive to disturbance from cable installation works. The two periods are as follows:

- the two hours either site of a high tide during the overwintering period (September to March inclusive); and
- the little tern breeding season, which runs from mid-April to mid-July.

The Applicant is cognisant of the need to accommodate the seasonal/timing constraints as part of the construction schedule, including balancing conflicting constraints, to avoid/minimise any adverse effects arising from construction. Where avoidance of a recommended seasonal window is not achievable, appropriate alternative mitigation and licensing (where required) will be realised to ensure protection of species and facilitate construction.

Work will be carried out to define the sensitive egg laying and chick rearing period for the Gronant Dunes little tern colony, during which time impacts upon prey availability may lead to a reduction in productivity. This will be used to inform any seasonal limitations that need to be placed upon certain work activities.

The Applicant will continue to engage with NRW and FCC on the protection of sensitive species during the construction period. Pre-commencement ecological surveys will be used as a basis for planning of specific activities. Activities will be timed to reduce impacts on ecological receptors where practicable.

A detailed Method Statement will be produced to outline how impacts on birds will be avoided during the works. This is likely to include planning of the time and duration of activities, toolbox talks for site contractors, and appropriate selection of plant machinery to minimise disturbance. Detailed Method Statements will be prepared by the Construction Contractor for prior approval before commencement of the works. The Method Statements will be developed in collaboration with NRW and shared with NRW-MLT for approval at least three months prior to works commencing.

8.11 Assessment of significance

The impacts of construction, operation and maintenance, and decommissioning phases of the Project have been assessed. The potential impacts arising from these phases are listed in Table 8-16 alongside the maximum design scenario against which each impact has been assessed.

In accordance with the Chartered Institute of Ecology and Environmental Management (CIEEM) Guidelines on Ecological Impact Assessment (CIEEM, 2022), the assessment of the likely ecological effects of the Project and identification of important ecological features has focused on Valued Ornithological Receptors (VORs). VORs are species of high ecological value, present within the offshore and intertidal study areas, that any potential impact upon them as a result of the Project would be considered to be significant.

The species which have been identified as VORs have been grouped into 4 categories, each of which combine species from taxonomic family groups with similar ecological characteristics relevant to their habitat use within the intertidal and offshore study areas. These are:

- non-breeding waterbirds (wildfowl, waders, gulls, herons and rails);
- Non-breeding seaducks, divers, grebes and cormorants;
- Breeding true seabirds; and
- Breeding terns.

8.11.1 The impact of temporary habitat loss leading to displacement and disturbance of birds

The impact of the construction and decommissioning is likely to result in the temporary removal of habitat that supports water birds. The potential impact on receptors is predicted to vary both spatially and temporally across habitats and seasons in which receptors are present in throughout the offshore and intertidal ornithology study area and through which elements of the Proposed Development. The new cable corridor and the associated vessels used during construction are likely to affect receptors utilising the intertidal area for foraging, loafing and roosting. Offshore species may be disturbed and displaced from their foraging grounds due to construction works and the associated vessel traffic. In addition, breeding species may be impacted by the loss of foraging habitat.

8.11.2 Non-breeding waterbirds (wildfowl, waders, gulls, herons and rails)

8.11.2.1 Construction and decommissioning phase

The impact of construction and decommissioning is likely to result in the temporary removal of habitats that support foraging and roosting for non-breeding waterbirds (wildfowl, waders, gulls, herons and rails). This group of receptors is most likely to be affected by the construction of the new cable route at the Point of Ayr landfall.

For each of these species the temporary removal of habitats may impact upon the availability of food resources and waterbirds may need to forage elsewhere to meet their daily energy requirement. Displaced birds may move to areas already occupied by other birds and thus face higher intra/inter-specific competition due to a higher density of individuals competing for the same resource. Alternatively, displaced birds may be forced to move into areas of lower quality (e.g. areas of lower food resources). Such resulting displacement could ultimately affect their demographic fitness (i.e. survival rates and breeding productivity) as well as potentially impacting on other birds in areas that displaced birds move to. Such impacts have the potential to lead to a change in the size or extent of distribution of the biogeographic population or the population that is the interest feature of a specific protected site (e.g. SPA).

Magnitude of impact

Temporary habitat loss as a result of the construction of offshore power and fibre optic cables connecting the Point of Ayr (PoA) Terminal to Douglas OP (seawards of MHWS) and decommissioning may lead to a temporary avoidance of the affected areas. The two landfall cables have a construction corridor width of 15 m each and will be set 30 m apart, both span the length of the intertidal (approximately 1.5 km in length). Assuming that waterbirds will not utilise the area within 500m of works (based upon the disturbance distance of non-breeding pink-footed goose as taken from Goodship & Furness, 2022), this equates to an affected area of 1.59 km^2. When compared with similar habitats available in the Dee Estuary this equates to 1.74% of available foraging habitats.

It is anticipated that the effects of the construction phase upon the supporting habitats will be reversible, and as work is expected to take up to 23 days, it is of short-term duration. A detailed Method Statement will be produced to outline how impacts on birds will be avoided during the works. The Method Statements will be developed in collaboration with NRW, and shared with NRW-MLT for approval at least three months prior to works commencing.

As works cover a relatively small area, are of short-term duration, and are reversible the magnitude of impact is deemed to be negligible.

Sensitivity of the receptor

As intertidal habitats are limited in nature, waterbirds and in particular waders are considered to be very vulnerable to the loss of foraging habitats on their wintering grounds (e.g. Burton *et al.,* 2006).

This group of receptors are considered to have medium recoverability based on their relatively low reproductive success and a stable or slightly decreasing trend in the numbers of wintering birds.

Many of the waterbird species recorded during the site-specific surveys are designated features of local SPA, Ramsar and SSSI sites, and are therefore of high to very high conservation value.

Waterbird VORs are deemed to be of high vulnerability, medium recoverability, and very high conservation importance. The sensitivity of the receptor is therefore, considered to be high.

8.11.3 Non-breeding seaducks, divers, grebes and cormorants

The impact of construction and decommissioning is likely to result in the temporary removal of habitats which are used by non-breeding seaducks, divers, grebes and cormorants. This group is most likely to be affected by works occurring in the nearshore waters, i.e. the construction of offshore power and fibre optic cables connecting the PoA Terminal to Douglas OP (seawards of MLWS).

As the result of temporary or permanent habitat loss, the fitness of displaced birds may be affected as birds may move to areas already occupied by birds or into areas of lower quality (e.g. areas of lower prey availability). Such impacts have the potential to lead to a change in the size or extent of distribution of the biogeographic population or the population that is the interest feature of a specific protected site (e.g. SPA).

8.11.3.1 Construction and decommissioning phase

Magnitude of impact

Displacement from disturbance has been fully assessed for species in this group in Offshore Ornithology Displacement (RPS Group, 2024b) and excess mortality was found to be below the 1% threshold (Table 8-10). The magnitude of impact on this species is therefore deemed negligible.

Sensitivity of the receptor

Both common scoter and red-throated diver are highly susceptible to disturbance often flushing from large distances and relocating even further away from the source of disturbance (Goodship & Furness, 2022). Therefore, they are deemed to have high vulnerability to the impact.

Common scoter and red-throated diver are qualifying features of the Liverpool Bay SPA, while cormorant is a feature of local SPA and Ramsar sites and therefore, these species are of very high conservation value. The majority of the other species in this receptor group are SSSI features with high conservation value.

The receptors are considered to have high recoverability based on an increasing trend in the numbers of wintering birds (Frost *et. Al.*, 2021).

Seaducks, divers, grebes and cormorants are deemed to be of high vulnerability, high recoverability and very high conservation importance. The sensitivity of the receptor is therefore, considered to be high.

8.11.4 Breeding true seabirds

8.11.4.1 Construction and decommissioning phase

The impact of construction and decommissioning is likely to result in the temporary removal of habitats which are used by breeding true seabirds. True seabirds are most likely to be impacted by disturbance and displacement offshore during the cable works and development of the new Douglas platform, and the associated vessels. As the result of temporary or permanent habitat loss, the fitness of displaced birds may be affected as birds may move to areas already occupied by birds or into areas of lower quality (e.g. areas of lower prey availability). Such impacts have the potential to lead to a change in the size or extent of distribution of the biogeographic population or the population that is the interest feature of a specific protected site (e.g. SPA).

Magnitude of impact

Displacement from disturbance has been fully assessed for species in this group in Offshore Ornithology Displacement (RPS Group, 2024b) and excess mortality was found to be below the 1% threshold (Table 8-10). In addition, the effects of displacement from this project are very temporary in nature and will only affect birds during a limited number of breeding seasons. The magnitude of impact on this species is therefore deemed negligible.

Sensitivity of the receptor

As pelagic habitats required by this group are large in extent, and as seabirds often have extensive foraging ranges (315 km mean max for northern gannet, as taken from Woodward, *et. Al.*, 2019), this group of receptors have low vulnerability to temporary and localised disturbance/displacement.

All receptor species in this group are designated features of local SPAs, and therefore of very high conservation value.

The receptors are considered to have high recoverability based on upward population trends (JNCC, 2019).

Breeding true seabirds are deemed to be of very high vulnerability, high recoverability and very high conservation importance. The sensitivity of the receptor is therefore, considered to be medium.

8.11.5 Breeding terns

8.11.5.1 Construction and decommissioning phase

The construction and decommissioning phase of the Eni development is likely to result in the temporary loss of habitat that supports breeding terns. The potential impact on receptors is predicted to vary both spatially and temporarily across habitats and seasons in which receptors are present. In relation to breeding terns, the cable installation and platform construction works, and their associated vessel traffic, has the potential to disturb breeding birds and displace them from their regular foraging grounds. This poses a risk if individuals move into areas of lower habitat quality or increased competition, and such impacts have the potential to lead to a change in the size or extent of distribution of the biogeographic population or the population that is the interest feature of a specific protected site (e.g. SPA).

Magnitude of impact

There are two breeding little tern colonies along the east and west of the shoreline from Point of Ayr. These colonies are likely to be impacted by the installation of the Douglas platform to Point of Ayr cables, as foraging birds may be disturbed and displaced by construction noise and vessel traffic. However, the amount of available foraging that will be affected at any one time will be 0.8% of their available foraging range with increases in mortality of 0.04 – 0.06% above baseline predicted.

There are three common tern colonies near to the Eni Development Area, along the estuaries of the River Dee and River Mersey, and in the Ribble and Alt Estuary. The amount of available foraging area that will be affected at any one time will be 0.16% with increases in mortality of 0.003 – 0.006% above baseline predicted.

Sandwich tern have a foraging range of 34.3 km (Woodward *et al*., 2019), so no SPA colonies will be directly affected with most affected birds being passage birds, and passage birds are more flexible in their foraging habits than breeding birds which are fixed to a colony.

Therefore, the magnitude of impact upon this species group is considered negligible.

Sensitivity of the receptor

Although terns are flexible in their habitat use during the non-breeding season, the receptors are overall considered to be very vulnerable to the loss of foraging grounds. The terns present within the Proposed Development area have medium (common tern and sandwich tern) to high (little tern) habitat specialisation (Wade *et al.*, 2016) and their foraging ranges vary from 5 km to 34.3 km (Woodward *et al.,* 2019). The maximum vulnerability of this receptor group is considered to be high.

The receptor species in this group are all designated features of local SPAs, and therefore of very high conservation value.

The receptors are considered to have medium recoverability based on their relatively low reproductive success and a stable or slightly decreasing trend in the numbers of breeding birds (JNCC, 2019).

Breeding terns are deemed to be of very high vulnerability, medium recoverability and high conservation importance. The sensitivity of the receptor is therefore, considered to be high.

8.11.6 Significance of effect

Table 8-23: Summarising The Significance Of Effect For The Impact Of Temporary Habitat Loss Leading To Displacement And Disturbance Of Birds During The Construction And Decommissioning Phases

Species	Magnitude of impact	Sensitivity of receptor	Significance of effect
Non-breeding waterbirds (wildfowl, waders, gulls, herons, and rails)	Negligible	High	**Minor**
Non-breeding seaducks, divers, grebes and cormorants	Negligible	High	**Minor**
Breeding true seabirds	Negligible	Medium	**Negligible**
Breeding terns	Negligible	High	**Minor**

8.11.7 The impact of disturbance and displacement from airborne sound and presence of vessels and infrastructure

All phases of the Project involve airborne noise due to the presence of vessels and infrastructure within the site boundary. The potential impact on receptors is predicted to vary both spatially and temporally across habitats and seasons in which receptors are present throughout the offshore and intertidal ornithology study area. The construction of a cable corridor and the associated vessels used during all phases are likely to affect receptors utilising the intertidal area for foraging, loafing and roosting. Offshore species may be disturbed and displaced from their foraging grounds due to noise from works and the presence of associated vessel across all phases.

8.11.8 Non-breeding waterbirds (wildfowl, waders, gulls, herons and rails)

8.11.8.1 Construction and decommissioning

This group of receptors is most likely to be affected by vessels associated with the construction of the new cable route at Point of Ayr as there is a high density of intertidal species foraging and roosting here. Gulls may be displaced from foraging habitat in both the intertidal and offshore development areas, depending on the species. For example, little gull which forage offshore in the Liverpool Bay SPA.

For each of these species, noise may cause displacement and the movement of individuals into areas already occupied by other birds and thus face higher intra/inter-specific competition due to a higher density of individuals competing for the same resource. Alternatively, displaced birds may be forced to move into areas of lower quality (e.g. areas of lower food resources). Such resulting displacement could ultimately affect their demographic fitness (i.e. survival rates and breeding productivity) as well as potentially impacting on other birds in areas that displaced birds move to.

Such impacts have the potential to lead to a change in the size or extent of distribution of the biogeographic population or the population that is the interest feature of a specific protected site (e.g. SPA).

Magnitude of impact

As the effects of visual disturbance are generally considered to occur to a greater distance than those of noise (Cutts, *et. Al*., 2013) and as the visual effects of disturbance and displacement have already been considered within the impact of temporary habitat loss leading to displacement and disturbance of birds. The magnitude of effect of this impact is deemed to be negligible.

Sensitivity of the receptor

Waterbirds and in particular waders are considered to be vulnerable to noise disturbance (Cutts *et al.*, 2013), this coupled with the limited availability of similar intertidal habitats makes waterbirds vulnerable to this impact.

This group of receptors at the site have a maximum sensitivity of moderate to very high, and they are considered to have medium recoverability based on their relatively low reproductive success and a stable or slightly decreasing trend in the numbers of wintering birds (Frost *et. Al*., 2021).

Many of the waterbird species recorded during the site-specific surveys are designated features of local SPA, Ramsar and SSSI sites, and are therefore of high to very high conservation value.

Waterbird VORs are deemed to be of high vulnerability, medium recoverability and high to very high conservation importance. The sensitivity of the receptor is therefore, considered to be high.

8.11.8.2 Operation and maintenance

Extra maintenance vessels will not affect this receptor group that depends heavily upon the intertidal.

Magnitude of impact

There will be no extra disturbance to the intertidal zone and therefore the magnitude of impact is no change.

Sensitivity of the receptor

Waterbirds and in particular waders are considered to be vulnerable to noise disturbance (Cutts *et al.*, 2013), this coupled with the limited availability of similar intertidal habitats makes waterbirds vulnerable to this impact.

This group of receptors at the site have a maximum sensitivity of moderate to very high, and they are considered to have medium recoverability based on their relatively low reproductive success and a stable or slightly decreasing trend in the numbers of wintering birds (Frost *et. Al.*, 2021).

Many of the waterbird species recorded during the site-specific surveys are designated features of local SPA, Ramsar and SSSI sites, and are therefore of high to very high conservation value.

Waterbird VORs are deemed to be of high vulnerability, medium recoverability and high to very high conservation importance. The sensitivity of the receptor is therefore, considered to be high.

8.11.9 Non-breeding seaducks, divers, grebes and cormorants

8.11.9.1 Construction and decommissioning

This group of receptors is likely to be disturbed by the presence of vessels within nearshore waters most heavily during the construction phase.

The disturbance generated from the movement of vessels through nearshore waters may lead to birds moving to areas already occupied by birds or into areas of lower quality (e.g. areas of lower prey availability). Such impacts have the potential to lead to a change in the size or extent of distribution of the biogeographic population or the population that is the interest feature of a specific protected site (e.g. SPA).

Magnitude of impact

As the effects of visual disturbance are generally considered to occur to a greater distance than those of noise (Cutts, *et. Al.*, 2013) and as the visual effects of disturbance and displacement have already been considered within the impact of temporary habitat loss leading to displacement and disturbance of birds. The magnitude of effect of this impact is deemed to be negligible.

Sensitivity of the receptor

Overall, this group of receptors have a medium to high habitat specialisation and are considered to be very vulnerable to disturbance (Goodship and Furness, 2022).

Common scoter and red-throated diver are qualifying features of the Liverpool Bay SPA, while cormorant is a feature of local SPA and Ramsar sites and therefore, these species are of very high conservation value. The majority of the other species in this receptor group are SSSI features with high conservation value.

The receptors are considered to have medium recoverability based on their relatively low reproductive success and a stable or slightly decreasing trend in the numbers of wintering birds (Frost *et. Al.*, 2021).

Seaducks, divers, grebes and cormorants are deemed to be of high vulnerability, medium recoverability and very high conservation importance. The sensitivity of the receptor is therefore, considered to be high.

8.11.9.2 Operation and maintenance

The operation and maintenance phase will involve minimal vessel movements, there is, however, potential for brief localised disturbance events.

Magnitude of impact

Due to the brief and local nature of these disturbance events the magnitude of impact is no change.

Sensitivity of the receptor

Overall, this group of receptors have a medium to high habitat specialisation and are considered to be very vulnerable to disturbance (Goodship and Furness, 2022).

Common scoter and red-throated diver are qualifying features of the Liverpool Bay SPA, while cormorant is a feature of local SPA and Ramsar sites and therefore, these species are of very high conservation value. The majority of the other species in this receptor group are SSSI features with high conservation value.

The receptors are considered to have high recoverability based on an increasing trend in the numbers of wintering birds (Frost *et. Al.*, 2021).

Seaducks, divers, grebes and cormorants are deemed to be of high vulnerability, medium recoverability and very high conservation importance. The sensitivity of the receptor is therefore, considered to be high.

8.11.10 Breeding true seabirds

8.11.10.1 Construction and decommissioning

True seabirds are most likely to be impacted by noise disturbance offshore during the cable works, alterations to existing platforms and wells, and the development of the new Douglas platform, due to the associated vessel traffic, as well as the infrastructure itself. As a result of this disturbance, receptors may be displaced to areas already occupied by birds or into areas of lower quality (e.g. areas of lower prey availability). Such impacts have the potential to lead to a change in the size or extent of distribution of the biogeographic population or the population that is the interest feature of a specific protected site (e.g. SPA).

Magnitude of impact

As the effects of visual disturbance are generally considered to occur to a greater distance than those of noise (Cutts, *et. Al.*, 2013), and the visual effects of disturbance and displacement have already been considered within the impact of temporary habitat loss leading to displacement and disturbance of birds. The magnitude of effect of this impact is deemed to be negligible.

Sensitivity of the receptor

The receptors in this group have large foraging ranges and very low habitat specialisation, this makes them of low vulnerability to disturbance by airborne noise and the presence of vessels and infrastructure.

All receptor species in this group are designated features of local SPAs, and therefore of very high conservation value.

The receptors are considered to have medium recoverability based on their relatively low reproductive success and a stable or slightly decreasing trend in the numbers of wintering birds.

Breeding true seabirds are deemed to be of low vulnerability, medium recoverability, and very high conservation importance. The sensitivity of the receptor is therefore, considered to be medium.

8.11.10.2 Operation and maintenance

The operation and maintenance phase will involve minimal vessel movements, there is however potential for brief localised disturbance events.

Magnitude of impact

Due to the brief and local nature of these disturbance events the magnitude of impact is no change.

Sensitivity of the receptor

The receptors in this group have large foraging ranges and very low habitat specialisation, this makes them of low vulnerability to disturbance by airborne noise and the presence of vessels and infrastructure.

All receptor species in this group are designated features of local SPAs, and therefore of very high conservation value.

The receptors are considered to have medium recoverability based on their relatively low reproductive success and a stable or slightly decreasing trend in the numbers of wintering birds.

Breeding true seabirds are deemed to be of low vulnerability, medium recoverability and very high conservation importance. The sensitivity of the receptor is therefore, considered to be medium.

8.11.11 Breeding terns

8.11.11.1 Construction and decommissioning

This group of receptors is likely to be disturbed by the presence of vessels within nearshore waters most heavily during the construction phase.

The disturbance generated from the movement of vessels through nearshore waters may lead to birds moving to areas already occupied by birds or into areas of lower quality (e.g. areas of lower prey availability). Such impacts have the potential to lead to a change in the size or extent of distribution of the biogeographic population or the population that is the interest feature of a specific protected site (e.g. SPA).

Magnitude of impact

As the effects of visual disturbance are generally considered to occur to a greater distance than those of noise (Cutts, *et. Al*., 2013) and as the visual effects of disturbance and displacement have already been considered within the impact of temporary habitat loss leading to displacement and disturbance of birds. The magnitude of effect of this impact is deemed to be negligible.

Sensitivity of the receptor

Terns are generally tolerant of disturbance when they are foraging, with quoted a disturbance by boat distance of 100 m (Goodship & Furness, 2022). This makes them of low vulnerability to disturbance by airborne sound and the presence of vessels and infrastructure.

The receptor species in this group are all designated features of local SPAs, and therefore of very high conservation value.

The receptors are considered to have medium recoverability based on their relatively low reproductive success and a stable or slightly decreasing trend in the numbers of breeding birds (JNCC, 2019).

Breeding terns are deemed to be of very low vulnerability, medium recoverability and high conservation importance. The sensitivity of the receptor is therefore, considered to be medium.

8.11.11.2 Operation and maintenance

The operation and maintenance phase will involve minimal vessel movements, there is however potential for brief localised disturbance events.

Magnitude of impact

Due to the brief and localised nature of these disturbance events the magnitude of impact is no change.

Sensitivity of the receptor

Terns are generally tolerant of disturbance when they are foraging, with quoted a disturbance by boat distance of 100 m (Goodship & Furness, 2022). This makes them of low vulnerability to disturbance by airborne sound and the presence of vessels and infrastructure.

The receptor species in this group are all designated features of local SPAs, and therefore of very high conservation value.

The receptors are considered to have medium recoverability based on their relatively low reproductive success and a stable or slightly decreasing trend in the numbers of breeding birds.

Breeding terns are deemed to be of very low vulnerability, medium recoverability and high conservation importance. The sensitivity of the receptor is therefore, considered to be medium.

8.11.12 Significance of effect

Table 8-24: Summarising The Significance Of Effect For The Impact Of Disturbance And Displacement From Airborne Sound And Presence Of Vessels And Infrastructure During The Construction And Decommissioning Phases

Species	Magnitude of impact	Sensitivity of receptor	Significance of effect
Non-breeding waterbirds (wildfowl, waders, gulls, herons and rails)	Negligible	High	**Minor**
Non-breeding seaducks, divers, grebes and cormorants	Negligible	High	**Minor**
Breeding true seabirds	Negligible	Medium	**Negligible**
Breeding terns	Negligible	Medium	**Negligible**

Table 8-25: Summarising The Significance Of Effect For The Impact Of Disturbance And Displacement From Airborne Sound And Presence Of Vessels And Infrastructure During The Operation And Maintenance Phase

Species	Magnitude of impact	Sensitivity of receptor	Significance of effect
Non-breeding waterbirds (wildfowl, waders, gulls, herons and rails)	No change	High	**No change**
Non-breeding seaducks, divers, grebes and cormorants	No change	High	**No change**

Species	Magnitude of impact	Sensitivity of receptor	Significance of effect
Breeding true seabirds	No change	Medium	**No change**
Breeding terns	No change	Medium	**No change**

8.11.13 The impact of collision with static offshore infrastructure

Collisions of seabirds and/or migratory waterbirds with static offshore structures may result in the death or injury of individuals. Therefore, seabird species which forage within, or commute through, the Proposed Development area may be vulnerable to such effects, as is also the case for migratory waterbirds which transit this area on migration. Risk of collision of seabirds to offshore stationary structures is likely to be restricted to species attracted to lights (such as storm-petrels and shearwaters; Ronconi *et al*., 2015 & Deakin *et al*., 2022) that may become disoriented under specific circumstances or to species attracted to the platform due to potential roosting and nesting opportunities (e.g. gull species; Ronconi *et al*., 2015).

Given the offshore location of the Eni Development Area, it is extremely unlikely that any of the migratory waterbird species associated with European sites would make more frequent movements across the Proposed Development area (e.g. when commuting between foraging and roosting sites), and it is considered that collision risk for these species is limited to their migratory movements.

8.11.14 All receptors

8.11.14.1 Operation and maintenance phase

All species groups are migratory to differing degrees and all groups may be present during the passage periods. Those species that are attracted to light are more likely to be affected but during periods of poor visibility all species may be at risk.

Magnitude of impact

Many of the platforms are already *in situ* so impacts may be similar in the future as they currently are, this will certainly be the case for those impacts that occur due to poor visibility. There is one extra platform to be built plus the additional lighting that will be involved when all platforms are fully operational. The impacts are negligible (the area of platforms is low when compared to the area available for migrating birds to pass through and the avoidance rate of birds in ideal conditions is likely to be high), however the duration will be long term and will last for the Project’s lifespan and unless the platforms are fully dismantled the effects are not reversable. However, due to the very slight predicted change from the size or extent of distribution of the relevant biogeographic population or the population that is the interest feature of a specific protected site, the magnitude of impact is no change.

Sensitivity of the receptor

Although collision with static offshore infrastructure has been recorded, there are not quantitative assessments on which to base judgement. However, when taken at a high level it is likely that in periods of good visibility most birds will avoid static infrastructure. Certain species that are attracted to light may be at higher risk, nonetheless the risks are likely to be negligible at most and are many of the risks will be present whether the platforms are in use or not. All receptors are considered to have a low vulnerability to impacts.

Many of the receptor species are designated features of SPAs, and therefore of very high conservation value.

The receptors are considered to have medium recoverability based on their relatively low reproductive success and a stable or slightly decreasing trend in the numbers of breeding birds.

As this receptor group has high conservation value, medium recoverability, and low vulnerability to the impact it is of medium sensitivity.

8.11.15 Significance of effect

Table 8-26: Summarising The Significance Of Effect For The Impact Of Collision With Static Offshore Infrastructure During The Operation And Maintenance Phase

Species	Magnitude of impact	Sensitivity of receptor	Significance of effect
All receptors	No change	Medium	**No change**

8.11.16 Indirect impacts to birds from changes in prey availability

There is the potential for changes in bird prey (e.g. fish species or intertidal invertebrates) abundance and distribution to arise as a result of construction, operation and maintenance as well as decommissioning activities. Reduction or disruption to prey availability to birds may cause displacement from foraging grounds in the area, or result in reduced energy intake, affecting survival rates or productivity in the population. Changes in prey distribution, availability or abundance in the marine environment due to the presence of offshore infrastructure, and as a result of operation and maintenance activities that increase sedimentation or increase subsea noise levels.

8.11.17 Non-breeding seaducks, divers, grebes and cormorants

There is a potential for disturbance and/or displacement to sensitive fish and shellfish species as a result of underwater noise resulting from construction activities, such as piling, UXO clearance, and vessel noise. In addition increased sedimentation created during the cable laying phase may reduce the ability of birds to locate prey items.

8.11.17.1 All phases

Magnitude of impact

Due to the limited size of the area that will be affected, when compared with species' total foraging ranges, any effects are likely to be localised in nature, up to medium term (construction of the platform will be the longest in duration at 20 months), and reversible in the short-term. In addition, the magnitude of impact caused by changes in prey availability will be similar in nature to displacement which has already been shown to cause less than a 1% increase in additional mortality. Most impacts will occur during the construction phase, therefore the magnitude of impact during this phase is considered negligible.

During the operation and maintenance phase the magnitude of impact is predicted to be no change.

Sensitivity of the receptor

Species in this group include red-throated diver and common scoter which are primary features of the Liverpool Bay SPA they are therefore of very high conservation value. All species in this group show long-term increase or stability in their populations (Austin, *et. Al.*, 2023) and are therefore of medium recoverability. All species are of medium vulnerability to local changes in prey availability as they are highly mobile and can follow shifts in prey abundance. This receptor group is of medium sensitivity.

8.11.18 Breeding true seabirds

There is a potential for disturbance and/or displacement to sensitive fish species as a result of underwater noise resulting from construction activities, such as piling, UXO clearance, and vessel noise. In addition increased sedimentation created during the cable burial phase may reduce the ability of birds to locate prey items.

8.11.18.1 All phases

Magnitude of impact

Due to the limited size of the area that will be affected when compared with species total foraging ranges any effects are likely to be localised in nature, up to medium term (construction of the platform will be the longest in duration at 20 months), and reversible in the short-term. In addition, the magnitude of impact caused by changes in prey availability will be similar in nature to displacement which has already been shown to cause less than a 1% increase in additional mortality. Most impacts will occur during the construction phase, therefore the magnitude of impact during this phase is considered negligible.

During the operation and maintenance phase the magnitude of impact is predicted to be no change.

Sensitivity of the receptor

As many species in this group are primary features of SPAs with connectivity to the Proposed Development, and as the UK holds significant proportions of the global populations of species such as Manx shearwater, this receptor group is of very high conservation value. The receptors are considered to have medium recoverability based on their relatively low reproductive success and a stable or slightly decreasing trend in the numbers of wintering birds. Due to the limited area that will be affected by this impact (and the medium-term reversible nature of the impact) coupled with the large foraging ranges of this group (315 km mean max for gannet) this receptor group has a low vulnerability to this impact.

Therefore this group is of medium sensitivity.

8.11.19 Breeding terns

There is a potential for disturbance and/or displacement to sensitive fish species as a result of underwater noise resulting from construction activities. In addition, increased sedimentation created during the cable laying phase may reduce the ability of birds to locate prey items.

8.11.19.1 All phases

Magnitude of impact

Although birds in this group will only be directly displaced due to disturbance caused by vessels and movement above water, the underwater effects of noise and sedimentation have the potential to cause displacement of prey items over a wider area.

Displacement of prey due to underwater noise created by cable laying activities has been quantified as affecting between 2.4% and 2.9% of the little tern foraging range (see Little Tern Foraging Distribution Technical Report (RPS, 2024c). As common tern have a larger foraging range (18 km from Woodward *et al.*, 2014), the area affected will be approx. 0.01% which is negligible.

Displacement caused by sedimentation is harder to quantify due a lack of numerical data in the literature, however dredging works for the West Hoyle Bank will be approx. 1 km across, 60 m in width and 7 m in depth, these will take approx. two to three weeks to complete and may result in average Suspended Sediment Concentration (SSC) values of over 3000 mg/l in shallower waters. In addition, the cable plough itself may result in SSCs of over 1000 g/l in the shallower nearshore waters where the little tern forage Physical Processes Technical Report (RPS, 2024d). This is over the 1 g/l that may be harmful to adult fish (Engell-

Sørensen and Skyt, 2001), and it would be reasonable to assume that some displacement of fish may occur, although it is not possible to quantify this. Additionally, fish eggs may be smothered and killed which will further reduce the amount of small prey items available for the little tern.

Assuming works were to take place during the breeding season (which for little tern is between April and July), then although the impacts caused by construction may be high in any one year, the impacts will be reversible causing no long-term effects to the biogeographic populations of little tern and common tern. Taking that into consideration the magnitude of impact during construction is taken as a precautionary ‘low’.

Although work is still needed to define the sensitive egg laying and chick rearing period for the Gronant Dunes colony, measures to limit works during the sensitive egg laying and chick rearing period when little tern are concentrated within a small foraging range are to be discussed further with NRW. Works carried out after chick fledging when the little tern are not confined to a small foraging range would have a negligible impact. Therefore, for these receptors the magnitude of impact for construction is presented for both work during the breeding period and for works outside of the breeding period.

During the operation and maintenance phase the magnitude of impact is predicted to be no change.

Sensitivity of the receptor

This receptor group is of high conservation value, as species in this group include little tern and common tern, which are breeding features of two SPAs (the Dee Estuary, and Liverpool Bay) that directly overlap with the Proposed Development. Both little tern and common tern show downward trends in breeding populations (JNCC, 2019) and therefore have a low recoverability. Due to the limited foraging range of little tern (5 km mean max as taken from Woodward, *et. al*., 2019) this species is considered to have high vulnerability to the impact.

8.11.20 Significance of effect

Table 8-27: Summarising The Significance Of Effect For ‘Indirect Impacts To Birds From Changes In Prey Availability’ For The VORs During The Construction And Decommissioning Phase

Species	Magnitude of impact	Sensitivity of receptor	Significance of effect
Non-breeding seaducks, divers, grebes and cormorants	Negligible	Medium	**Negligible**
Breeding true seabirds	Negligible	Medium	**Negligible**
Breeding terns assuming works during the breeding period	Low	High	**Moderate**
Breeding terns assuming works during the non-breeding period	Negligible	High	**Negligible**

Table 8-28: Summarising The Significance Of Effect For ‘Indirect Impacts To Birds From Changes In Prey Availability’ For The VORs During The Operation And Maintenance Phase

Species	Magnitude of impact	Sensitivity of receptor	Significance of effect
Non-breeding seaducks, divers, grebes and cormorants	No change	Medium	**No change**
Breeding true seabirds	No change	Medium	**No change**
Breeding terns	No change	High	**No change**

8.11.21 The impact of accidental pollution in the surrounding area

Although there is a risk of pollution being accidentally released during the construction, operation and maintenance as well as decommissioning phases of the Eni Development Area from sources including vessels/vehicles and equipment/machinery, the likelihood of an accidental release of pollutants is extremely low, but should an event occur, effects would be limited in spatial extent. In addition, it is anticipated that the risk of such events occurring will be managed by the implementation of measures set out in standard industry guidance documents such as ERP, OPEPs and SOPEPs.

8.11.22 All receptors

All species of bird utilising the environment in the vicinity of a pollution incident may be vulnerable to either direct mortality from oil coverage preventing flight for example, or indirectly via a reduction in ability to forage.

8.11.22.1 All phases

Magnitude of impact

Although the likelihood of a pollution event occurring is low, should an event occur, the impact is predicted to be of local spatial extent and short-term duration. In addition, the implementation of measures set out in standard industry guidance documents such as ERP, OPEPs and SOPEPs will aid in limiting the environmental impacts of any releases of contaminants. The magnitude is therefore, considered to be negligible.

Sensitivity of the receptor

Species that spend large amounts of time in the water (e.g. foraging divers and scoters, and pursuit feeders such as auks) or on the sea surface (e.g. seaducks), are considered more vulnerable to pollution incidents (such as the accidental release of synthetic compounds, fuels or other substances) than surface feeding species such as gull species. Other receptors such as waders, geese and gulls are deemed to be less vulnerable to pollution incidents although there may be indirect impacts caused by a loss in foraging resources.

The receptors identified are deemed to be of low vulnerability, high recoverability, and high conservation importance. The sensitivity of the receptor is therefore, considered to be medium.

8.11.23 Significance of effect

Table 8-29: Summarising The Significance Of Effect For The Impact Of Accidental Pollution In The Surrounding Area During All Phases

Species	Magnitude of impact	Sensitivity of receptor	Significance of effect
All receptors	Negligible	Medium	**Negligible**

8.11.24 The impacts of the creation of roosting and nesting habitats among project infrastructure

The introduction of newly refurbished infrastructure and additional components of the Proposed Development has the potential to create new roosting and nesting habitats, which may attract some species of seabirds. The main infrastructure that could potentially serve as roosting and/or nesting habitat within the Proposed Development area would include the reconfigured platforms. Three already existing offshore platforms will be reconfigured with new modules and structures, and one new platform will be built.

8.11.25 Breeding true seabirds

Only certain species of seabird have proven to nest or roost on offshore structures habitually (Dierschke *et al*.. 2016) namely cormorants and gulls (roosting; Burke *et al*., 2012, Hope Jones, 1980, Tasker *et al*., 1986) and kittiwake (nesting).

Nesting bird surveys carried out on the existing platforms in 2022 (LBA Survey Report, 2022) found nesting kittiwake – 493 nests on the Douglas complex, 70 nests on Hamilton, 54 nests on Hamilton Nort, 15 nests on Lennox. Occasional roosting herring gull and cormorant were also noted although these were not quantified.

8.11.25.1 Operation and maintenance phase

Magnitude of impact

As black-legged kittiwake are not an interest feature of any of the designated sites with connectivity, and as the positive impacts upon SPA feature species cormorant and herring gull are not quantified, the magnitude of impact is predicted to be a negligible positive impact.

Sensitivity of the receptor

Of the species that are currently benefitting from the existing platforms, and will see increases in nesting habitat, black-legged kittiwake are of medium conservation value in the Liverpool Bay area. Although there is no connectivity to important breeding populations, this species is red listed in the BOCC 5. They are of medium vulnerability to positive effect caused the creation of new nesting habitat and are of medium recoverability. Therefore, the sensitivity of the receptor is medium.

8.11.26 Significance of effect

Table 8-30: Summarising The Significance Of Effect For The Impacts Of The Creation Of Roosting And Nesting Habitats Among Project Infrastructure For The Operation And Maintenance Phase

Species	Magnitude of impact	Sensitivity of receptor	Significance of effect
Breeding true seabirds	Negligible (positive)	Medium	**Minor (positive)**

8.12 Cumulative effect assessment

8.12.1 Methodology

The Cumulative Effects Assessment (CEA) takes into account the impacts associated with the Project together with other projects and plans. The projects and plans selected as relevant to the CEA present within this chapter are based upon the results of a screening exercise (Cumulative Effects Assessment – Screening Report (RPS Group, 2024e)). Each project has been considered on a case-by-case basis for screening in or out of this chapter's assessment based upon data confidence, effect-receptor pathways and the spatial/temporal scales involved.

The offshore and intertidal ornithology CEA methodology has followed the methodology set out within the Environmental Impact Assessment methodology of the Environmental Statement. As part of the assessment, all projects and plans considered alongside the Project have been allocated into 'tiers' reflecting their current stage within the planning and development process, these are listed below.

A tiered approach to the assessment has been adopted using the following categories:

- Tier 1 - the Project considered alongside projects:
  - under construction;
  - permitted application;
  - submitted application; and
  - those currently operational that were not operational when baseline data were collected, and/or those that are operational but have an evidenced ongoing impact.
- Tier 2 – the Project considered alongside Tier 1 projects, as as projects where the:
  - scoping report has been submitted and is in the public domain.
- Tier 3 – the Project considered alongside Tier 1 and Tier 2 projects as well as projects where the:
  - scoping report has not been submitted;
  - identified in a relevant development plan, and
  - identified in other plans and programmes.

This tiered approach is adopted to provide a clear assessment of the HyNet North West Project alongside other projects, plans and activities.

The specific projects, plans and activities scoped into the CEA are outlined in **Table 8-32**.

Some of the potential impacts considered within the HyNet North West Project alone assessment are specific to a particular phase of the development (e.g. construction, operations and maintenance and decommissioning). Where the potential for cumulative effects with other plans or projects only have potential to occur where there is spatial or temporal overlap with the Project during certain phases of development, impacts associated with a certain phase may be omitted from further consideration were no plans or projects have been identified that have the potential for cumulative effects during this period.

Impacts screened out of the CEA are included in Table 8-31 below. As per standard EIA methodology, where the potential significant effect for the Proposed Development alone is assessed as negligible, or where an impact is predicted to be highly localised, these will not be considered within the Proposed Development CEA, as there is not considered to be a potential for cumulative effects with other plans, projects or activities (Volume 1, chapter 5: Environmental Impact Assessment Methodology).

Table 8-31: Impacts Screened Out Of The CEA

Impact	Project phase	Receptor group	Justification
Temporary habitat loss leading to disturbance and displacement of birds	Construction	• Breeding true seabirds	The impact is 'Negligible' in EIA terms (**Table 8-23**)
The impact of disturbance and displacement from airborne sound and presence of vessels and infrastructure	Construction	• Breeding true seabirds • Breeding terns	The impact is 'Negligible' in EIA terms (**Table 8-24**)
	Operation and maintenance	• All receptors	The impact is 'No change' in EIA terms (**Table 8-25**)
Collision with static offshore infrastructure	Operation and maintenance	• All receptors	The impact is 'Negligible' in EIA terms (**Table 8-26**)
Indirect impacts to birds from changes in prey availability	Operation and maintenance	• Non-breeding seaducks, divers, grebes, and cormorants • Breeding true seabirds	The impact is 'Negligible' in EIA terms (**Table 8-27**)

Impact	Project phase	Receptor group	Justification
The impact of accidental pollution in the surrounding area	Construction and operation and maintenance	• All receptors	The impact is 'Negligible' in EIA terms (**Table 8-29**)
Creation of roosting and nesting habitats among project infrastructure	Operation and maintenance	• Breeding true seabirds	The impact is positive in EIA terms (**Table 8-30**)

Table 8-32: List Of Other Projects, Plans And Activities Considered Within The CEA

Project/Plan	Status	Distance from the Project (km)	Description of project/plan	Start date of license	Expiration date of license	Overlap with the Project
Tier 1						
Gwynt y Môr	Operational	0	160 3 MW wind turbines. Hub height 98m. Rotor diameter 107m.	03/12/2008	03/12/2033	Spatial and temporal overlap (construction and operation and maintenance phase)
North Hoyle offshore wind farm	Operational	0	30 2 MW wind turbines. Hub height 70m. Rotor diameter 80m.	01/01/2003	01/01/2028	Spatial and temporal overlap (construction phase)
MaresConnect Interconnector	Permitted	0	Proposed 750 MW subsea and underground electricity interconnector system linking the electricity grids in Ireland and Great Britain.	No data	No data	Spatial and temporal overlap (operation and maintenance phase, no data relating to construction phase)
Mostyn Energy Park extension	Applied	4	Proposed extension to the docks at Mostyn energy park.	No data	No data	Temporal overlap (during construction and operation and maintenance phase)
Rhyl Flats wind farm	Operational	31.05	25 3.6 MW wind turbines. Hub height 80m. Rotor diameter 107m.	01/01/2002	01/01/2027	Temporal overlap (construction and operation and maintenance phase)
Morlais renewable energy	No data	72	No data	14/12/2021	13/12/2060	Temporal overlap (construction and operation and maintenance phase)
Dublin Array offshore wind farm	Operational	160	600 MW offshore wind power project. Area of 54 km^2.	23/12/2022	23/12/2067	Temporal overlap (construction and operation and maintenance phase)
North Irish Sea Array wind farm	Operational	160	500 MW capacity.	23/12/2022	23/12/2067	Temporal overlap (construction and operation and maintenance phase)
GE wind farm	Operational	165	No data	2003	No data	Temporal overlap (construction and operation and maintenance phase)
GE wind farm	Operational	165	No data	2002	No data	Temporal overlap (construction and operation and maintenance phase)
Bray offshore wind farm	Applied	165	210 MW offshore wind power project with 70 turbines of a maximum height of 160m and rotor diameter of up to 120m.	No data	No data	Temporal overlap (construction and operation and maintenance phase)
Kish offshore wind farm	Applied	165	225 MW offshore wind farm with 75 turbines of a maximum height of 160 m and rotor diameter of up to 120 m.	No data	No data	Temporal overlap (construction and operation and maintenance phase)

Project/Plan	Status	Distance from the Project (km)	Description of project/plan	Start date of license	Expiration date of license	Overlap with the Project
Oriel offshore wind farm	Active	165	No data	23/12/2022	23/12/2067	Temporal overlap (construction and operation and maintenance phase)
Arklow offshore wind farm	Active	165	No data	23/12/2022	23/12/2067	Temporal overlap (construction and operation and maintenance phase)
Codling offshore wind farm	Active	165	No data	23/12/2022	23/12/2067	Temporal overlap (construction and operation and maintenance phase)
Marine renewable tidal array	Licensed	170	Tidal array of 50 to 100 turbines – 25-year consent	No data	No data	Temporal overlap (construction and operation and maintenance phase)
Ballyhenry Bay Strangford Lough tidal test	Active	170	The project aims to deploy a floating tidal turbine platform moored to the seabed in the QUB tidal test site which has been leased from the Crown Estate. The unique turbine system will experience close to its maximum rated velocity, fully testing the system in a relevant tidal environment.	21/03/2022	20/03/2025	Temporal overlap (construction phase)
Erebus offshore floating windfarm	Licensed	217	The project aims to deploy a fully floating windfarm 45 km off the Pembrokeshire coast	17/02/2023	31/12/2065	Temporal overlap (construction phase)
Awel y Môr	Submitted	1.1	Offshore wind farm to generate in excess of 500 MW.	01/01/2023	01/01/2055	Temporal overlap (construction and operation and maintenance phase)
Tier 2						
Morgan and Morecambe offshore wind farms transmission assets	Pre-application	3	The offshore and onshore assets that will be used to transport electricity from the Morgan and Morecambe Offshore Wind Farms to the National Grid substation at Penwortham	No data	No data	Temporal overlap (construction and operation and maintenance phase)
Morgan offshore wind farm generation assets	Pre-application	7.53	Offshore wind farm with up to 107 turbines with a maximum height of 324 m and maximum rotor diameter of 280 m.	No data	No data	Temporal overlap (construction and operation and maintenance phase)
Morecambe offshore wind farm generation assets	Pre-application	30	Offshore wind farm with a nominal capacity of 480 MW and between 20 and 40 fixed bottom turbines.	01/01/2026	No data	Temporal overlap (construction and operation and maintenance phase)

Project/Plan	Status	Distance from the Project (km)	Description of project/plan	Start date of license	Expiration date of license	Overlap with the Project
Mona offshore wind farm	Pre-application	No data	Offshore wind farm with up to 107 turbines with a maximum height of 324 m and maximum rotor diameter of 280 m, and a total capacity of approximately 1.5 GW.	01/01/2028	31/12/2065	Spatial and temporal overlap (construction and operation and maintenance phase)
Mooir Vannin offshore wind farm	Pre-application	63	Offshore Wind Farm situated off the isle of Man	01/01/2026	01/01/2032	Temporal overlap (construction and maintenance
Fair Head tidal energy park	Planning	205	Phase 1: 10 MW Offshore development tidal array. Phase 2: 90 MW Offshore tidal development.	Ongoing	Ongoing	Temporal overlap (construction and operation and maintenance phase)

The MDSs identified in Table 8-33 have been selected as those having the potential to result in the greatest effect on an identified receptor or receptor group. The cumulative effects presented and assessed in this section have been selected from the MDSs relating to the Project alone, presented in Table 8-16 ,due to there being potential for cumulative effects. Effects of greater adverse significance are not predicted to arise should any other development scenario (e.g. different turbine layout), to that assessed here, be taken forward in the final design scheme.

Table 8-33: Maximum Design Scenario Considered For The Assessment Of Potential Cumulative Effects On Offshore Ornithology

a C=construction, O=operation and maintenance, D=decommissioning

Potential cumulative effect	Phase[a] C	O	D	Maximum Design Scenario	Justification
Temporary habitat loss leading to disturbance and displacement of birds	✓	✗	✓	MDS as described for the Project (Table 8-16) assessed cumulatively with the following wind farms: **Construction** **Tier 1** • Gwynt y Môr • North Hoyle wind farm • MaresConnect • Mostyn Energy Park extension • Rhyl Flats wind farm • Morlais • Dublin Array • North Irish Sea Array • GE wind farm (2003) • GE wind farm (2002) • Bray offshore wind farm • Kish offshore wind farm • Oriel offshore wind farm • Arklow offshore wind farm • Codling offshore wind farm • Marine renewable tidal array • Ballyhenry Bay Strangford Lough tidal test • Erebus offshore wind farm • Awel y Môr **Tier 2** • Morgan offshore wind farm generation assets • Morecambe offshore wind farm generation assets • Mona offshore wind farm • Mooir Vannin offshore wind farm • Fair Head tidal energy park **Decommissioning** • Expected end of lifetime 2050.	There is a possibility that construction could overlap spatially with North Hoyle and Gwynt y Môr, and temporally with all Tier 1 and Tier 2 projects listed within the MDS column. There is a possibility that the decommissioning phase of the Project could overlap temporally with several projects. The maximum design would include those projects listed during the construction phase excluding: • North Hoyle wind farm • Rhyl Flats wind farm • Ballyhenry Bay Strangford Lough tidal test
Disturbance and displacement from airborne	✓	✓	✓	MDS as described for the Project (Table 8-16) assessed cumulatively with the following wind farms:	There is a possibility that construction could overlap spatially with North Hoyle and Gwynt y Môr, and temporally with all Tier 1 and Tier 2 projects listed within the MDS column.

Potential cumulative effect	Phase[a] C	O	D	Maximum Design Scenario	Justification
sound and presence of vessels and infrastructure				**Construction** **Tier 1** • Gwynt y Môr • North Hoyle wind farm • MaresConnect • Mostyn Energy Park extension • Rhyl Flats wind farm • Morlais • Dublin Array • North Irish Sea Array • GE wind farm (2003) • GE wind farm (2002) • Bray offshore wind farm • Kish offshore wind farm • Oriel offshore wind farm • Arklow offshore wind farm • Codling offshore wind farm • Marine renewable tidal array • Ballyhenry Bay Strangford Lough tidal test • Erebus offshore wind farm • Awel y Môr **Tier 2** • Morgan offshore wind farm generation assets • Morecambe offshore wind farm generation assets • Mona offshore wind farm • Mooir Vannin offshore wind farm • Fair Head tidal energy park **Operation and Maintenance** **Tier 1** • Gwynt y Môr • Rhyl Flats wind farm • MaresConnect • Mostyn Energy Park extension • Morlais • Dublin Array • North Irish Sea Array • GE wind farm (2003) • GE wind farm (2002) • Bray offshore wind farm • Kish offshore wind farm • Oriel offshore wind farm • Arklow offshore wind farm • Codling offshore wind farm • Marine renewable tidal array • Erebus offshore wind farm	There is potential for a cumulative effect from the construction and operation and maintenance activities associated with the listed projects, and so a quantitative cumulative effect assessment is required. There is a possibility that the decommissioning phase of the Project could overlap temporally with several projects. The maximum design would include those projects listed during the construction phase excluding: • North Hoyle wind farm • Rhyl Flats wind farm • Ballyhenry Bay Strangford Lough tidal test

Potential cumulative effect	Phase[a] C	O	D	Maximum Design Scenario	Justification
				• Awel y Môr **Tier 2** • Morgan offshore wind farm generation assets • Morecambe offshore wind farm generation assets • Mona offshore wind farm • Mooir Vannin offshore wind farm • Fair Head tidal energy park **Decommissioning** • Expected end of lifetime 2050.	
Indirect impacts to birds from changes to prey availability	✓	✓	✓	MDS as described for the Project (Table 8-16) assessed cumulatively with the following wind farms: **Construction** **Tier 1** • Gwynt y Môr • North Hoyle wind farm • MaresConnect • Mostyn Energy Park extension • Rhyl Flats wind farm • Morlais • Dublin Array • North Irish Sea Array • GE wind farm (2003) • GE wind farm (2002) • Bray offshore wind farm • Kish offshore wind farm • Oriel offshore wind farm • Arklow offshore wind farm • Codling offshore wind farm • Marine renewable tidal array • Ballyhenry Bay Strangford Lough tidal test • Erebus offshore wind farm • Awel y Môr **Tier 2** • Morgan and Morecambe offshore windfarm transmission assets • Morgan offshore wind farm generation assets • Morecambe offshore wind farm generation assets • Mona offshore wind farm • Mooir Vannin offshore wind farm • Fair Head tidal energy park **Operation and Maintenance** **Tier 1** • Gwynt y Môr	There is a possibility that construction could overlap spatially with North Hoyle and Gwynt y Môr, and temporally with all Tier 1 and Tier 2 projects listed within the MDS column. There is potential for a cumulative effect from the construction and operation and maintenance activities associated with the listed projects, and so a quantitative cumulative effect assessment is required. There is a possibility that the decommissioning phase of the Project could overlap temporally with several projects. The maximum design would include those projects listed during the construction phase excluding: • North Hoyle wind farm • Rhyl Flats wind farm • Ballyhenry Bay Strangford Lough tidal test

Potential cumulative effect	Phase[a] C	O	D	Maximum Design Scenario	Justification
				• Rhyl Flats wind farm • Morlais • Mostyn Energy Park extension • Dublin Array • North Irish Sea Array • GE wind farm (2003) • GE wind farm (2002) • Bray offshore wind farm • Kish offshore wind farm • Oriel offshore wind farm • Arklow offshore wind farm • Codling offshore wind farm • Marine renewable tidal array • Erebus offshore wind farm • Awel y Môr **Tier 2** • Morgan and Morecambe offshore windfarm transmission assets • Morgan offshore wind farm generation assets • Morecambe offshore wind farm generation assets • Mona offshore wind farm • Mooir Vannin offshore wind farm • Fair Head tidal energy park **Decommissioning** **Tier 1** • Gwynt y Môr • North Hoyle wind farm • Rhyl Flats • Ballyhenry Bay Strangford Lough tidal test	

8.13 Cumulative effects impact assessment

A description of the significance of cumulative effects upon offshore ornithology receptors arising from each identified impact is given below.

The CEA is limited by the data available upon which to base the assessment. Due to the age of developments in the Irish Sea and surrounding areas which heave the potential to contribute to a cumulative impact upon receptors, few have comparable datasets upon which to base an assessment.

Additionally, older developments did not carry out certain impact assessments (e.g. displacement and/or collision risk) for species such as black-legged kittiwake, northern gannet, northern fulmar, Manx shearwater and gull species (herring gull, great black-backed gull and lesser black-backed gull) due to limited data at the time of assessment on the species' behavioural response to the presence of offshore wind turbines. As such the CEA is carried out using data from projects with available species data to do so. For projects in early stages (i.e. Tier 3) there was insufficient project information in the public domain to allow the effects to be reasonably understood and a cumulative assessment undertaken. Tier 3 projects therefore at this time have not been included in the cumulative assessment below.

For the cumulative assessment, impacts from Tier 1 and Tier 2 projects have been assessed together where applicable.

Table 8-34: Summarising the available data for the CEA

Project	Impacts assessed	Data available
Gwynt y Mor offshore wind farm	Temporary habitat loss leading to disturbance and displacement of birds	No data available, windfarm has been in operation since 2008 and is thus considered as background impacts.
	Disturbance and displacement from airborne sound and presence of vessels and infrastructure	
	Indirect impacts to birds from changes to prey availability	
North Hoyle offshore wind farm	Temporary habitat loss leading to disturbance and displacement of birds	No data available, windfarm has been in operation since 2003 and is thus considered as background impacts.
	Disturbance and displacement from airborne sound and presence of vessels and infrastructure	
	Indirect impacts to birds from changes to prey availability	
Mares Connect	Temporary habitat loss leading to disturbance and displacement of birds	No data available.
	Disturbance and displacement from airborne sound and presence of vessels and infrastructure	
	Indirect impacts to birds from changes to prey availability	
Mostyn Energy Park extension	Temporary habitat loss leading to disturbance and displacement of birds	No, qualitative assessment only. The project determined a moderate adverse effect on intertidal waterbirds which was reduced to **minor** through the implementation of construction measures.
	Disturbance and displacement from airborne sound and presence of vessels and infrastructure	No, qualitative assessment only. The project determined a moderate adverse effect on intertidal waterbirds which was reduced to **minor** through the implementation of construction measures.
	Indirect impacts to birds from changes to prey availability	No, qualitative assessment only. The project determined an insignificant to **minor** adverse effect on fish and shellfish.
Rhyll Flats offshore wind farm	Temporary habitat loss leading to disturbance and displacement of birds	No data available, windfarm has been in operation since 2003 and is thus considered as background impacts.
	Disturbance and displacement from airborne sound and presence of vessels and infrastructure	
	Indirect impacts to birds from changes to prey availability	
Morlais	Temporary habitat loss leading to disturbance and displacement of birds	Yes, quantitative data available.

Project	Impacts assessed	Data available
	Disturbance and displacement from airborne sound and presence of vessels and infrastructure	Yes, quantitative data available.
	Indirect impacts to birds from changes to prey availability	No, qualitative assessment only. The project determined a **negligible** impact significance.
Dublin Array offshore wind farm	Temporary habitat loss leading to disturbance and displacement of birds	No data available.
	Disturbance and displacement from airborne sound and presence of vessels and infrastructure	
	Indirect impacts to birds from changes to prey availability	
North Irish Sea Array offshore wind farm	Temporary habitat loss leading to disturbance and displacement of birds	No data available.
	Disturbance and displacement from airborne sound and presence of vessels and infrastructure	
	Indirect impacts to birds from changes to prey availability	
GE offshore wind farm (2002)	Temporary habitat loss leading to disturbance and displacement of birds	No data available, windfarm has been in operation since 2002 and is thus considered as background impacts.
	Disturbance and displacement from airborne sound and presence of vessels and infrastructure	
	Indirect impacts to birds from changes to prey availability	
GE offshore wind farm (2003)	Temporary habitat loss leading to disturbance and displacement of birds	No data available, windfarm has been in operation since 2003 and is thus considered as background impacts.
	Disturbance and displacement from airborne sound and presence of vessels and infrastructure	
	Indirect impacts to birds from changes to prey availability	
Bray offshore wind farm	Temporary habitat loss leading to disturbance and displacement of birds	Qualitative assessment only. The project determined a **negligible** impact significance. Windfarm has been in operation since 2003 and is thus considered as background impacts.
	Disturbance and displacement from airborne sound and presence of vessels and infrastructure	Qualitative assessment only. The project determined a **negligible** impact significance. Windfarm has been in operation since 2003 and is thus considered as background impacts.
	Indirect impacts to birds from changes to prey availability	Qualitative assessment only. The project determined a **negligible** impact significance. Windfarm has been in operation since 2003 and is thus considered as background impacts.

Project	Impacts assessed	Data available
Kish offshore wind farm	Temporary habitat loss leading to disturbance and displacement of birds	Qualitative assessment only. The project determined a **negligible** impact significance. Windfarm has been in operation since 2003 and is thus considered as background impacts.
	Disturbance and displacement from airborne sound and presence of vessels and infrastructure	Qualitative assessment only. The project determined a **negligible** impact significance. Windfarm has been in operation since 2003 and is thus considered as background impacts.
	Indirect impacts to birds from changes to prey availability	Qualitative assessment only. The project determined a **negligible** impact significance. Windfarm has been in operation since 2003 and is thus considered as background impacts.
Oriel offshore wind farm	Temporary habitat loss leading to disturbance and displacement of birds	No data available
	Disturbance and displacement from airborne sound and presence of vessels and infrastructure	
	Indirect impacts to birds from changes to prey availability	
Arklow offshore wind farm	Temporary habitat loss leading to disturbance and displacement of birds	No data available
	Disturbance and displacement from airborne sound and presence of vessels and infrastructure	
	Indirect impacts to birds from changes to prey availability	
Codling offshore wind farm	Temporary habitat loss leading to disturbance and displacement of birds	No data available, windfarm has been in operation since 2005 and is thus considered as background impacts.
	Disturbance and displacement from airborne sound and presence of vessels and infrastructure	
	Indirect impacts to birds from changes to prey availability	
Marine renewable tidal array	Temporary habitat loss leading to disturbance and displacement of birds	No data available, project has been in operation since 2015 and is thus considered as background impacts.
	Disturbance and displacement from airborne sound and presence of vessels and infrastructure	
	Indirect impacts to birds from changes to prey availability	
Ballyhenry Bay Strangford Lough tidal test	Temporary habitat loss leading to disturbance and displacement of birds	No data available
	Disturbance and displacement from airborne sound and presence of vessels and infrastructure	

Project	Impacts assessed	Data available
	Indirect impacts to birds from changes to prey availability	
Erebus floating offshore wind farm	Temporary habitat loss leading to disturbance and displacement of birds	No data available, Erebus did not assess this impact for any of the receptors likely to be impacted by the project.
	Disturbance and displacement from airborne sound and presence of vessels and infrastructure	
	Indirect impacts to birds from changes to prey availability	No quantitative data available, qualitative assessment only. Erebus determined a **negligible** impact.
Awel y Mor offshore wind farm	Temporary habitat loss leading to disturbance and displacement of birds	Yes, quantitative data available.
	Disturbance and displacement from airborne sound and presence of vessels and infrastructure	Yes, quantitative data available.
	Indirect impacts to birds from changes to prey availability	Yes, quantitative data available.
Morgan offshore wind farm generation	Temporary habitat loss leading to disturbance and displacement of birds	No, Morgan did not assess this impact for any of the receptors likely to be impacted by the project.
	Disturbance and displacement from airborne sound and presence of vessels and infrastructure	No, Morgan did not assess this impact for any of the receptors likely to be impacted by the project.
	Indirect impacts to birds from changes to prey availability	No, a qualitative assessment was made only for razorbill which was determined to be a **minor** impact. All other receptors were screened out of this impact based upon habitat specialisation scores from Wade *et al.* (2016).
Morecambe offshore wind farm generation	Temporary habitat loss leading to disturbance and displacement of birds	Yes, quantitative data available.
	Disturbance and displacement from airborne sound and presence of vessels and infrastructure	Yes, quantitative data available.
	Indirect impacts to birds from changes to prey availability	No quantitative data available, a qualitative assessment was made. Morecambe determined a **minor** effect on the affected receptors.
Mona offshore wind farm	Temporary habitat loss leading to disturbance and displacement of birds	No quantitative data available, a qualitative assessment was made. Mona determined a **minor** effect on the affected receptors.
	Disturbance and displacement from airborne sound and presence of vessels and infrastructure	No quantitative data available, a qualitative assessment was made. Mona determined a **minor** effect on the affected receptors.
	Indirect impacts to birds from changes to prey availability	A qualitative assessment was made only for guillemot, Atlantic puffin, and razorbill which was determined to be a **minor** impact. All other receptors were screened out of this impact based upon

Project	Impacts assessed	Data available
		habitat specialisation scores from Wade *et al*. (2016).
Mooir Vannin offshore wind farm	Temporary habitat loss leading to disturbance and displacement of birds	No data available. Scoping report only although red-throated diver may be present in high enough numbers for displacement effects.
	Disturbance and displacement from airborne sound and presence of vessels and infrastructure	
	Indirect impacts to birds from changes to prey availability	
Morgan/Morecambe offshore wind farm transmission	Temporary habitat loss leading to disturbance and displacement of birds	Yes, quantitative data available.
	Disturbance and displacement from airborne sound and presence of vessels and infrastructure	Yes, quantitative data available.
	Indirect impacts to birds from changes to prey availability	
Fairhead tidal park	Temporary habitat loss leading to disturbance and displacement of birds	No quantitative data available, qualitative assessment only. The project determined a **negligible** impact significance.
	Disturbance and displacement from airborne sound and presence of vessels and infrastructure	No quantitative data available, qualitative assessment only. The project determined a **negligible** impact significance.
	Indirect impacts to birds from changes to prey availability	No quantitative data available, qualitative assessment only. The project determined a **negligible** impact significance.

8.13.1 The impact of temporary habitat loss leading to displacement and disturbance of birds

There is potential for cumulative displacement as a result of construction and decommissioning associated with the Proposed Development in combination with other developments.

Disturbance and subsequent displacement of seabirds during the construction phase is primarily centred around where construction vessels and piling activities are occurring. The activities may displace individuals that would normally reside within and around the area of sea where the Proposed Development is located. This represents habitat loss, which will potentially reduce the area available to those seabirds to forage, loaf and/or moult.

Table 8-35: Summarising the quantitative data available for cumulative displacement (B – Breeding, NB – Non-breeding).

Species	Developments with quantitative displacement data											
	Proposed Development		Morlais		Morecambe		Awel y Mor		Morgan/Morcambe transmission		Total	
	B	NB	B	NB	B	NB	B	NB	B	NB	B	NB
Common scoter	-	0.49 – 0.98	-	-	-	-	-	0 – 0.007	-	0.09 – 0.98	-	**0.58 – 1.967**
Red-throated diver	-	02 – 0.89	-	0.1	-	0.01	-	0 – 0.582	-	0.03 – 0.35	-	**0.16 – 1.932**
Great cormorant	-	0.02 – 0.04	-	-	-	-	-	-	-	-	-	**0.02 – 0.04**
Sandwich tern	-	0.167 – 0.837	-	-	-	-	-	-	-	-	-	**0.167 – 0.837**
Little tern	0.02 – 0.04	-	-	-	-	-	-	-	-	-	**0.02 – 0.04**	-
Common tern	0.003 – 0.006	-	-	-	-	-	-	-	-	-	**0.003 – 0.006**	-

8.13.2 Non-breeding waterbirds (wildfowl, waders, gulls, herons and rails)

8.13.2.1 Construction and decommissioning phase

Although there is a potential for cumulative effects arising from multiple projects, the area of the Proposed Development where there are likely to be negative impacts is confined to the landfall plus 500 m buffer. Connectivity for the intertidal waterbirds is accepted to be 20 km (core foraging range for pink-footed goose – NatureScot, 2016). The only additional projects that have impacts upon the intertidal zone within 20 km of the Proposed Development are Awel Y Mor, specifically where their cable makes landfall at Y Ffrith, and Mostyn Energy Park extension.

Cumulative magnitude of impact

The magnitude of impact from the assessment of the Proposed Development is negligible. The Awel y Mor ES found that after proposed mitigation measures there was no significant effect.

The Mostyn Energy Park extension used the following measures to reduce the impact to minor:

- Soft starts;
- Cold weather construction restriction;
- Screening; and,

- Noise suppression system.

In addition, a detailed Method Statement will be produced to outline how impacts on birds will be avoided during the works at the Proposed Development. The Method Statements will be developed in collaboration with NRW, and shared with NRW-MLT for approval at least three months prior to works commencing. (see 8.10). The addition of Mostyn Energy Park extension and Awel y Mor landfall increase the magnitude of impact to low.

Sensitivity of the receptor

Waterbird and in particular waders are considered to be very vulnerable to the loss of foraging habitats on their wintering grounds (e.g. Burton *et al*., 2006).

This group of receptors are considered to have medium recoverability based on their relatively low reproductive success and a stable or slightly decreasing trend in the numbers of wintering birds.

Many of the waterbird species recorded during the site-specific surveys are designated features of local SPA, Ramsar and SSSI sites, and are therefore of high to very high conservation value.

Waterbird VORs are deemed to be of high vulnerability, medium recoverability, and very high conservation importance. The sensitivity of the receptor is therefore, considered to be high.

8.13.3 Non-breeding seaducks, divers, grebes and cormorants

8.13.3.1 Construction and decommissioning phase

There is potential for cumulative impacts for this receptor group. Connectivity for this group is limited to the Liverpool Bay with the most disturbance sensitive species (and those of highest conservation concern) being red-throated diver and common scoter. Offshore Ornithology Baseline (RPS Group, 2024a) presents evidence from HiDef Aerial Surveying Limited (2023); Lawson *et al.* (2016); Bradbury *et al.* (2014); and Waggit *et al.* (2022), who all found that these species were concentrated in the nearshore waters.

As this receptor group is found in the nearshore waters, they are unaffected by the generation aspects of many of the OWF which are situated beyond their range, in addition, for those projects that are closer in to shore but are operational, no additional displacement can be expected as displacement has already occurred. Table 8-35 summarises the available displacement data available for this group of receptors.

Cumulative magnitude of impact

Table 8-35 sums the quantitative data available for species within this group, namely common scoter and red-throated diver. For common scoter the cumulative displacement is between 0.58% and 1.967% excess mortality above the environmental baseline. For red-throated diver this is between 0.16% and 1.932% excess mortality above the environmental baseline. The upper limits of these estimates are above the 1% threshold.

However, as all of these works are due to be short-term and reversible in nature, and permanent displacement for this receptor group is not expected during operation and maintenance, the cumulative magnitude of impact is deemed to be low.

Sensitivity of the receptor

Both common scoter and red-throated diver are highly susceptible to disturbance often flushing from large distances and relocating even further away from the source of disturbance. Therefore, they are deemed to have high vulnerability to the impact.

Common scoter and red-throated diver are qualifying features of the Liverpool Bay SPA, while cormorant is a feature of local SPA and Ramsar sites and therefore, these species are of very high conservation value. The majority of the other species in this receptor group are SSSI features with high conservation value.

The receptors are considered to have high recoverability based on an increasing trend in the numbers of wintering birds (Frost, *et. al*., 2021).

Seaducks, divers, grebes and cormorants are deemed to be of high vulnerability, high recoverability and very high conservation importance. The sensitivity of the receptor is therefore, considered to be high.

8.13.4 Breeding terns

8.13.4.1 Construction and decommissioning phase

There is potential for cumulative impacts, although this is limited to the foraging ranges of common and little tern.

Cumulative magnitude of impact

The magnitude of impact for the Proposed Development is negligible, and as there are no additional projects that will impact the little tern foraging range, and no available data for projects that will impact the common tern foraging range the cumulative magnitude of impact for this receptor group remains negligible.

Sensitivity of the receptor

Although terns are flexible in their habitat use during the non-breeding season, the receptors are overall considered to be very vulnerable to the loss of foraging grounds. The terns present within the Proposed Development area have medium (common tern and sandwich tern) to high (little tern) habitat specialisation (Wade *et al.*, 2016) and their foraging ranges vary from 5 km to 34.3 km (Woodward *et al.,* 2019). The maximum sensitivity of this receptor group is considered to be very high.

The receptor species in this group are all designated features of local SPAs, and therefore of very high conservation value.

The receptors are considered to have medium recoverability based on their relatively low reproductive success and a stable or slightly decreasing trend in the numbers of breeding birds (JNCC, 2019).

Breeding terns are deemed to be of very high vulnerability, medium recoverability and high conservation importance. The sensitivity of the receptor is therefore, considered to be high.

8.13.5 Cumulative significance of effect

Table 8-36: Summarising The Cumulative Significance Of Effect For The Impact Of Temporary Habitat Loss Leading To Displacement And Disturbance Of Birds During The Construction And Decommissioning Phases

Species	Cumulative magnitude of impact	Sensitivity of receptor	Significance of effect
Non-breeding waterbirds (wildfowl, waders, gulls, herons and rails)	Low	High	**Minor**
Non-breeding seaducks, divers, grebes and cormorants	Low	High	**Minor**
Breeding terns	Negligible	High	**Minor**

8.13.6 The impact of disturbance and displacement from airborne sound and presence of vessels and infrastructure

There is potential for cumulative displacement as a result of construction and decommissioning associated with the Proposed Development in combination with other developments.

Disturbance and subsequent displacement of birds during the construction phase is primarily centred around where construction vessels and piling activities are occurring. The activities may displace individuals that would normally reside within and around the area of sea where the Proposed Development is located. This in effect represents indirect habitat loss, which will potentially reduce the area available to those birds to forage, loaf and/or moult. Cumulative displacement is summarised in Table 8-35.

8.13.7 Non-breeding waterbirds (wildfowl, waders, gulls, herons and rails)

8.13.7.1 Construction and decommissioning phases

Although there is potential for cumulative effects arising from multiple projects, the area of the Proposed Development where there are likely to be negative impacts is confined to the landfall plus 500 m buffer. Connectivity for the intertidal waterbirds is accepted to be 20 km (core foraging range for pink-footed goose – NatureScot, 2016). The only additional project that has impacts upon the intertidal zone within 20 km of the Proposed Development is Awel Y Mor, specifically where their cable makes landfall at Y Ffrith.

Cumulative magnitude of impact

The magnitude of impact for this receptor group during the construction and decommissioning phases is deemed to be similar to those from 'the impact of temporary habitat loss leading to displacement and disturbance of birds' and is therefore low.

Sensitivity of the receptor

Waterbird and in particular waders are considered to be very vulnerable to the loss of foraging habitats on their wintering grounds (e.g. Burton *et al.,* 2006).

This group of receptors are considered to have medium recoverability based on their relatively low reproductive success and a stable or slightly decreasing trend in the numbers of wintering birds.

Many of the waterbird species recorded during the site-specific surveys are designated features of local SPA, Ramsar and SSSI sites, and are therefore of high to very high conservation value.

Waterbird VORs are deemed to be of high vulnerability, medium recoverability, and very high conservation importance. The sensitivity of the receptor is therefore, considered to be high.

8.13.8 Non-breeding seaducks, divers, grebes and cormorants

8.13.8.1 Construction and decommissioning phases

There is potential for cumulative impacts for this receptor group. Connectivity for this group is limited to the Liverpool Bay with the most disturbance sensitive species (and also those of highest conservation concern) being red-throated diver and common scoter. Offshore Ornithology Baseline (RPS Group, 2024a) presents evidence from HiDef Aerial Surveying Limited (2023); Lawson *et al.* (2016); Bradbury *et. al*. (2014); and Waggit *et al*. (2022), who all found that these species were concentrated in the nearshore waters.

As this receptor group is found in the nearshore waters, they are unaffected by the generation aspects of many of the OWF which are situated beyond their range, in addition, for those projects that are closer in to shore but are operational, no additional displacement can be expected as displacement has already occurred. The projects with additional impacts are summarised in Table 8-35.

Cumulative magnitude of impact

The magnitude of impact for this receptor group during the construction and decommissioning phases is deemed to be similar to those from 'the impact of temporary habitat loss leading to displacement and disturbance of birds' and is therefore low.

Sensitivity of the receptor

Overall, this group of receptors have a medium to high habitat specialisation and are considered to be very vulnerable to disturbance (Goodship and Furness, 2022).

Common scoter and red-throated diver are qualifying features of the Liverpool Bay SPA, while cormorant is a feature of local SPA and Ramsar sites and therefore, these species are of very high conservation value. The majority of the other species in this receptor group are SSSI features with high conservation value.

The receptors are considered to have medium recoverability based on their relatively low reproductive success and a stable or slightly decreasing trend in the numbers of wintering birds (Frost *et al*., 2021).

Seaducks, divers, grebes and cormorants are deemed to be of high vulnerability, medium recoverability and very high conservation importance. The sensitivity of the receptor is therefore, considered to be high.

8.13.9 Cumulative significance of effect

Table 8-37: Summarising The Cumulative Significance Of Effect For The Impact Of Disturbance And Displacement From Airborne Sound And Presence Of Vessels And Infrastructure For The Construction And Decommissioning Phases

Species	Cumulative magnitude of impact	Sensitivity of receptor	Significance of effect
Non-breeding waterbirds (wildfowl, waders, gulls, herons and rails)	Low	High	**Minor**
Non-breeding seaducks, divers, grebes and cormorants	Low	High	**Minor**

8.13.10 Indirect impacts to birds from changes in prey availability

There is potential for cumulative impacts as a result of construction, operation, and decommissioning, associated with the Proposed Development in combination with other developments.

8.13.11 Breeding terns

8.13.11.1 All phases

There is potential for cumulative impacts, although this is limited to the foraging ranges of common and little tern.

Cumulative magnitude of impact

The magnitude of impact for the Proposed Development alone is low during the sensitive egg laying and chick rearing period and negligible outside of this period, and as there are no additional projects that will impact the little tern foraging range, and no available data for projects that will impact the common tern foraging range the cumulative magnitude of impact for this receptor group remains low.

Sensitivity of the receptor

This receptor group is of high conservation value as species in this group include little tern and common tern which are breeding features of two SPAs (the Dee Estuary, and Liverpool Bay) that directly overlap with the Proposed Development. Both little tern and common tern show downward trends in breeding populations (JNCC, 2019) and are therefore of low recoverability. Due to the limited foraging range of little tern (5 km mean max as taken from Woodward, *et. al*., 2019) this species group is considered to have high vulnerability to the impact.

8.13.12 Cumulative significance of effect

Table 8-38: Summarising The Cumulative Significance Of Effect For The Indirect Impacts To Birds From Changes In Prey Availability For All Phases

Species	Cumulative magnitude of impact	Sensitivity of receptor	Significance of effect
Breeding terns assuming works during the breeding period	Low	High	**Moderate**
Breeding terns assuming works during the non-breeding period	Negligible	High	**Negligible**

8.14 Transboundary effects

A screening of transboundary impacts has been carried out and has identified that there are no potential significant effects with regard to offshore and intertidal ornithology from the HyNet North-West Project upon the interests of other states.

8.15 Inter-related effects

Inter-relationships are the impacts and associated effects of different aspects of the Project on the same receptor. These are as follows.

- Project lifetime effects: Assessment of the scope for effects that occur throughout more than one phase of the Project (construction, operation and maintenance and decommissioning), to interact and potentially create a more significant effect on a receptor than if just assessed in isolation in these three phases (e.g. construction noise effects from drilling, operational noise from transport vessels and decommissioning disturbance).
- Receptor led effects: Assessment of the scope for all effects to interact, spatially and temporally, to create inter-related effects on a receptor. As an example, all effects on offshore ornithology, such as displacement/disturbance, collision and increased concentrations of suspended sediments, may interact to produce a different, or greater effect on this receptor than when the effects are considered in isolation. Receptor-led effects may be short term, temporary or transient effects, or incorporate longer term effects.

8.16 Conclusion

- Information on offshore ornithology within the Proposed Development area was collected through review of available literature, other offshore wind farm assessments, UK statutory guidance, and detailed analysis of data collected during the site-specific intertidal surveys.
- Table 8-39 presents a summary of the impacts in respect to offshore ornithology.
- For breeding terns, it is concluded that there will be moderate adverse significant effects arising from the Proposed Development during the construction and decommissioning phases due to indirect impacts upon prey availability assuming that works are timed to coincide with the breeding period.
- If mitigation measures limiting works during the breeding period are taken then the residual effects will be negligible during construction and decommissioning phases due to indirect impacts upon prey availability.
- For all other species it is concluded that there will be no significant impacts from the Proposed Development during the construction, operation, and decommissioning phases.
- Table 8-40 presents a summary of the cumulative impacts. Overall, it is concluded that there are no additional significant cumulative effects to any species from other projects.
- There will be no significant effects, either alone or cumulatively, during the operational phase of the project.
- The only significant effects, either alone or cumulatively, occur during the construction/decommissioning phase.
- No transboundary impacts have been identified in relation to offshore ornithology. Overall, it is concluded that there will be no significant transboundary effects arising from the Proposed Development.

Table 8-39: Summary Of The Impacts In Relation To Offshore Ornithology

Description of impact	Phase[a] C	O	D	Magnitude of impact	Sensitivity of the receptor	Significance of effect
Temporary habitat loss leading to displacement/disturbance of birds	✓	×	✓	**Non-breeding waterbirds** C: Negligible D: Negligible **Non-breeding seaducks** C: Negligible D: Negligible **Breeding seabirds** C: Negligible D: Negligible **Breeding terns** C: Negligible D: Negligible	**Non-breeding waterbirds** C: High D: High **Non-breeding seaducks** C: High D: High **Breeding seabirds** C: Medium D: Medium **Breeding terns** C: High D: High	**Non-breeding waterbirds** C: Minor D: Minor **Non-breeding seaducks** C: Minor D: Minor **Breeding seabirds** C: Negligible D: Negligible **Breeding terns** C: Minor D: Minor
Disturbance and displacement from airborne sound and presence of vessels and infrastructure	✓	✓	✓	**Non-breeding waterbirds** C: Negligible	**Non-breeding waterbirds** C: High	**Non-breeding waterbirds** C: Minor

Description of impact	Phase[a] C	O	D	Magnitude of impact	Sensitivity of the receptor	Significance of effect
				O: No change D: Negligible **Non-breeding seaducks** C: Negligible O: No change D: Negligible **Breeding seabirds** C: Negligible O: No change D: Negligible **Breeding terns** C: Negligible O: No change D: Negligible	O: High D: High **Non-breeding seaducks** C: High O: High D: High **Breeding seabirds** C: Medium O: Medium D: Medium **Breeding terns** C: Medium O: Medium D: Medium	O: No change D: Minor **Non-breeding seaducks** C: Minor O: No change D: Minor **Breeding seabirds** C: Negligible O: No change D: Negligible **Breeding terns** C: Negligible O: No change D: Negligible
Collision with static offshore infrastructure	×	✓	×	**All receptors** O: No change	**All receptors** O: Medium	**All receptors** O: No change
Indirect impacts to birds from changes in prey availability	✓	✓	✓	**Non-breeding seaducks** C: Negligible O: No change D: Negligible **Breeding seabirds** C: Negligible O: No change D: Negligible **Breeding terns with construction during the breeding season** C: Low O: No change D: Low **Breeding terns with construction during the non-breeding season** C: Negligible O: No change D: Negligible	**Non-breeding seaducks** C: Medium O: Medium D: Medium **Breeding seabirds** C: Medium O: Medium D: Medium **Breeding terns with construction during the breeding season** C: High O: High D: High **Breeding terns with construction during the non-breeding season** C: High O: High D: High	**Non-breeding seaducks** C: Negligible O: No change D: Negligible **Breeding seabirds** C: Negligible O: No change D: Negligible **Breeding terns with construction during the breeding season** C: Moderate O: No change D: Moderate **Breeding terns with construction during the non-breeding season** C: Negligible O: No change D: Negligible
Accidental pollution in the surrounding area	✓	✓	✓	**All receptors** A: Negligible	**All receptors** A: Medium	**All receptors** A: Negligible

Description of impact	Phase[a] C	O	D	Magnitude of impact	Sensitivity of the receptor	Significance of effect
Creation of roosting and nesting habitats among project infrastructure	×	✓	×	**Breeding seabirds** O: Negligible (positive)	**Breeding seabirds** O: Medium	**Breeding seabirds** O: Minor (positive)

C=construction, O=operational and maintenance, D=decommissioning, A=all phases

Table 8-40: Summary Of The Cumulative Impacts In Relation To Offshore Ornithology

Description of impact	Phase[a] C	O	D	Cumulative magnitude of impact	Sensitivity of the receptor	Cumulative significance of effect
Temporary habitat loss leading to displacement/disturbance of birds	✓	×	✓	**Non-breeding waterbirds** C: Low D: Negligible **Non-breeding seaducks** C: Low D: Low **Breeding terns** C: Negligible D: Negligible	**Non-breeding waterbirds** C: High D: High **Non-breeding seaducks** C: High D: High **Breeding terns** C: High D: High	**Non-breeding waterbirds** C: Minor D: Minor **Non-breeding seaducks** C: Minor D: Minor **Breeding terns** C: Minor D: Minor
Disturbance and displacement from airborne sound and presence of vessels and infrastructure	✓	×	✓	**Non-breeding waterbirds** C: Low D: Negligible **Non-breeding seaducks** C: Low D: Low	**Non-breeding waterbirds** C: High D: High **Non-breeding seaducks** C: High D: High	**Non-breeding seaducks** C: Minor D: Minor **Breeding terns** C: Minor D: Minor
Indirect impacts to birds from changes in prey availability	✓	×	✓	**Breeding terns with construction during the breeding season** C: Low O: No change D: Low **Breeding terns with construction during the non-breeding season** C: Negligible O: No change D: Negligible	**Breeding terns with construction during the breeding season** C: High O: High D: High **Breeding terns with construction during the non-breeding season** C: High O: High D: High	**Breeding terns with construction during the breeding season** C: Moderate O: No change D: Moderate **Breeding terns with construction during the non-breeding season** C: Negligible O: No change D: Negligible

C=construction, O=operational and maintenance, D=decommissioning, A=all phases

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MAKING COMPLEX EASY
A TETRA TECH COMPANY

Liverpool Bay CCS Ltd
HYNET CARBON DIOXIDE TRANSPORTATION AND STORAGE PROJECT - OFFSHORE

Environmental Statement
Volume 2, chapter 9: Shipping and Navigation

EHE7228B
Liverpool Bay CCS Limited
Final
February 2024
Offshore ES
Shipping and Navigation

rpsgroup.com

Glossary

Term	Meaning
Cumulative effect assessment	Assessment of the likely effects arising from the offshore components of the HyNet CO_2 Transportation and Storage System ('Proposed Development') alongside the likely effects of other development activities in the vicinity of the Proposed Development.
Effect	The consequence of an impact
Environmental Impact Assessment	A statutory process by which certain planned projects must be assessed before a formal decision to proceed can be made. It involves the collection and consideration of environmental information, which fulfils the assessment requirements of the EIA Directive and EIA Regulations, including the publication of an Environmental Impact Assessment (EIA) Report.
Impact	A change that is caused by an action
Magnitude	Size, extent, and duration of an impact.
Maximum Design Scenario	The maximum design parameters of each Proposed Development asset (both on and offshore) considered to be a worst case for any given assessment but within the range of the Project Design Envelope.
Mitigation Measure	Measure which would avoid, reduce, or remediate an impact
Non-statutory stakeholder	Organisations with whom the regulatory authorities may choose to engage who are not designated in law but are likely to have an interest in a proposed development.
Project	The HyNet Carbon Dioxide Transportation and Storage Project.
Project Design Envelope (PDE)	Also known as the Rochdale Envelope, the PDE concept is routinely utilised in both onshore and offshore planning applications to allow for some flexibility in design options, particularly offshore, and more particularly for foundations and turbine type, where the full details of the project are not known at application submission but where sufficient detail is available to enable all environmental impacts to be appropriately considered during the EIA.
Project lifetime effects	Effects that occur throughout more than one phase of the project (construction, operations and maintenance, and decommissioning) interacting to potentially create a more significant effect upon a receptor than if just assessed in isolation in a single phase.
Proposed Development	The offshore components of the Project which are subject of this Environmental Statement, as described in Chapter 3: Proposed Development Description.
Receptor-led effects	Effects that interact spatially and/or temporally resulting in inter-related effects upon a single receptor.
Residual Impact	Residual impacts are the final impacts that occur after the proposed mitigation measures have been put into place, as planned.
Scoping Opinion	Sets out the Secretary of State's response to the Applicants Scoping Report and contains the range of issues that the Secretary of State, in consultation with statutory stakeholders, has identified should be considered within the EIA.
The Applicant	This is Liverpool Bay CCS Ltd.
Transboundary effects	Impacts from a project within one state affect the environment of another state(s).

Acronyms and Initialisations

Acronym/Initialisation	Description
AIS	Automatic Identification System
ALARP	As Low As Reasonably Practicable'
ATBA	Area To Be Avoided
AtoN	Aid to Navigation
CAA	Civil Aviation Authority
CBRA	Cable Burial Risk Assessment

Acronym/Initialisation	Description
CCS	Carbon Capture and Storage
CEA	Cumulative Effects Assessment
CoCP	Code of Construction Practice
COLREG	International Regulations for Preventing Collisions at Sea
CO_2	Carbon Dioxide
CSIP	Cable Specification and Installation Plan
CtL	Consent to Locate
CTV	Crew Transfer Vessel
EcIA	Ecological Impact Assessment
EEA	European Economic Area
EIA	Environmental Impact Assessment
EMF	Electromagnetic Field
EMP	Environmental Management Plan
Eni	Eni UK Limited
EPA	Environmental Protection Agency
ES	Environmental Statement
ESCA	European Subsea Cables UK Association
FLCP	Fisheries Liaison and Coexistence Plan
FLO	Fisheries Laison Officer
FO	Fibre Optic
KIS-ORCA	Kingfisher Information Service – Offshore Renewables and Cable Awareness
LOA	Length Overall
MCA	Marine and Coastguard Agency
MDS	Maximum Design Scenario
MHWS	Mean High Water Springs
MLWS	Mean Low Water Spring
MMO	Marine Management Organisation
NRA	Navigational Risk Assessment
NSTA	North Sea Transition Authority, preceded by the Oil and Gas Authority
NtM	Notice to Marinas
OP	Offshore Platform
OPRED	Offshore Petroleum Regulator for Environment and Decommissioning
PDE	Project Design Envelope
RYA	Royal Yachting Association
SOLAS	The International Convention for the Safety of Life at Sea (SOLAS)
UK	United Kingdom
UKHO	United Kingdom Hydrographic Office
VMP	Vessel Management Plan

Units

Units	Description
%	Percent
GT	Gross Tonnes
km	Kilometres
m	Metres (distance)
nm	Nautical Mile (distance; equal to 1.852 km)

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9 SHIPPING AND NAVIGATION

9.1 Introduction

This chapter of the Offshore ES presents the assessment of the likely significant effects (as per the “EIA Regulations”) on the environment of the Proposed Development on shipping and navigation. Specifically, this chapter considers the potential impacts from the construction, operation and maintenance, and decommissioning of the offshore components (seaward of the MHWS mark) of the Proposed Development, which includes the cables leading to MHWS).

The Proposed Development assessed in this chapter and in the Navigational Risk Assessment Technical Report (NRA) (Anatec Limited and RPS Group, 2023) includes the subsea power cables and the proposed Douglas CCS platform, as well as movements to and from the sites for activities associated with repurpose of existing pipelines, modification to wells and modifications to existing platforms. The assessment does not cover work carried out within the existing safety zones.

The shipping and navigation assessment of effects has followed the International Maritime Organization (IMO) Formal Safety Assessment (FSA) methodology since this is the internationally recognised approach for assessing the impact to shipping and navigation users, and is the approach required for the Maritime and Coastguard Agency (MCA)’s methodology (Annex 1 of Marine Guidance Note (MGN) 654) (MCA, 2021a), noting that MGN 654 is intended for Offshore Renewable Energy Installations (OREIs) as opposed to Carbon Capture and Storage (CCS) developments.

This chapter summarises information contained within the NRA (Anatec Limited and RPS Group, 2023).

9.2 Purpose of this chapter

The primary purpose of the Offshore ES is outlined in volume 1, chapter 1 of the of the Offshore ES. It is intended that the Offshore ES will provide the statutory and non-statutory stakeholders with sufficient information to determine the likely significant effects of the Proposed Development on the receiving environment.

In particular, this Shipping and Navigation ES Chapter:

- Presents the existing shipping and navigation baseline established from desk studies and consultation with stakeholders;
- Identifies any assumptions and limitations encountered in compiling the shipping and navigation information;
- Presents the likely significant environmental impacts on Shipping and Navigation arising from the Proposed Development and reaches a conclusion on the likely significant effects on Shipping and Navigation, based on the information gathered and the analysis and assessments undertaken; and
- Highlights any necessary monitoring and/or mitigation measures which are recommended to prevent, minimise, reduce or offset the likely significant adverse effects of the Proposed Development on Shipping and Navigation.

9.3 Study area

The Proposed Development Shipping and Navigation study area is defined as a bounding box encompassing a 10 nm buffer on the proposed new Douglas CCS platform location, plus a 5 nm buffer on the proposed cable routes. The study area is considered sufficient to appropriately characterise the shipping activity and navigational features of relevance to the Proposed Development and to encompass any vessel traffic which may be impacted by the Proposed Development. The study area has been presented to and approved by stakeholders during consultation on the NRA approach (see Section 9.5). It is noted that a Physical Work Area is also defined surrounding the proposed cable route and the Douglas, Hamilton, Hamilton North and Lennox platforms. This area defines the area in which any of the work associated with the Proposed Development is expected to be take place.

The Shipping and Navigation study area is presented in Figure 9.1.

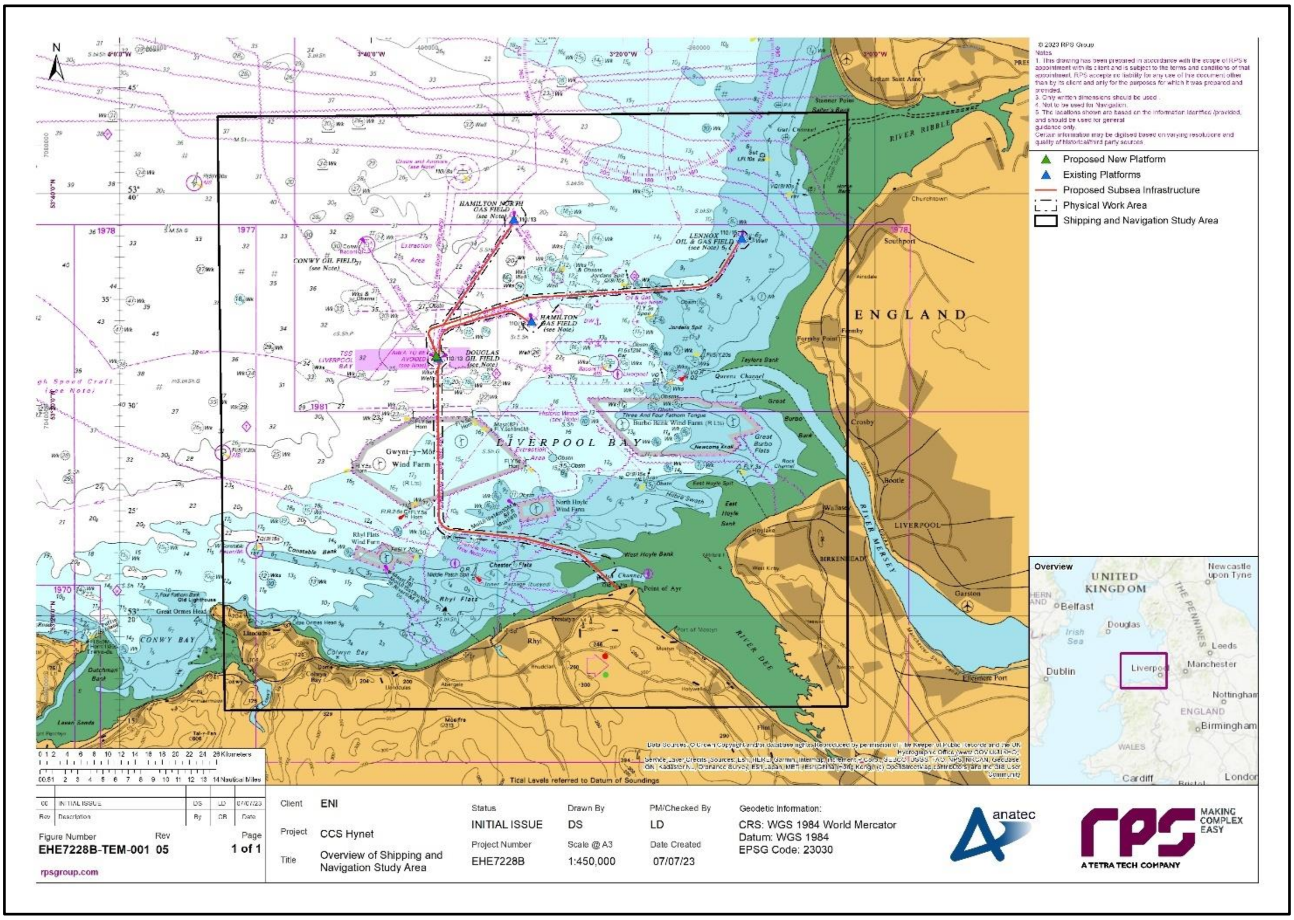

Figure 9.1: Shipping and Navigation Study Area

9.4 Policy and Legislative Context

The policy context for the HyNet Carbon Dioxide Transportation and Storage Project- Offshore is set out in Chapter 2: Policy and Legislative Context of the Offshore ES.

A summary of policy provisions relevant to Shipping and Navigation is set out in Table 9.1, with relevant legislation set out in Table 9.2.

Table 9.1: Summary of Marine Policies Relevant to Shipping and Navigation

Relevant Policy	Summary of Provision	How and Where Considered in the Offshore ES
UK Marine Policy Statement (DEFRA, 2011)	The UK Marine Policy Statement provides a framework for preparing Marine Plans and taking decisions affecting the marine environment. Paragraph 3.4.7 states "*Increased competition for marine resources may affect the sea space available for the safe navigation of ships. Marine plan*	Displacement of existing routes and activity, and the resultant increase in collision risk has been considered within the impact assessment (see Section 9.11).

Relevant Policy	Summary of Provision	How and Where Considered in the Offshore ES
	authorities and decision makers should take into account and seek to minimise any negative impacts on shipping activity, freedom of navigation and navigational safety and ensure that their decisions are in compliance with international maritime law".	
North-West Marine Plan (MMO, 2021)	*NW-PS-1: Ports and harbours are essential to realising economic and social benefits for the north-west marine plan areas and the UK. NW-PS-1 makes sure that proposals do not restrict current port and harbour activity or future growth, enabling long-term strategic decisions, and supporting competitive and efficient port and shipping operations.* *NW-PS-2: Within the north-west marine plan areas, there are International Maritime Organization routeing systems that are essential for shipping activity, freedom of navigation and navigational safety. NW-PS-2 confirms that proposals that compromise these important navigation routes should not be authorised. NW-PS-2 enables and supports safe, profitable and efficient marine businesses.* *NW-PS-3: The north-west marine plan areas are very busy with respect to high-density navigation routes, strategically important navigation routes and passenger services. NW-PS-3 confirms that proposals that pose a risk to safe navigation or the viability of these routes and services should not be authorised. NW-PS-3 aims to protect these routes and services by enabling and promoting safe, profitable and efficient marine businesses.* *NW-CAB-1: Subsea cabling is important to the growth and sustainability of telecommunications, offshore wind farms and electricity transmission. NW-CAB-1 supports and encourages cable burial where possible, to meet the needs of the sector while enabling co-existence with other users of the north west marine plan areas.*	All marine planning policies for ports, harbours and shipping have been considered fully in the ES chapter. Particular regard has been given to the possibility of the displacement of vessel traffic and the reduction in access to local ports. Mitigation measures have been identified in Section 9.10 to reduce the effect of these impacts. The primary means of cable protections is planned to be cable burial, with external protection only anticipated to be used at cable crossings.
Welsh National Marine Plan (Welsh Government, 2019)	*P&S_ 02: Ports and Shipping (supporting)* *These safeguarding policies seek to minimise negative impacts on shipping activity, ensure freedom of navigation and navigational safety which are provided under international law, and protect the efficiency and resilience of continuing port operations, including their economic interests. They do this by ensuring that developments or other activities which may restrict ports and shipping in terms of continuing current operations and responding to future development*	All marine planning policies for ports, harbours and shipping have been considered fully in the ES chapter. Particular regard has been given to the possibility of the displacement of vessel traffic and the reduction in access to local ports. Mitigation measures have been identified in Section 9.10 to reduce the effect of these impacts. The primary means of cable protections is planned to be cable burial, with external protection only anticipated to be used at cable crossings.

Relevant Policy	Summary of Provision	How and Where Considered in the Offshore ES
	opportunities are considered and addressed in decision making. They also recognise the significant potential for coexistence of compatible activities with ports and shipping. Displacement of shipping should be avoided where possible. *CAB_01: Subsea cabling (supporting):* *451. The Subsea Cable sector can reduce the potential for conflict, and increase co-location and coexistence opportunities, by undertaking burial of the cable, however the nature of activity over buried cables needs to be considered in light of prudent maritime practice and national and international law. Preference should be given to this method of cable installation where there is possibility of significant impact by other activities and where seabed conditions are suitable. Where burial is not achievable or desirable, alternative protection measures may be appropriate (in line with regulatory requirements and industry good practice).*	

Table 9.2: Summary of Legislation Relevant to Shipping and Navigation

Relevant Legislation	Summary of Provision	How and Where Considered in the Offshore ES
United Nations Convention on the Law of the Sea (UNCLOS) (UNCLOS, 1982)	UNCLOS defines the rights and responsibilities of all nations with respect to their use of the sea throughout the world. Article 60(7) states "*Artificial islands, installations and structures and the safety zones around them may not be established where interference may be caused to the use of recognised sea lanes essential to international navigation*".	UNCLOS is considered fully throughout this ES chapter. Particular regard is given to internationally recognised sea lanes (main commercial routes) which are considered a key element of the shipping and navigation baseline presented in Section 9.7 and have been considered when assessing the significance of impacts in Section 9.11.
Submarine Telegraph Act (UK Government, 1885)	An Act to carry into effect an International Convention for the Protection of Submarine Telegraph Cables. Article II states *"It is a punishable offence to break or injure a submarine cable, wilfully or by culpable negligence, in such manner as might interrupt or obstruct telegraphic communication, either wholly or partially, such punishment being without prejudice to any civil action for damages."* *This provision does not apply to cases where those who break or injure a cable do so with the lawful object of saving their ship, after they have taken every necessary precaution to avoid so breaking or injuring the cable.*	This has been taken into consideration in the assessment of impact from anchors or fishing gear in Section 9.11.

Relevant Legislation	Summary of Provision	How and Where Considered in the Offshore ES
Convention on International Regulations for Preventing Collisions at Sea (COLREGs) (IMO, 1972/78)	The COLREGs define the rules which must be adhered to *by all vessels navigating internationally.* Rule 8 Part (a) states *"Any action taken to avoid collision shall be taken in accordance with the Rules of this Part and shall, if the circumstances of the case admit, be positive, made in ample time and with due regard to the observance of good seamanship."* Rule 19 Part (b) states *"Every vessel shall proceed at a safe speed adapted to the prevailing circumstances and conditions of restricted visibility A power-driven vessel shall have her engines ready for immediate manoeuvre."*	The COLREGs in full are considered throughout this ES chapter with particular regard to collision avoidance (Rule 8) and conduct of vessels in restricted visibility (Rule 19) when considering collision risk in the impact assessment contained within Section 9.11.
Chapter V, Safety of Navigation, of the Annex to the International Convention for the Safety of Life at Sea (SOLAS) (IMO, 1974)	SOLAS Chapter V is an international agreement that sets basic minimum criteria for all seafarers, dependent on the *size and type of vessel.* Regulation 33 states *"The master of a ship at sea which is in a position to be able to provide assistance on receiving a signal from any source that persons are in distress at sea, is bound to proceed with all speed to their assistance"*	SOLAS Chapter V in full is considered throughout this ES chapter with particular regard to rendering assistance to persons in distress (Regulation 33) and passage planning (Regulation 34) when considering anchor interaction with subsea cables and emergency response capability in the impact assessment contained within Section 9.11.

9.5 Consultation

A summary of the key issues raised during consultation undertaken to date specific to Shipping and Navigation is presented in Table 9.3 below, together with how these issues have been considered in the production of this Offshore ES chapter. Further detail is presented within the NRA (Anatec Limited and RPS Group, 2023).

Table 9.3: Summary of Key Consultation of Relevance to Shipping and Navigation

Date	Consultee and type of response	Issue raised	Response to issue raised and/or where considered in this chapter
27/01/2023	OPRED – Scoping Opinion	Section 3.5: Offshore Construction Phase - Offshore Power and Fibre Optic (FO) Cables. Clarification regarding the target cable burial depth is requested. It is advised that, if a minimum cable burial depth cannot be met due to ground condition, the cable should (generally) be protected by rock armouring in order to reduce the risk of navigational hazards.	Cables are anticipated to be buried to a target depth of between 2-3m, as per Section 9.8.1. Where burial is not possible, such as at cable crossings, external protection is to be deployed in line with the findings of a Cable Burial Risk Assessment (CBRA) (see Section 9.10).
		The Proposed Development area for the Project carries a significant amount of through traffic to major ports, with a number of important international shipping routes in close proximity. The Developer is required to take into consideration any changes in vessel routing,	The vessel traffic baseline has been characterised in Section 9.7. Vessel displacement has been considered in Section 9.11.1, with local port access assessed in Section 9.11.4. Due to the proposed development largely coinciding

Date	Consultee and type of response	Issue raised	Response to issue raised and/or where considered in this chapter
		particularly in heavy weather, to ensure shipping can continue to make safe passage without large-scale deviations. Any reduction in navigable depth should be referenced to chart data.	with existing infrastructure, it is not anticipated that significant deviation will be required, with deviations mostly being temporary, localised deviations during the construction phase.
		The Navigational Risk Assessment should establish how the phases of the Project are managed to a point where risks are reduced and considered to be 'as low as reasonably practicable' (ALARP).	The FSA methodology is described in Section 9.9, with embedded mitigation measures used to reduce the risks to ALARP outlined in Section 9.10.
		It noted that the ES will consider the potential impacts of the construction, operation and maintenance and decommissioning phases of the Project and will follow the IMO Formal Safety Assessment methodology. The ES should provide details on the possible impacts of navigational issues for both commercial and recreational craft specifically: i. Collision Risk; ii. Navigational Safety; iii. Risk Management and Emergency response including potential impacts to search and rescue (SAR) and emergency response in the area to ensure there are no impacts on SAR operations; iv. Marking and lighting of site and information to mariners; v. Effect on small craft navigational and communication equipment; vi. The risk to drifting recreational craft in adverse weather or tidal conditions; and vii. The likely squeeze of small craft into the routes of larger commercial vessels."	The listed impacts have been assessed within Section 9.11, with impacts assessed for all three phases of the Proposed Development. Impacts have been assessed following the IMO FSA as outlined in Section 9.9.
		A safe realistic under keel clearance (UKC) assessment should be undertaken for the maximum drafts of vessels, both observed and anticipated. A link to The Maritime and Coastguard Agency (MCA) Under Keel Clearance Policy is provided in Annex 2.	Under keel clearance has been assessed within the impact assessment presented in Section 9.9. If areas are identified where water depth reduction may exceed 5%, a detailed draught assessment will be carried out post-consent to determine any safety risk to navigation.
		The Developer should ensure that any cables which need to be buried meet the appropriate burial depth and that evidence of this is	Cables are expected to be buried to a target depth of 2-3 m. Cable burial and protection will be informed by CBRA (see Section 9.10).

Date	Consultee and type of response	Issue raised	Response to issue raised and/or where considered in this chapter
		provided by completing a Burial Protection Index study.	
		Subject to the traffic volumes, the Developer should note that an anchor penetration study may also be necessary. If cable protection measures are required (rock bags or mattresses), the MCA is willing to accept a 5% reduction in surrounding reference depths referenced to Chart Datum. This will be particularly relevant where depths are decreasing towards shore and potential impacts on navigable water increase. Where this is not achievable, the Developer must discuss this further with the MCA and Trinity House.	Suitable cable burial and/or external protection will be informed by a CBRA as noted in Section 9.10. Following surveys, if it is identified that additional protection is required and the MCA condition of no more than 5% reduction in water depth is exceeded, a review of impacts on shipping local to the affected area will be carried out. Consultation with the MCA and Trinity House will also be carried out as per MGN 654.
		It is advised that no effects are scoped out of the ES assessment with regards to shipping and navigation pending the outcome of the Navigational Risk Assessment (NRA) and further stakeholder consultation.	No effects were scoped out of the assessment with regards to shipping and navigation, which is presented in Section 9.11.
26/06/2023	RYA – Consultation meeting	RYA are content with the NRA methodology, impacts, consultees, and mitigation measures presented.	Noted that RYA are content with the approach.
		It was noted that the local recreational users are unlikely to have any issues with the Proposed Development.	Noted that the Proposed Development is unlikely to cause issues for recreational users in the area.
27/06/2023	Port of Liverpool – Consultation meeting	It was noted that the baseline presented aligned with the experience of the Port of Liverpool in the area, noting that wind farm vessels cross the Rock Channel out of the Mersey broadcasting as passenger vessels.	Wind farms vessels are represented appropriately within the baseline assessment in Section 9.7. Noted that the data recorded is in agreement with local experience.
		It was noted that ferry operators may be a useful consultee. The Port of Liverpool offered to disseminate information to ferry operators.	Noted. Ferry operators will be informed of the works via the Port of Liverpool and local Notices to Mariners (Section 9.10).
		It was noted that dredging takes place constantly within the Queen's Channel, however the TSS lies outside the port limits and is not dredged.	Dredging activity has been noted in the traffic baseline presented in Section 9.7.
		It was recommended that use of Liverpool pilots could be considered for the project vessels as they form a liaison with vessel traffic. Local notices to mariners can also be issued by the port.	Liaison with local ports and harbours and promulgation of information via local notices to mariners are noted as embedded mitigation as listed in Section 9.10.

Date	Consultee and type of response	Issue raised	Response to issue raised and/or where considered in this chapter
		Part of the Proposed Development lies within the Port of Liverpool limits and will require liaison with the port.	Liaison with local ports and harbours is noted as an embedded mitigation as listed in Section 9.10.
		No concerns were raised with the Proposed Development or the proposed methodology for the assessment, noting that much of the infrastructure coincides or replaces existing infrastructure.	Noted that no concerns were raised with the methodology presented.
29/06/2023	MCA – Consultation meeting	The RYA Coastal Atlas was recommended as a data source to inform on recreational traffic.	Consultation was undertaken with the RYA to inform the NRA, with no concerns raised regarding recreational vessels in the area. Therefore AIS was considered sufficient to inform on recreational activity in the area.
		The MCA queried whether decommissioning works at the existing Douglas complex were included within the scope of the assessment.	Douglas decommissioning works are subject to a separate permit process and are not included within the scope of the NRA. Consideration has been given to the overlapping timescales, with the existing Douglas complex and the proposed Douglas CCS platform expected to be on site at the same time for a period of time.
		The MCA raised no concerns with the NRA methodology, impacts or mitigation measures presented.	Noted that the MCA accept the methodology, impacts and mitigation measures presented.
29/06/2023	Trinity House – Consultation meeting	Trinity House noted that the platform lighting and marking falls under the remit of the Standard Marking Schedule as opposed to IALA guidance.	Suitable lighting and marking will be in place on the Douglas CCS platform in accordance with the Standard Marking Schedule and in agreement with Trinity House, as noted in Section 9.10.
		Trinity House raised no concerns with the NRA methodology, impacts or mitigation measures presented.	Noted that Trinity House accept the methodology, impacts and mitigation measures presented.
29/06/2023	Port of Mostyn – Consultation meeting	Port of Mostyn raised no concerns with the NRA methodology, impacts or mitigation measures presented.	Noted that the Port of Mostyn accept the methodology, impacts and mitigation measures presented.
		It was noted that there are several wind farm projects being developed in the area and the Port of Mostyn may see an increase in the vessels associated with these, including potentially construction vessels.	Future wind farm developments and potential resultant changes to the vessel traffic baseline are noted in Section 9.7.5 and considered in the cumulative assessment (Section 9.12).
29/06/2023		It was noted that the project boundaries for offshore wind farms	Possible changes to planned wind farm boundaries are

Date	Consultee and type of response	Issue raised	Response to issue raised and/or where considered in this chapter
	UK Chamber of Shipping – Consultation meeting	in the planning phase may differ from the as-built footprint of arrays.	noted in the discussion of the future traffic baseline detailed in Section 9.7.5.
		It was noted that the construction of wind farms in the area may lead to significant traffic deviations and alter the existing traffic baseline.	Noted in the future traffic baseline presented in Section 9.7.5 that traffic patterns may change in response to the construction of offshore wind farms. Traffic deviations considered in the cumulative assessment (Section 9.12)
		The Chamber queried whether the proposed Douglas CCS platform would qualify for an automatic 500 m safety zone, but noted that they would support.	It is assumed that a new 500m safety zones will be established around the new Douglas platform as part of the embedded mitigation measures listed in Section 9.10.
		Disruption to the Liverpool Bay TSS during the construction phase was noted to be the primary concern for the Chamber, given that the as-built project would have minimal differences to existing infrastructure.	Vessel deviations and reduced access to local ports and harbours has been assessed within the impact assessment presented in Section 9.11. Disruption to the Liverpool Bay TSS is expected to be very short-term and localised due to the speed of the cable-lay activities.
		The Chamber raised no concerns with the NRA methodology, impacts or mitigation measures presented.	Noted that the Chamber accept the methodology, impacts and mitigation measures presented.

9.6 Methodology to Inform the Baseline

9.6.1 Data Sources

Information on the shipping and navigation baseline was collected though a detailed desktop review of currently accessible studies and datasets. The baseline has been established though the use of data on vessel traffic, navigational features and historical incident data in proximity to the Proposed Development. Key data sources are listed in Table 9.4.

Table 9.4: Summary of Key Data Sources

Title	Source	Description
12 Months AIS Data (January – December 2022)	12 Months AIS Data (January – December 2022)	Characterising vessel traffic movements within the study area
Navigational Features	Admiralty nautical charts 1978 & 1826 (UKHO, 2023)	Characterising other navigational features in the proximity to the proposed development
	Admiralty Sailing Directions NP37 "*West Coasts of England and Wales Pilot*" (UKHO, 2022)	

Title	Source	Description
Wind Farm Boundaries and Agreements	GIS for wind farms within England and Wales, The Crown Estate (TCE) 2023 (TCE, 2023)	Characterising wind farm boundaries and agreements in proximity to the proposed development
Maritime Incident Data	Marine Accident and Investigation Branch (MAIB) incident data, 2012-2021	Review of maritime incidents in proximity to the proposed development
	Royal National Lifeboat Institution (RNLI) incident data, 2013-2022	
	Department for Transport (DfT) UK civilian SAR helicopter taskings (April 2015 – 2022)	
Additional Fishing Data	Vessel Monitoring System (VMS) satellite fishing data 2020, MMO	Provide further information on fishing activities in proximity to the proposed development

9.6.2 Data Assumptions and Limitations

9.6.2.1 AIS Data

The carriage of AIS is required on board all vessels of greater than 300 Gross Tonnage (GT) engaged on international voyages, cargo vessels of more than 500 GT not engaged on international voyages, passenger vessels irrespective of size built on or after 1 July 2002, and fishing vessels over 15 m LOA.

When using the AIS dataset, it has been assumed that any vessels under an obligation to broadcast information via AIS have done so. It has also been assumed that those details broadcast via AIS (such as vessel type and dimensions) are accurate unless clear evidence to the contrary was identified. There may be occasional range limitations in tracking certain vessels, especially smaller (Class B AIS) vessels in winter. However the limitations of the AIS data are not considered to compromise confidence in the assessment.

Since the vessel traffic data includes only AIS data, there are limitations associated with vessels not broadcasting on AIS. However, the MCA and Trinity House were content with the methodology and data sources, including the use of additional data sources such as VMS data and consultation feedback. The AIS data, complemented by the additional data sources, is considered to be suitably comprehensive and adequate for the assessment.

Military vessels are not required to broadcast on AIS and may therefore be under-represented.

9.6.2.2 Historical Incident Data

Although all UK commercial vessels are required to report incidents to the MAIB, this is not mandatory for non-UK vessels unless they are in a UK port, within territorial waters or carrying passengers to a UK port. There are also no requirements for non-commercial recreational craft to report incidents to the MAIB. Nevertheless, the MAIB incident database is considered to be a suitable source for the characterisation of historical incidents and adequate for the assessment.

9.6.2.3 Admiralty Charts

The Admiralty Charts published by the UKHO are updated periodically, and therefore the information shown may not be reflective of real-time features within the shipping and navigation study area with complete accuracy. Taking into account that that the consultees include local port authorities, the characterisation of navigational features is considered to be suitably comprehensive and adequate for the assessment. Only those aids to navigation which are charted and considered key to the establishing the shipping and navigation baseline are shown.

9.7 Existing baseline description

9.7.1 Overview of Baseline Environment

A summary of the shipping and navigation baseline is provided in the following sections. Further detailed analysis of the baseline is provided within the NRA (Anatec Limited and RPS Group, 2023).

9.7.2 Navigational Features

This section presents an overview of the navigational features in proximity to the Proposed Development. The key navigational features are presented in Figure 9.2. Navigational features are presented in separately in more detail within the NRA (Anatec Limited and RPS Group, 2023).

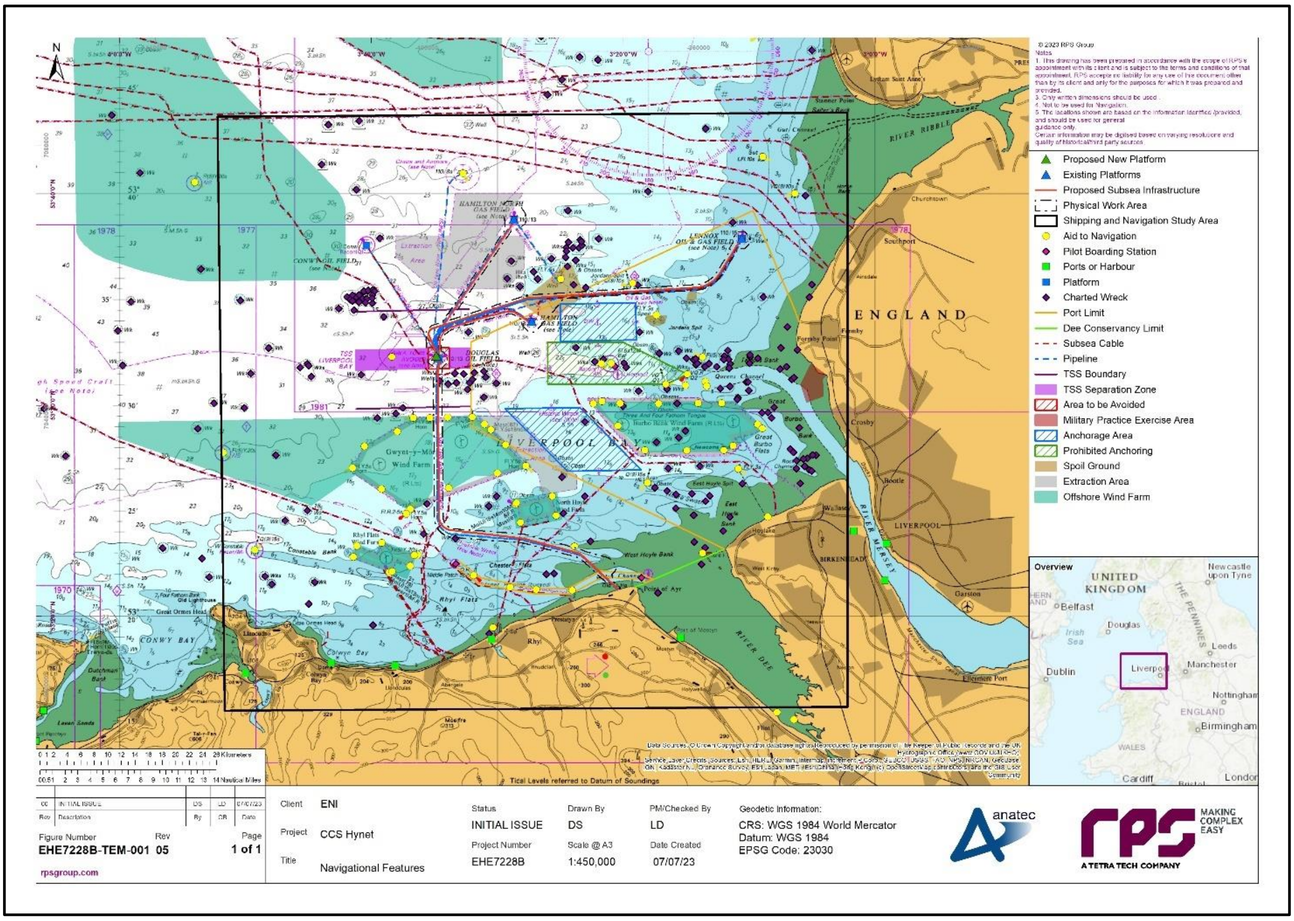

Figure 9.2: Navigational Features

The proposed Douglas CCS platform associated with the Proposed Development lies within the existing safety zone at the existing Douglas complex, located 200 m north of the accommodation platform. This safety zone also lies within an Area to be Avoided and is inside the separation zone of the Liverpool Bay TSS. The westbound lane of the TSS lies to the north of the Douglas location, with the westbound lane to the south. The Liverpool Bay TSS is a key thoroughfare used by vessels visiting ports within the River Mersey, accessed via the Queen's Channel.

Ports within the Mersey include the Port of Liverpool, which is made up of several facilities including container docks, tanker facilities and passenger ferry terminals. The port limits of the Port of Liverpool extend into Liverpool Bay, with the western limit defined by the eastern edge of the Liverpool Bay TSS. The limits therefore encompass the existing platforms at Lennox and Hamilton, and part of the cable routes which form part of the Proposed Development. The Mersey also serves as the access to the Manchester Ship Canal, which houses terminals accommodating cargoes ranging from aggregates, animal feed, biomass and wind turbine components.

The other significant port limit in the shipping and navigation study area is the Port of Mostyn limit, which extends out from the River Dee. Mostyn is accessed via the Welsh Channel, with the port limits extending beyond the Dee Conservancy limits to encompass the channel. The Welsh Channel is crossed by the Proposed Development close to the landfall at Point of Ayr.

Charted anchorages are located within the Port of Liverpool limits, with three deep water anchorage berths located 0.5 nm south of the cable route to Lennox, with a prohibited anchoring zone neighbouring this to the south. A further nine anchor berths are located south of this, between the Burbo Bank and Gwynt y Môr wind farms. These anchorages are typically used by commercial vessels such as cargo vessels and tankers, many of which are awaiting pilotage through the Queen’s Channel to the Port of Liverpool.

There are six offshore wind farm projects in proximity to the Proposed Development, with four of these already constructed: Burbo Bank, North Hoyle, Rhyl Flats and Gwynt y Môr. The proposed cable route between Douglas and the landfall passes through the Gwynt y Môr wind farm, crossing the inter-array cables. The Gwynt y Môr wind farm is expected to be extended to the west by the Awel y Môr wind farm, for which the consent application has been submitted. The Mona wind farm boundary is located 5 nm to the north-west of the Proposed Development, and is in the pre-planning phase. Similarly, the Morecambe wind farm is located 6 nm to the north of the Hamilton North platform.

There are numerous subsea cables in the area. The included export cables associated with the offshore wind farms, including the Burbo Bank, North Hoyle and Gwynt y Môr cables which are crossed by the Proposed Development. The Proposed Development also cross the Western Link power cable which runs from Hoylake to Ireland. There are a number of cables running from the English coast to Ireland and the Isle of Man located to the north of the Proposed Development. Existing pipelines in the area run in similar routes to the cables associated with the Proposed Development, and are planned to be repurposed.

There are a number of aids to navigation (AtoN) and charted wrecks in proximity to the Proposed Development. AtoN include the Hamilton OSU in the north of the shipping and navigation study area, which is marked as an AtoN, buoys marking pilot boarding stations for Mostyn and Liverpool, and peripheral structures associated with the various wind farms in the area. There is one charted wreck within the Physical Work Area, 1.2 nm to the south of the proposed Douglas platform.

9.7.3 Emergency Response Resources and Historical Incident Review

This section summarises the existing emergency response resources and historical incident data in proximity to the Proposed Development.

SAR helicopter provision is provided by Bristow Group on behalf of HMCG from 10 base stations around the UK. The closest station to the Proposed Development is at Caernarfon, 32 nm to the southwest, which responded to the majority of taskings within the shipping and navigation study area. Other responding stations included Humberside (100 nm to the east), St Athan (120 nm to the south) and Lee on Solent (174 nm) to the southeast. Between 2015 and 2022, 153 helicopter taskings were recorded within the shipping and navigation study area. These were primarily in coastal areas, primarily along the Welsh coast south of the Proposed Development.

The HMCG coordinates SAR operations through a network of 11 Maritime Rescue Coordination Centres (MRCC), including a Joint Rescue Coordination Centre (JRCC) based in Hampshire.

All of the MCA’s operations, including SAR, are divided into 18 geographical regions. The proposed development is within Area 15: “Great Orme to West Scottish Border including the Lakes”. The closest MRCC to the proposed development is at Holyhead, located approximately 40 nm to the west. It is noted that incident response is not necessarily coordinated by the nearest MRCC, as operators may be unavailable and calls re-routed to another MRCC.

The location of the RNLI stations in proximity to the Proposed Development, along with the incidents recorded between 2013 and 2022 are presented in Figure 9.3. The RNLI operate a fleet of more than 350 lifeboats out of more than 230 stations across the UK and Ireland, with several of these located close to the Proposed Development. The Rhyl station responded to 34% of callouts within the shipping and navigation study area, with New Brighton (14%), Llandudno (13%), Conwy (13%) and Hoylake (11%) also responding to a significant proportion. Over the ten-year period, there were an average of 158 callouts per year within the shipping and navigation study area, with these largely concentrated along the coastline. The most common incident type responded to by the RNLI was "Person in Danger", which accounted for 37%, followed by machinery failures (16%). Common casualty types, alongside "Person in Danger" incidents, were recreational vessels (25%) and personal craft (10%). Six incidents were recorded within the Physical Work Area, with three "person in danger" incidents and three machinery failures.

All UK flagged vessels and non-UK flagged vessels in UK territorial waters (12 nm), a UK port or carrying passengers to a UK port are required to report incidents to the MAIB. Over the ten year period, there was an average of 12 to 13 incidents per year recorded within the study area. The most common incident types were machinery failures (22%), "Accident to Person" (19%) and grounding/stranding incidents (18%). The most common type of vessel involved in incidents was "other commercial", which includes vessels such as workboats, dredgers, SAR craft and tugs, and accounted for 35% of incidents recorded by the MAIB. Cargo vessels (22%), service ships (15%) and recreational craft (11%) also accounted for a significant number of incidents within the study area.

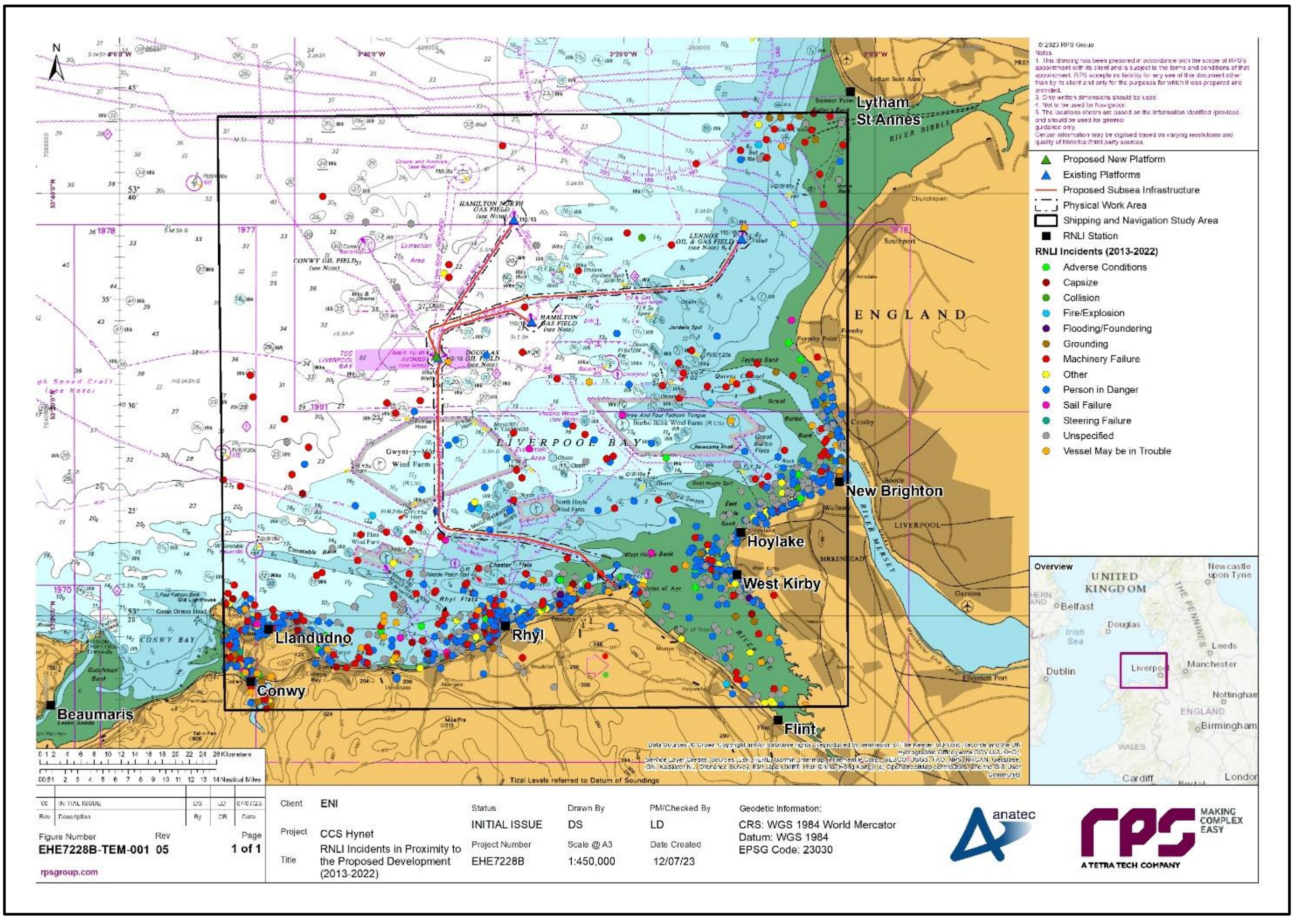

Figure 9.3: RNLI Stations and Incidents in Proximity to the Proposed Development

9.7.4 Vessel Traffic Overview

The vessel traffic baseline within the shipping and navigation study area has been identified from 12 months of AIS data, covering the entirety of 2022.

A plot of the vessel tracks recorded on AIS within the shipping and navigation study area is presented in Figure 9.4. It is noted that a number of tracks have been classified as temporary or non-routine and have been removed. These included vessels undertaking surveys, including unmanned survey vessels and vessels undertaking guard duty. Vessels which remained stationary in port, or alongside oil & gas installations and wind turbines have also been removed from the analysis to ensure that a fair representation is given to typical vessel traffic movements in the area.

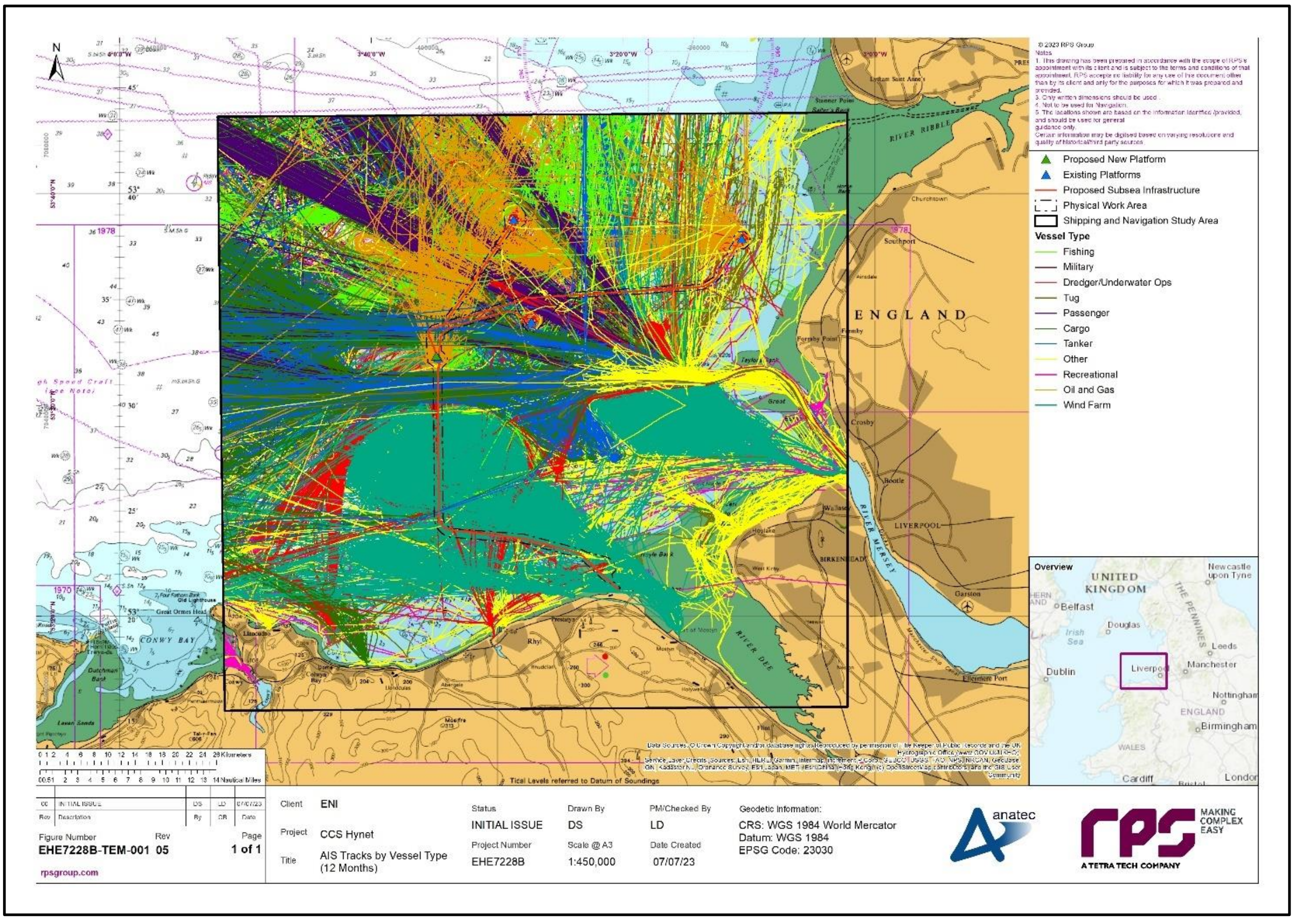

Figure 9.4: AIS Tracks by Vessel Type – (12 Months)

Figure 9.6 presents the average daily vessel count within the study area and within the Physical Work Area, presented using unique vessels per day[1].

[1] Vessels are only counted once per day in order to avoid over-counting of vessels due to exiting and re-entering the study area or broken AIS tracks

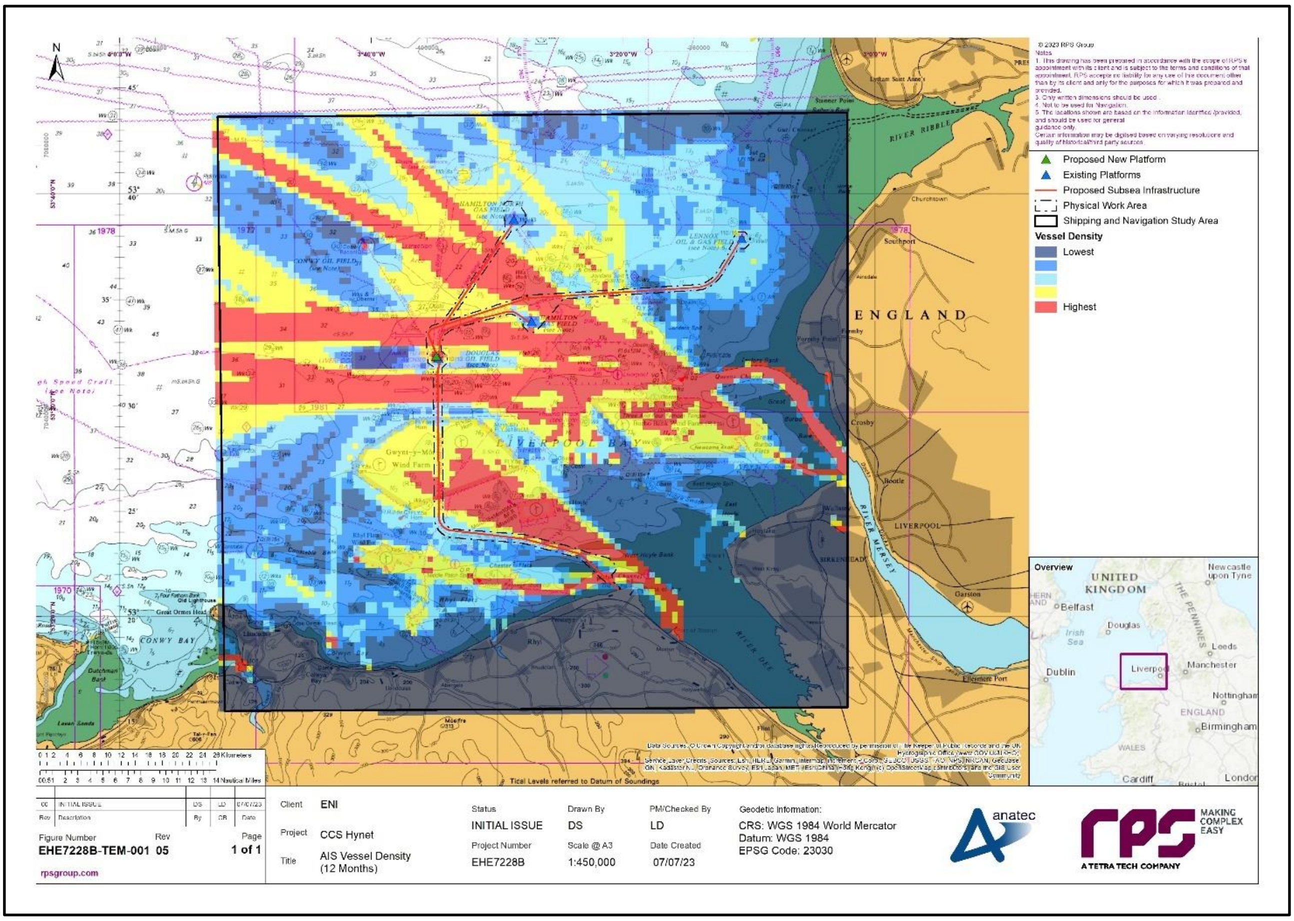

Figure 9.5: AIS Vessel Density – (12 Months)

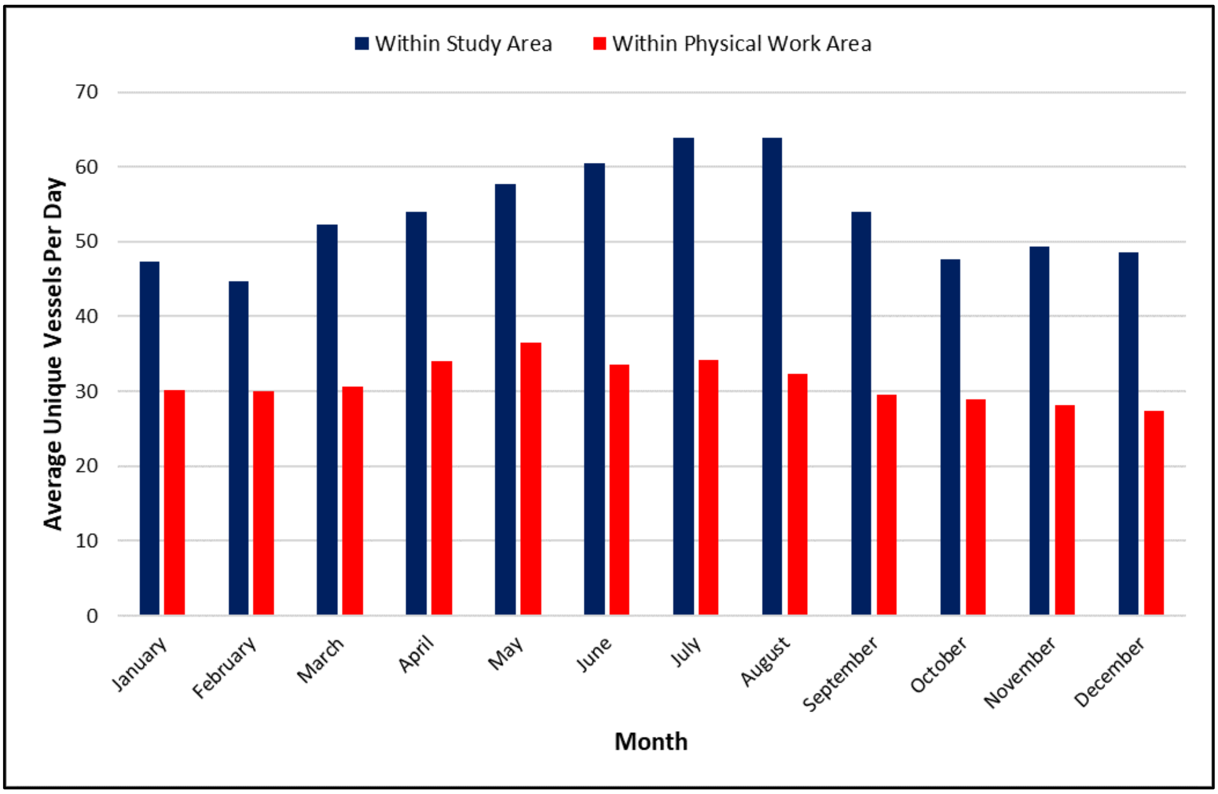

Figure 9.6: Average Daily Vessel Count per Month (2022)

There was an average of 54 vessels per day within the study area, with July being the busiest month, when an average of 64 vessels per day were recorded. The quietest month was February, when an average of 45 vessels per day were recorded. The difference in vessels counts can be attributed largely to recreational activity in the summer months, while passenger and wind farm vessels were also more frequent over the summer. Within the Physical Work Area, there were an average of 31 unique vessels per day, with the most vessels recorded in May with 36 vessels per day, compared with a low of 27 unique vessels per day in December.

The vessel density heatmap presented in the NRA (Anatec Limited and RPS Group, 2023) highlights the high density areas of traffic within the study area. High density regions included the Queen's Channel, which serves as the main access route to the ports within the River Mersey including Liverpool and the Manchester Ship Canal, the Liverpool Bay TSS which channels the traffic to the north and south of the proposed location of the Douglas CCS platform, as well as the various wind farms in the area and their associated vessel routes. Main vessel routes used by cargo vessels, tankers and passenger vessels heading to Ireland also form high density routes towards the northwest of the study area. It was noted during consultation that the Port of Liverpool carries out frequent maintenance dredging of the Queen's Channel, further contributing to this high density area.

The most common vessel type recorded in the shipping and navigation study area was cargo vessels, accounting for 29% of unique vessels per day recorded in the area, followed by wind farm vessels (18%) and tankers (17%). Cargo vessels and tankers tended to be recorded on the main commercial routes as highlighted by the density heatmap, while wind farm vessels were typically recorded close to the coastline, and were recorded on transit to or within the various wind farms in the study area, including Gwynt-y-Môr, Burbo Bank and Rhyl Flats.

On average, there were 16 cargo vessels and 9 tankers recorded within the shipping and navigation study area per day. Common destinations for these vessels included Liverpool and other ports within the Mersey, Belfast, Dublin, Antwerp and Rotterdam. The majority of these vessels were recorded utilising the Liverpool Bay TSS, while the anchorages close to the entry to the Queen’s Channel were also regularly used by commercial vessels.

The average length of vessels recorded within the shipping and navigation study area throughout 2022 was 91m, with the largest vessel being a 349 m container ship, recorded transiting the Liverpool Bay TSS on passage between Liverpool and Antwerp. In general, larger vessels within the shipping and navigation study area were recorded utilising the Liverpool Bay TSS and on well-defined routes to the northwest, including ferry routes to Ireland. Smaller vessels tended to include crew transfer vessels associated with the wind farms, as well as pilot vessels, and therefore are largely seen inshore of the Douglas platform location. Wind farm vessels based in the Port of Mostyn, transiting to the Rhyl Flats and Gwynt-y-Môr wind farms.

The average vessel draught recorded in the shipping and navigation study area was 4.5m, with the deepest being 14m, recorded by a crude oil tanker visiting Liverpool via the Liverpool Bay TSS and the Queen’s Channel on passage from Algeria. Traffic patterns by draught were largely similar to those by length, with the deepest draught vessels typically using the main routes through the area, such as the TSS and the Queen’s Channel, while shallower draught vessels were recorded throughout the study area, particularly around the wind farms and near shore areas.

DWT traffic patterns were similar, with the largest vessels typically transiting via the well-defined routes through the shipping and navigation study area, and smaller vessels recorded more widely throughout the area. The average DWT recorded was 8,644, with the largest being a crude oil tanker recorded visiting Tranmere, with a DWT of 164,608.

The fastest vessels recorded in the study area tended to be the vessels on regular passenger routes, as well as wind farm vessels while on passage between the wind farms and Port of Mostyn. Slower vessels tended to include fishing vessels, wind farm vessels located within the wind farms and oil and gas vessels in proximity to installations in the north of the study area. The average speed of vessels recorded in the study area was 8.0 knots, with the highest being 35.8 knots by a lifeboat working close to shore.

There were seven to eight unique vessels per day recorded at anchor within the shipping and navigation study area. A significant proportion of the anchored vessels were concentrated within the charted anchorage areas located between the Gwynt y Môr and Burbo Bank wind farms. A large number of wind farm vessels were also recorded at anchor around the boundaries of the two wind farms, particularly at Gwynt y Môr. The most common type of anchored vessels were tankers (45%), followed by cargo vessels (29%) and wind farm vessels (22%).

On average, one fishing vessel was recorded per day within the study area. April was the busiest month in terms of fishing activity, with three unique vessels per day recorded on average. Common gear types recorded within the study area included dredgers (40%), potter/whelkers (39%) and beam trawlers (13%). Fishing activity was most common in the north of the study area, with some potting activity recorded within the Gwynt y Môr wind farm.

In addition to AIS, VMS satellite data for 2020 was reviewed to inform on fishing vessel movements. Fishing density as reported by the MMO showed a good correlation between with the baseline as established using AIS data.

Throughout 2022 two unique recreational vessels per day were recorded within the study area. Recreational activity was highest during the summer, peaking at seven unique vessels per day in August, with very little recreational activity recorded in the winter, noting that recreational vessels tend to be under-represented on AIS due to carriage requirements. Recreational activity was primarily associated with either the Mersey ports, or with Conwy Bay in the southwest of the study area. Recreational vessels on passage were also recorded, particularly in the western extent of the study area. The majority (96%) of recreational vessels recorded within the study area were UK-registered.

9.7.5 Future Baseline Scenario

An assessment of the factors which may impact the future shipping has been carried out and is described within this section.

The key impact on vessel routeing in the area is expected to be the construction of a number of wind farms in the area. In particular, Mona, Morgan and Morecambe wind farms, if consented, have the potential to significantly alter routes visiting the Mersey ports, particularly routes (including ferry routes) to Ireland. It is noted that all of these wind farms are in the pre-planning phase and will be subject to their own consenting process and boundaries therefore have the potential to differ significantly from any finally constructed projects. The Awel y Môr wind farm, located to the west of the Gwynt y Môr, may also displace existing traffic into the Liverpool Bay TSS. It was noted during consultation that these may also lead to an increase in wind farm vessels utilising the Port of Mostyn, including construction vessels. In line with industry experience, commercial vessels are expected to maintain a minimum mean distance of 1 nm from wind farm structures. There is potential for smaller vessels, such as fishing vessels and recreational vessels to pass within wind farms.

Port arrival statistics from the Department for Transport (DfT, 2022) covering the period from 2017 to 2021 for key ports within or accessed via the Mersey (Liverpool, Manchester and Garston) to determine trends in shipping in the recent years. Vessel arrivals for the three ports are shown in Figure 9.7.

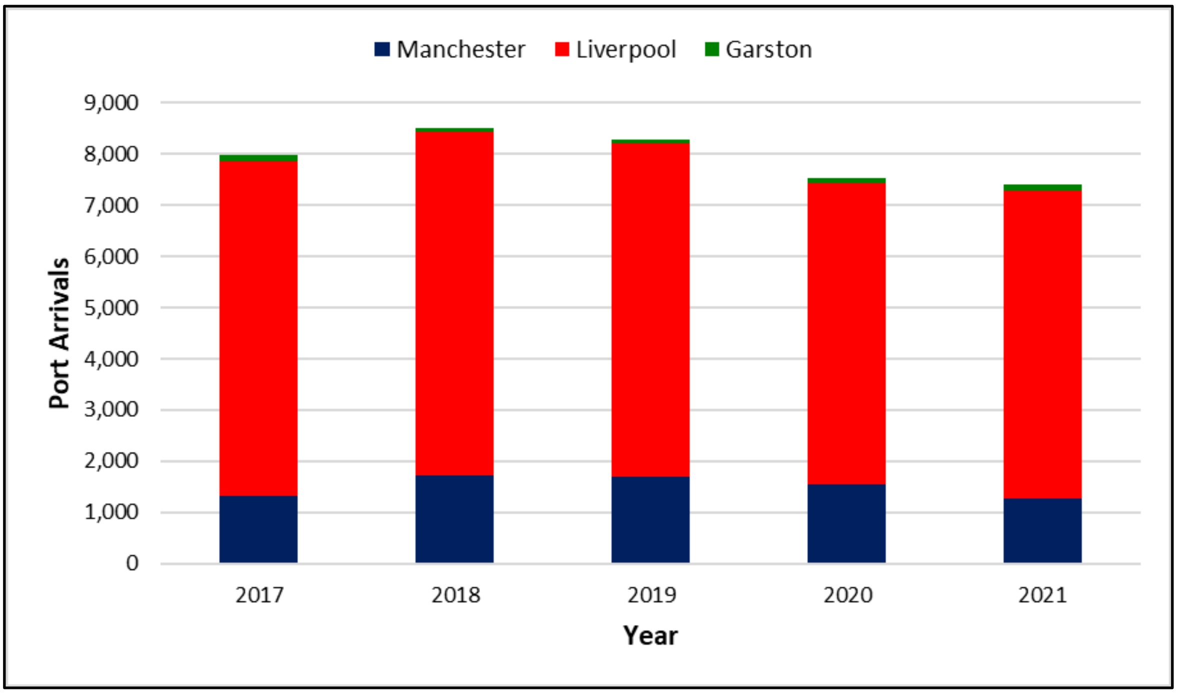

Figure 9.7: Port Arrivals 2017 – 2021

Port arrivals at all three ports has declined by 8% since 2017, noting that there is potential for this to have been impacted by Brexit and the COVID-19 pandemic. Manchester arrivals have declined by 3%, with Liverpool and Garston seeing a 9% and 16% decline respectively. Overall, this decline equates to approximately 600 fewer arrivals in 2021 compared with 2017. Vessel arrivals peaked in 2018, with approximately 8,500 arrivals between the three ports.

The Port of Liverpool and the Manchester Ship Canal are operated by Peel Ports, who have plans to invest £200m in sustainable port infrastructure projects by Summer 2024. There are currently no detailed plans on expansion at either of the Liverpool or Manchester. In 2016, Liverpool saw the completion of the Liverpool2 container terminal, which increased the port's ability to handle the largest container ships. Garston is operated by Associated British Ports, and recently underwent enhancement to the dry bulk storage offering at the port.

Fishing trends are difficult to project into the future, noting that trends are dependent on numerous factors including fish stocks and quotas. Changes to legislation following Brexit may also impact the size and make-up of the fishing fleet in UK waters.

Recreational activity can be similarly difficult to predict, but is assumed to remain similar or slightly increase in future years. Similarly the make-up of recreational traffic may vary, with sail and electric-powered vessels expected to become more prominent in place of diesel-fuelled craft. The locations of recreational activity may also vary, while volume of activity may be dependent on other factors such as the weather, climate change and the economy.

9.8 Key Parameters for Assessment

9.8.1 Maximum Design Scenario

A range of potential project impacts on shipping and navigation have been identified which could potentially occur during the construction, operation and maintenance, and decommissioning phases of the Proposed Development.

Impacts that have been scoped into the assessment are outlined in Table 9.5 along with the identified maximum design scenarios. The maximum design scenarios have been selected as those having the potential to result in the greatest effect on an identified user or user group. These scenarios have been selected from the details provided in volume 1, chapter 3 of the of the Offshore ES. Effects of greater adverse significance are not predicted to arise should any other development scenario, based on details within the Project Design Envelope (PDE) (e.g. different infrastructure layout), to that assessed here, be taken forward in the final design scheme.

Table 9.5: Maximum Design Scenario Considered for Each Impact as Part of the Assessment of Likely Significant Effects on Shipping and Navigation

Potential Impact	Phase C	Phase O&M	Phase D	Maximum Design Scenario	Justification
Vessel displacement leading to increased vessel to vessel collision risk between third-party vessels	✓	✓	✓	**Construction Phase** • Cable installation expected to take up to two months • Douglas CCS Platform installation is expected to take up to five months • Maximum of 2 HLV on site making up to 4 return trips • Maximum of 2 jack-up vessels on site making up to 4 return trips • Maximum of 17 tug/anchor handlers making up to 22 return trips • Maximum of 12 cargo barges making up to 17 return trips • Maximum of 3 dive support/light construction vessels making up to 3 return trips • Maximum of 2 survey vessels making up to 3 return trips • Maximum of 6 crew transfer vessels making up to 216 return trips • Maximum of one cable installation vessel making one return trip • Maximum of 5 support vessels making up to 83 return trips • Maximum of 2 multicats making up to 2 return trips • Maximum of 3 working boats making up to 3 return trips • Maximum of one trench support vessel making one return trip • Maximum of one seabed preparation vessel making one return trip • Maximum of one cable protection installation vessel making one return trip • Maximum of one cable burial installation vessel making one return trip • 500 m advisory safe passing distances around cable installation vessels • 500 m safety zone around the Douglas CCS platform **Operation and Maintenance Phase** • Anticipated operation and maintenance phase lasting 25 years. • Maximum of one jack-up vessel on site at one time, making up to 15 return trips • Maximum of 3 other vessels (multi-purpose support/Inspection, maintenance and repair vessels (IMR)) on site at one time making up to 15 return trips • 500 m safety zone around the Douglas CCS platform	Greatest number of vessels associated with the Proposed Development and greatest duration, resulting in the maximum temporal effect and maximum displacement of third-party vessels, leading to the maximum effect on vessel to vessel collision risk

Potential Impact	Phase C	Phase O&M	Phase D	Maximum Design Scenario	Justification
				• 500 m advisory safe passing distance around cable maintenance vessels during periods of major maintenance **Decommissioning Phase** • It is anticipated that decommissioning works will be similar in terms of the maximum design scenario to the construction phase.	
Increased vessel to vessel collision risk between third-party vessels and project vessels	✓	✓	✓	**Construction Phase** • Cable installation expected to take up to two months • Douglas CCS Platform installation is expected to take up to five months • Overall programme for works at existing platforms expected to take up to four years • Maximum of 2 HLV on site making up to 4 return trips • Maximum of 2 jack-up vessels on site making up to 4 return trips • Maximum of 17 tug/anchor handlers making up to 22 return trips • Maximum of 12 cargo barges making up to 17 return trips • Maximum of 3 dive support/light construction vessels making up to 3 return trips • Maximum of 2 survey vessels making up to 3 return trips • Maximum of 6 crew transfer vessels making up to 216 return trips • Maximum of one cable installation vessel making one return trip • Maximum of 5 support vessels making up to 83 return trips • Maximum of 2 multicats making up to 2 return trips • Maximum of 3 working boats making up to 3 return trips • Maximum of one trench support vessel making one return trip • Maximum of one seabed preparation vessel making one return trip • Maximum of one cable protection installation vessel making one return trip • Maximum of one cable burial installation vessel making one return trip • 500 m advisory safe passing distances around cable installation vessels • 500 m safety zone around the Douglas CCS platform **Operation and Maintenance Phase** • Anticipated operation and maintenance phase lasting 25 years. • Maximum of one jack-up vessel on site at one time making up to 15 return trips	Greatest number of vessels associated with the Proposed Development and greatest duration, resulting in the maximum temporal effect, on vessel to vessel collision risk involving a project vessel and third-party vessel.

Potential Impact	Phase			Maximum Design Scenario	Justification
	C	O&M	D		
				• Maximum of 3 other vessels (multi-purpose support/IMR vessels) on site at one time making up to 15 return trips • One mobile offshore drilling unit (MODU) anticipated on site for well operations every 10 years **Decommissioning Phase** • It is anticipated that decommissioning works will be similar in terms of the maximum design scenario to the construction phase.	
Vessel to platform allision risk	×	✓	×	**Operation and Maintenance Phase** • Anticipated operation and maintenance phase lasting 25 years. • Platform topside dimensions of 76.7 m x 45.6 m	Maximum dimensions and operational lifetime of the Proposed Development resulting in the maximum temporal effect on vessel to platform allision risk.
Reduced access to local ports	✓	✓	✓	**Construction Phase** • Cable installation expected to take up to two months • Douglas CCS Platform installation is expected to take up to five months • Overall programme for works at existing platforms expected to take up to four years • Maximum of 2 HLV on site making up to 4 return trips • Maximum of 2 jack-up vessels on site making up to 4 return trips • Maximum of 17 tug/anchor handlers making up to 22 return trips • Maximum of 12 cargo barges making up to 17 return trips • Maximum of 3 dive support/light construction vessels making up to 3 return trips • Maximum of 2 survey vessels making up to 3 return trips • Maximum of 6 crew transfer vessels making up to 216 return trips • Maximum of one cable installation vessel making one return trip • Maximum of 5 support vessels making up to 83 return trips • Maximum of 2 multicats making up to 2 return trips • Maximum of 3 working boats making up to 3 return trips • Maximum of one trench support vessel making one return trip • Maximum of one seabed preparation vessel making one return trip	Maximum duration of the installation works and operational lifetime of the Proposed Development, utilising the maximum number of project vessels, resulting in the maximum effect on access to local ports.

Potential Impact	Phase C	Phase O&M	Phase D	Maximum Design Scenario	Justification
				• Maximum of one cable protection installation vessel making one return trip • Maximum of one cable burial installation vessel making one return trip • 500 m advisory safe passing distances around cable installation vessels • 500 m safety zone around the Douglas CCS platform **Operation and Maintenance Phase** • Anticipated operation and maintenance phase lasting 25 years. • 500 m safety zone around the Douglas CCS platform. • 500 m advisory safe passing distance around cable maintenance vessels during periods of major maintenance. • One mobile offshore drilling unit (MODU) anticipated on site for well operations every 10 years. **Decommissioning Phase** • It is anticipated that decommissioning works will be similar in terms of the maximum design scenario to the construction phase.	
Anchor interaction with subsea cable	✗	✓	✗	**Operation and Maintenance Phase** • Anticipated operation and maintenance phase lasting 25 years. • 5 subsea cables with a total length of 126 km • Target burial depth of 2-3 m • 42 potential cable crossings with a total cable length of 8.4 km • External rock protection at cable crossings with a maximum height of 0.8 m.	Greatest length of subsea cables and maximum number of cable crossings with external protection giving the maximum potential for anchor interaction.
Fishing gear interaction with subsea cable	✗	✓	✗	**Operation and Maintenance Phase** • Anticipated operation and maintenance phase lasting 25 years. • 5 subsea cables with a total length of 126 km • Target burial depth of 2-3 m • 42 potential cable crossings with a total cable length of 8.4 km	Greatest length of subsea cables and maximum number of cable crossings with external protection giving the maximum potential for fishing interaction.

Potential Impact	Phase C	Phase O&M	Phase D	Maximum Design Scenario	Justification
				• External rock protection at cable crossings with a maximum height of 0.8 m.	
Vessel grounding due to reduced under keel clearance	✗	✓	✗	**Operation and Maintenance Phase** • Anticipated operation and maintenance phase lasting 25 years. • 5 subsea cables with a total length of 126 km • Target burial depth of 2-3 m • 42 potential cable crossings with a total cable length of 8.4 km • External rock protection at cable crossings with a maximum height of 0.8 m.	Greatest length of subsea cables and maximum number of cable crossings with external protection giving the maximum potential for reduced under keel clearance.
Interference with magnetic interference	✗	✓	✗	**Operation and Maintenance Phase** • Anticipated operation and maintenance phase lasting 25 years. • 5 subsea cables with a total length of 126 km • Target burial depth of 2-3 m	Greatest length of subsea cables and maximum temporal impact on magnetic compasses
Reduction of emergency response capability due to increased incident rates for SAR responders and increased demand on the available resources	✓	✓	✓	**Construction Phase** • Cable installation expected to take up to two months • Douglas CCS Platform installation is expected to take up to five months • Overall programme for works at existing platforms expected to take up to four years • Maximum of 2 HLV on site making up to 4 return trips • Maximum of 2 jack-up vessels on site making up to 4 return trips • Maximum of 17 tug/anchor handlers making up to 22 return trips • Maximum of 12 cargo barges making up to 17 return trips • Maximum of 3 dive support/light construction vessels making up to 3 return trips • Maximum of 2 survey vessels making up to 3 return trips • Maximum of 6 crew transfer vessels making up to 216 return trips • Maximum of one cable installation vessel making one return trip • Maximum of 5 support vessels making up to 83 return trips	Greatest length of subsea cables and maximum project vessels on site giving the maximum potential for reduction SAR capability

<table>
<tr><th rowspan="2">Potential Impact</th><th colspan="3">Phase</th><th rowspan="2">Maximum Design Scenario</th><th rowspan="2">Justification</th></tr>
<tr><th>C</th><th>O&M</th><th>D</th></tr>
<tr><td></td><td></td><td></td><td></td><td>
• Maximum of 2 multicats making up to 2 return trips
• Maximum of 3 working boats making up to 3 return trips
• Maximum of one trench support vessel making one return trip
• Maximum of one seabed preparation vessel making one return trip
• Maximum of one cable protection installation vessel making one return trip
• Maximum of one cable burial installation vessel making one return trip
• 500 m advisory safe passing distances around cable installation vessels
• 500 m safety zone around the Douglas CCS platform
Operation and Maintenance Phase
• Anticipated operation and maintenance phase lasting 25 years.
• 500 m safety zone around the Douglas CCS platform
• 500 m advisory safe passing distance around cable maintenance vessels during periods of major maintenance
• One mobile offshore drilling unit (MODU) anticipated on site for well operations every 10 years
Decommissioning Phase
• It is anticipated that decommissioning works will be similar in terms of the maximum design scenario to the construction phase.
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9.8.2 Impacts scoped out of the Assessment

No impacts to shipping and navigation have been scoped out of the assessment.

9.9 Methodology for Assessment of Effects

9.9.1 Overview

The shipping and navigation assessment of effects has followed the FSA methodology since this is the internationally recognised approach for assessing the impact to shipping and navigation users, and is the approach required for the MCA's methodology (Annex 1 of MGN 654). The following guidance documents have been considered:

- MGN 654 (Merchant and Fishing) Safety of Navigation: Offshore Renewable Energy Installations (OREIs) – Guidance on UK Navigational Practice, Safety and Emergency Response and its annexes (MCA, 2021a); and
- Revised Guidelines for FSA for Use in the IMO (International Maritime Organization) Rule-Making Process (IMO, 2018)
- MGN 661 (Merchant and Fishing) Navigation – Safe and Responsible Anchoring and Fishing Practices (MCA, 2008)

It is noted that the assessment therefore differs from the standard EIA Methodology outlined in chapter 5.

9.9.2 Impact Assessment Criteria

The FSA approach is used to assess the risk associated with the hazards identified due to the proposed development, based on baseline data, expert opinion, stakeholder concerns and lessons learnt from existing offshore developments. Embedded mitigation measures which have been identified as relevant to reducing risk are also considered. The risk ranking was undertaken by Anatec during an internal hazard review and ranking, based on extensive consultation with stakeholders, including presentation of identified hazards and proposed mitigation measures, and discussions on any stakeholder concerns. The findings are presented in the Risk Control Log in the NRA (Anatec Limited and RPS Group, 2023).

Determining the significance of effects is a two-step process that involves defining the severity of consequence and the frequency of occurrence. This section describes the criteria applied in the assessment of significance in Section 9.11 to assign values to each of the two factors.

The criteria for defining the severity of consequence are presented in Table 9.6. For the level of assistance required to manage environmental damage, the tiers indicated relate to the incident response matrix provided in the National Contingency Plan (MCA, 2014).

Table 9.6: Severity of Consequence Ranking Definitions

Rank	Description	Definition			
		People	Property	Environment	Business
1	Negligible	No perceptible risk	No perceptible risk	No perceptible risk	No perceptible risk
2	Minor	Slight injury(ies)	Minor damage to property, (i.e. superficial damage)	Tier 1[2] local assistance required	Minor reputational risks – limited to users

[2] Tier 1 – Local (within the capability of one local authority, offshore installation operator or harbour authority

Rank	Description	Definition			
		People	Property	Environment	Business
3	Moderate	Multiple minor or single serious injury	Damage not critical to operations	Tier 2[3] limited external assistance required	Local reputational risks
4	Serious	Multiple serious injuries or single fatality	Damage resulting in critical risk to operations	Tier 2 regional assistance required	National reputational risks
5	Major	More than one fatality	Total loss of property	Tier 3[4] national assistance required	International reputational risks

The criteria for defining the frequency of occurrence of each effect is presented in Table 9.7.

Table 9.7: Frequency of Occurrence Ranking Definitions

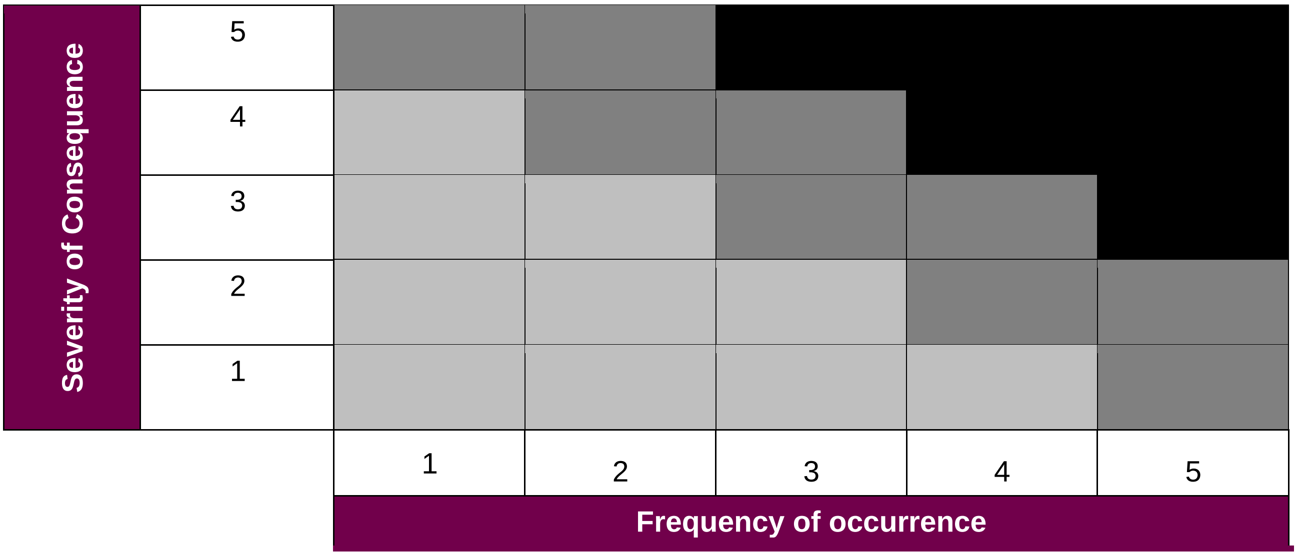
Rank	Description	Definition
1	Negligible	Less than 1 occurrence per 10,000 years
2	Extremely unlikely	1 per 100 to 10,000 years
3	Remote	1 per 10 to 100 years
4	Reasonably probable	1 per 1 to 10 years
5	Frequent	Yearly

The significance of an effect upon shipping and navigation is determined by correlating the severity of consequence and frequency of occurrence using the risk ranking matrix presented in Table 9.8.

[3] Tier 2 – Regional (beyond the capability of one local authority or requires additional contracted response from offshore operator or from ports or harbours

[4] Tier 3 – National (requires national resources coordinated by the MCA for a shipping incident and the operator for an offshore installation incident)

Table 9.8: Tolerability Matrix and Risk Rankings



	Unacceptable (high risk)
	Tolerable (intermediate risk)
	Broadly Acceptable (low risk)

Once identified, the significance of the impact will be assessed to ensure it is ALARP. Further risk control measures may be required to mitigate a hazard in line with the ALARP principles. Unacceptable risks are not considered to be ALARP.

For the purposes of this assessment:

- A level of effect of Unacceptable will be considered a ‘significant’ effect in terms of the EIA Regulations; and
- A level of effect of Broadly Acceptable or Tolerable (if ALARP) will be considered ‘not significant’ in terms of the EIA Regulations.

9.10 Embedded Mitigation

As part of the Proposed Development design process, a number of embedded mitigation measures have been adopted to reduce the potential for risk to shipping and navigation. These measures have and will continue to evolve over the development process as the EIA progresses and in response to consultation.

These measures typically include those that have been identified as good or standard practice and include actions that would be undertaken to meet existing legislation requirements. As there is a commitment to implementing these measures, and also to various standard sectoral practices and procedures, they are considered inherently part of the design of the Proposed Development.

The embedded mitigation measures within the design relevant to shipping and navigation are outlined in Table 9.9.

Table 9.9: Embedded Mitigation Measures Relevant To Shipping And Navigation

Embedded Mitigation Measures	Details
Promulgation of information advising on the nature, timing and location of activities, Safety Zones and advisory safe passing distances, including through Notices to Mariners.	Timely circulation of information via Notices to Mariners (NtM), Kingfisher/KIS-ORCA notifications, Radio Navigational Warnings, Navigational Telex (NAVTEX), and/or other navigational broadcast warnings as soon as reasonably practicable in advance of and during the works.
Lighting and marking of project vessels	Cable Lay Vessels (CLVs) and other vessels involved in cable installation will display appropriate marks and lights, and broadcast their status on AIS at all times, to indicate the nature of the work in progress, and highlight their restricted manoeuvrability.
Guard vessel and/or temporary Aid to Navigation (AtoN)	Where required based on risk assessment, guard vessels and/or temporary AtoNs may be deployed to guide vessels around any areas of construction activity.
Use of guard vessels at cable exposures	Where cable exposures exist that would result in significant risk (e.g. if cable burial is carried out post cable lay), guard vessels will be used where appropriate until the risk has been mitigated by burial and/or other protection methods.
Advisory safe passing distances and safety zones	Passing vessels will be requested to maintain an advisory safe passing distance around project vessels (e.g. cable installation vessels) restricted in manoeuvrability. It is assumed that a 500 m Safety Zone for the new Douglas CCS platform will be in place.
Marine coordination	Marine coordination and communication to manage project vessel movements.
Vessel Management Plan	A Vessel Management Plan (VMP) will be developed which will determine vessel routeing to and from construction areas and ports to avoid areas of high risk to marine mammals.
Development of and adherence to an Environmental Management Plan (EMP) that will be prepared and implemented during the construction, operational and maintenance and decommissioning phases of the Proposed Development. The EMP will include appendices detailing actions to minimise Invasive Non-Native Species (INNS) (the INNSMP), and a Marine Pollution Contingency Plan (MPCP) will be developed which will include planning for accidental spills, address all potential contaminant releases and include key emergency contact details	Measures will be adopted to ensure that the potential for release of pollutants from construction, operational and maintenance and decommissioning plant is minimised. These will likely include: designated areas for refuelling where spillages can be easily contained, storage of chemicals in secure designated areas in line with appropriate regulations and guidelines, double skinning of pipes and takes containing hazardous substances, and storage of these substances in impenetrable bunds. All vessels will be required to comply with the standards set out in the International Convention for the Prevention of Pollution from Ships (MARPOL).
Compliance with COLREGs and SOLAS	Compliance of all project vessels with international marine regulations as adopted by the Flag State, notably the COLREGs (IMO, 1972/78) and SOLAS (IMO, 1974).
Liaison with ports and harbours	Liaison with local ports and harbours, particularly the Port of Mostyn, during the construction phase.
Fishing liaison	Ongoing liaison with fishing fleets will be maintained via an appointed Fisheries Liaison Officer (FLO) and Fishing Industry Representative. Prior to construction, a Fisheries Liaison and Coexistence Plan (FLCP) will be developed, setting out in detail the planned

Embedded Mitigation Measures	Details
	approach to fisheries liaison and means of delivering any other relevant mitigation measures.
The Applicant is committed to marking and lighting the project in accordance with relevant industry guidance and as advised by relevant stakeholders including the MCA, Civil Aviation Authority (CAA) and Trinity House. This will include appropriate lighting and marking of Offshore Platforms (OPs). The Applicant will also ensure the project is adequately marked on nautical charts. A lighting and marking plan will be secured.	The new CCS platform will exhibit lights, marks, sounds, signals and other aids to navigation as required by the Standard Marking Schedule, and in consultation with Trinity House. The platform and cables will be suitably marked on Admiralty Charts, with associated note.
Scour Protection	Scour protection (e.g. rock berms) will only be used at third-party cable crossings and monitored as per below.
Suitable implementation and monitoring of Cable Protection	Suitable implementation and monitoring of cable protection informed by a CBRA. Cables will be buried to a target depth of 2-3m and only be protected using external protection (e.g. rock berms) at third-party crossings.
Development and adherence to a Cable Specification and Installation Plan (CSIP) post consent which will include cable burial where possible (in accordance with the specific policies set out in the North West Inshore and North West Offshore Coast Marine Plans (MMO, 2021)) and cable protection, as necessary.	The CSIP will set out appropriate cable burial depth in accordance with industry good practice, minimising the risk of cable exposure. The CSIP will also ensure that cable crossings are appropriately designed to mitigate environmental effects, these crossings will be agreed with relevant parties in advance of CSIP submission. The CSIP will include a detailed CBRA to enable informed judgements regarding burial depth to maximise the chance of cables remaining buried whilst limiting the amount of sediment disturbance to that which is necessary. Measures will seek to reduce the amount of Electromagnetic Field (EMF) which benthic and fish and shellfish receptors are exposed to during the operations and maintenance phase by increasing the distance between the seabed surface and the surface of the cables.
Where practicable any requirements for cable protection will be compliant with MGN 654	Following further survey and detailed engineering, if areas are identified where external protection is required and the MCA condition of no more than 5% reduction in water depth is not achievable, a location specific review of impacts to shipping and consultation with the MCA will be carried out and additional mitigations agreed as required.

9.11 Assessment of Significance

9.11.1 Vessel displacement leading to increased vessel to vessel collision risk between third-party vessels

9.11.1.1 Construction phase

Installation of the offshore Douglas CCS platform and cables may cause displacement of vessels around the areas of installation, which could lead to an increased risk of a collision between two third-party vessels during the construction phase. In particular vessels may be required to deviate around cable installation vessels, which are large, slow moving vessels which will be Restricted in Manoeuvrability (RAM). In addition, jack up vessels used for landfall works may also lead to vessel displacement close to the shore. As the offshore platform is located within the existing Safety Zone for the Douglas Complex and an Area To Be Avoided

(ATBA), and Liverpool Bay TSS lanes pass at least 0.4 nm from the proposed location, there is not expected to be any additional displacement associated with the construction of the new Douglas CCS platform within the existing Safety Zone. Works within the existing Hamilton, Hamilton North and Lennox Safety Zones are not covered in this NRA.

Vessel displacement will be more likely in busier areas of shipping. From the baseline assessment, passing vessel activity was significant across the Proposed Development, with higher density associated with the Liverpool Bay TSS lanes, vessels working at the Gwynt y Môr OWF and NW-SE routes used by the regular ferries running from Liverpool to Ireland.

Regular fishing and recreational activity was observed within the vicinity of the Proposed Development. Construction vessels may therefore cause a disruption to both local fishers and recreational boaters. Fishing activity was mostly recorded further offshore and was frequently recorded in the vicinity of the Physical Work Area to the north west of the proposed Douglas CCS platform. Recreational activity was recorded throughout the shipping and navigation study area, mainly passing out of the Queen's Channel, and are recorded crossing the Physical Work Area at various locations, including in near shore areas. It is noted that recreational craft and small fishing vessels close to shore will be under-represented by the AIS data.

The installation of the proposed Douglas CCS platform and new cables are expected to be carried out in Q1-Q2 2026. Preparations for the shore approach of the power cables from Douglas to Point of Ayr are proposed to commence in Q2 2025. Installation works for the new platform are expected to take up to five months, while cable laying works are expected to take up to two months. The spatial extent of construction areas where vessels may be required to deviate around vessels which are RAM is expected to be small at any given time.

Details of construction activities, including any advisory safe passing zones, will be suitably promulgated via NtMs, Kingfisher, Radio Navigational Warnings, NAVTEX and/or broadcast warnings to maximise awareness of ongoing construction activities. Guard vessels will be used where required to raise awareness of construction works to passing vessels and communication with the Ports of Liverpool and Mostyn will help to minimise collision risk associated with vessels using the port.

The appointment of an FLO will aid in ensuring local fishers are made aware of construction works. Local Notices to Mariners will help to inform recreational users. All vessels will be expected to comply with international marine legislation, including the COLREGs and SOLAS.

Severity of Consequence

In the event of a collision incident between third-party vessels, the most likely consequences are minor contact between the vessels resulting in minor damage to property and minor reputational effects on business but no perceptible effect on people. The maximum adverse scenario could involve one of the vessels foundering resulting in potential loss of life (PLL) and the environmental consequence of pollution. Such a scenario would be more likely if one of the vessels involved was a small craft which may have weaker structural integrity than a commercial vessel.

The severity of consequence is therefore considered to be **moderate**.

Frequency of Occurrence

The impact will be present throughout the construction phase which will last for up to six months. Given that third-party vessels are expected to be compliant with relevant Flag State regulations including the COLREGs, collision avoidance action ensure that the likelihood of an encounter developing into a collision incident is low. This is furthered by the promulgation of information which will maximise awareness of ongoing construction activities, thus allowing third-party vessels to passage plan in advance, if considered appropriate.

The frequency of occurrence is therefore considered to be **extremely unlikely**.

Significance of Risk

Overall, the severity of consequence is deemed to be moderate, and the frequency of occurrence is considered to be extremely unlikely. The effect will, therefore, be of **broadly acceptable** adverse significance, which is **not significant** in EIA terms.

9.11.1.2 Operation and maintenance phase

Once the Proposed Development is operational, vessel displacement associated with the new cables is limited to any repair or maintenance work required, which is expected to be minimal and localised in nature. As the new Douglas CCS platform will be located within an existing Safety Zone and ATBA, there is not expected to be any additional displacement associated with the platform during the operational phase.

9.11.1.3 Decommissioning phase

There may also be a risk of vessel displacement leading to increased vessel to vessel collision risk between third-party vessels created during the decommissioning phase.

Severity of Consequence

Since the numbers and types of vessels used to remove the cables and platform are expected to be similar to those used for installation, this impact is expected to be similar in nature to the equivalent construction phase impact.

Therefore, the most likely consequences associated with the maximum adverse scenario are as per the equivalent construction phase impact.

The severity of consequence is therefore considered to be **moderate**.

Frequency of Occurrence

The impact will be present throughout the decommissioning phase which is assumed to last for a similar timeframe as the construction period. Given that third-party vessels are expected to be compliant with Flag State regulations including the COLREGs, the likes of collision avoidance action ensure that the likelihood of an encounter developing into a collision incident is low. This is furthered by the promulgation of information which will maximise awareness of ongoing decommissioning activities, thus allowing third-party vessels to passage plan in advance.

The frequency of occurrence is therefore considered to be **extremely unlikely**.

Significance of Risk

Overall, the severity of consequence is deemed to be moderate, and the frequency of occurrence is considered to be extremely unlikely. The effect will, therefore, be of **broadly acceptable** adverse significance, which is **not significant** in EIA terms.

9.11.2 Increased vessel to vessel collision risk between a third-party vessel and a project vessel

9.11.2.1 Construction Phase

There is an increased collision risk created during the construction phase for all passing traffic due to the presence of vessels associated with the construction of the offshore platform and cables, and decommissioning and repurposing of the existing Hamilton Main, Hamilton North and Lennox satellite platforms. This includes vessels involved in surveys, seabed preparation, cable installation, platform installation, topside removal and installation, cable burial and/or protection installation, drilling of wells, commissioning of CO_2 pipelines and Landfall works. The nature of certain construction works, such as cable installation and other activities, requires large, slow moving vessels which will be RAM. Therefore, these vessels may have limited capability in taking avoidance action from a passing vessel on a collision course, should such a situation arise. In addition, there may be an increased collision risk between third-party vessels and jack ups used during Landfall works, and between third-party vessels and HLVs used for the platform installation. Due to their reduced size and increased mobility in comparison, smaller vessels associated with the construction phase (e.g. tugs, guard vessels, support vessels, Crew Transfer Vessels (CTVs)), are considered to pose a lesser risk of collision than that of the larger cable installation vessels, jack ups or HLVs.

The collision risk is likely to be greater in higher density shipping areas. Passing vessel activity was significant across the Proposed Development, with higher density associated with the Liverpool Bay TSS lanes, vessels working at the Gwynt y Môr OWF and NW-SE routes used by the regular ferries running from Liverpool to Ireland.

Up to four cable installation vessels which are RAM will be on site at any one time and a jack up vessel is expected to be used for Landfall works. Additional support vessels include one seabed preparation vessel, one trench support vessel, one cable protection installation vessel and one cable burial installation vessel, as well as survey vessels, crew/work boats and multicats. For the new Douglas CCS platform, there will be one HLV vessel and additional support vessels including tugs, cargo barges, survey vessels and crew boats. The installation of the proposed Douglas CCS platform and new cables are expected to be carried out in Q1-Q2 2026. Preparations for the shore approach of the power cables from Douglas to Point of Ayr are proposed to commence in Q2 2025. Installation works for the new platform are expected to take up to five months, while cable laying works are expected to take up to two months. The spatial extent of construction areas where vessels which are RAM are working is expected to be small at any given time. There will also be additional vessel movements associated with works to repurpose existing assets at the Hamilton Main, Hamilton North and Lennox platforms between Q4 2024 and Q3 2028, although these vessels are not expected to be RAM. Up to 128 return trips are anticipated during this time, the majority of which are associated with CTVs.

Project vessels will be managed by marine coordination, will display suitable marks and lights, will broadcast on AIS (where appropriate) and will be compliant with relevant Flag State regulations including the COLREGs and SOLAS.

Details of construction activities, including any advisory safe passing distances will be suitably promulgated via NtM, Kingfisher, Radio Navigational Warnings, NAVTEX and/or broadcast warnings to maximise awareness of ongoing construction activities. Communication with the Ports of Liverpool and Mostyn about the construction work activities and appointment of a FLO will also help to raise awareness of the works and minimise collision risk. Where required, guard vessels and/or temporary AtoNs will be used to raise awareness of construction work to passing vessels and to guide vessels around any areas of construction activities, and platform installation works will be located within the existing Safety Zone and ATBA at the Douglas Complex.

Severity of Consequence

The most likely consequences in the event of a collision incident between a project vessel and third-party vessel are minor contact between the vessels resulting in minor damage to property and minor reputational effects on business but no perceptible effect on people. The maximum adverse scenario could involve one of the vessels foundering resulting in PLL and the environmental consequence of pollution. Such a scenario would be more likely if the third-party vessel involved was a small craft which may have weaker structural integrity than a commercial vessel.

The severity of consequence is therefore considered to be **moderate**.

Frequency of Occurrence

The impact will be present throughout the construction phase which will last for up to four years, with cable laying works anticipated to take up to two months. The number of vessel movements to and from the Douglas Complex and satellite platforms are relatively low, the majority of which associated with CTVs. With the mitigation measures noted above implemented, it is considered unlikely that a close encounter between a third-party vessel and a project vessel will occur. In the event that such an encounter does occur, collision avoidance action would be implemented by the vessels as per the COLREGs, including Rule 18 which governs responsibilities between vessels if one is RAM, thus ensuring that the likelihood of the encounter developing into a collision incident is very low.

The frequency of occurrence is therefore considered to be **extremely unlikely.**

Significance of Risk

Overall, the severity of consequence is deemed to be moderate and the frequency of occurrence is considered to be extremely unlikely. The effect will, therefore, be of **broadly acceptable** adverse significance, which is **not significant** in EIA terms.

9.11.2.2 Operation and Maintenance phase

During the operation and maintenance phase, there will be up to 15 return trips by jack-up vessels and 15 return trips by other vessels visiting the new Douglas CCS platform, which is significantly fewer visits than currently received by the Douglas Complex. There is therefore not expected to be any additional vessel to vessel collision risk associated with vessels visiting the new Douglas CCS platform.

There will be a requirement to undertake inspection surveys as well as the potential for unplanned repair works on the proposed cables, which could result in an increased collision risk between a third-party vessel and a survey/maintenance vessel.

This risk is described under the construction phase, however maintenance/monitoring work is expected to be less disruptive and span a shorter period than cable construction works.

Routine inspections of the subsea structures are planned to two yearly and five years, with annual surveys on a seven year rolling programme also planned. There may also be requirements for cable repair and/or burial as required. Cable repairs/reburials may include vessels which are RAM. As per the construction phase, project vessels will be managed by marine coordination, will display suitable marks and lights, will broadcast on AIS and be compliant with relevant Flag State and international regulations including the COLREGs and SOLAS.

Similarly to the construction phase, details of major maintenance activities including any advisory clearance zones, as defined by risk assessment, will be suitably promulgated via NtM, Kingfisher, Radio Navigational Warnings, NAVTEX and/or broadcast warnings to maximise awareness of ongoing major maintenance activities.

Severity of Consequence

The most likely consequences in the event of a collision incident between a project vessel and third-party vessel are as per the equivalent construction phase impact, namely minor contact and damage to property and minor reputational effects on business, but no perceptible effect on people. The maximum adverse scenario could involve one of the vessels foundering resulting in PLL and the environmental consequence of pollution. Such a scenario would be more likely if the third-party vessel involved was a small craft which may have weaker structural integrity than a commercial vessel.

The severity of consequence is therefore considered to be **moderate**.

Frequency of Occurrence

The impact will be present throughout the operation and maintenance phase which will last for up to 25 years. With implementation of the embedded mitigation measures outlined in Section 9.10 it is considered unlikely that an encounter between a third-party vessel and a project vessel will occur. In the event that such an encounter does occur, collision avoidance action would be implemented by the vessels as per COLREGs, thus ensuring that the likelihood of the encounter developing into a collision incident is very low.

The likelihood of an encounter is decreased compared to the construction phase given the smaller scale of maintenance activities, although this is somewhat balanced by the much longer duration of the operation and maintenance phase.

The frequency of occurrence is therefore considered to be **extremely unlikely**.

Significance of Risk

Overall, the severity of consequence is deemed to be moderate and the frequency of occurrence is considered to be extremely unlikely. The effect will, therefore, be of **broadly acceptable** adverse significance, which is **not significant** in EIA terms.

9.11.2.3 Decommissioning Phase

There may also be an increased collision risk created during the decommissioning phase for all passing traffic due to the presence of vessels associated with decommissioning works.

Severity of Consequence

Since the numbers and types of vessel used to remove the cables and CCS platform are expected to be similar to those used for installation, this impact is expected to be similar in nature to the equivalent construction phase impact.

Therefore, the most likely consequences associated with the maximum adverse scenario are as per the equivalent construction phase impact.

The severity of consequence is therefore considered to be **moderate**.

Frequency of Occurrence

The impact will be present throughout the decommissioning phase which is assumed to last for a similar timeframe as the construction period. With the embedded mitigation measures previously noted implemented, it is considered unlikely that an encounter between a third-party vessel and a project vessel will occur. As per the equivalent construction phase impact, in the event that such an encounter does occur, collision avoidance action would be implemented by the vessels as per the COLREGs, thus ensuring that the likelihood of the encounter developing into a collision incident is very low.

The frequency of occurrence is therefore considered to be **extremely unlikely**.

Significance of Risk

Overall, the severity of consequence is deemed to be moderate and the frequency of occurrence is considered to be extremely unlikely. The effect will, therefore, be of **broadly acceptable** adverse significance, which is **not significant** in EIA terms.

9.11.3 Vessel to platform allision risk

9.11.3.1 Operation and maintenance phase

Once the new Douglas CCS platform has been installed, there may be a risk of vessel to structure allision. This could be a powered allision (i.e. vessels under power alluding with the platform due to watchkeeper failure) or a drifting allision (i.e. due to machinery or engine failure, causing the vessel to drift into the platform).

Should an allision occur, the consequences will depend on multiple factors including the energy of the impact, structural integrity of the vessel and sea state at the time of the impact. In general powered allisions are expected to generate higher impact energies than drifting allisions. The most likely consequences will be minor damage with the vessel able to resume passage and undertake a full inspection at the next port. As an unlikely worst case, the vessel could founder resulting in a PLL and pollution.

Additionally, commercial vessels are expected to comply with international and flag state regulations (including the COLREGs and SOLAS) and will be able to passage plan in advance given the promulgation of information relating to the Proposed Development.

This risk is mitigated by the location of the proposed new Douglas CCS platform within an existing Area to be Avoided, which restricts vessels from transiting close to the platform. It is also assumed that a 500 m Safety Zone will be in place and that the platform has suitable operational lighting and marking in accordance with the Standard Marking Schedule for offshore installations.

Severity of Consequence

The most likely consequences in the event of an allision incident between a third-party vessel and the new Douglas CCS platform are minor contact and damage to property and minor reputational effects on business, but no perceptible effect on people. The maximum adverse scenario could involve the vessel foundering resulting in PLL and the environmental consequence of pollution. Such a scenario would be more likely if the vessel involved was a small craft which may have weaker structural integrity than a commercial vessel.

The severity of consequence is therefore considered to be **moderate**.

Frequency of Occurrence

The impact will be present throughout the operation and maintenance phase which will last for up to 25 years. With implementation of the embedded mitigation measures outlined in Section 9.10, including the 500 m Safety Zone and ATBA, and the familiarity of vessels with the existing structures in the Douglas Complex, an allision incident is considered to be unlikely.

The frequency of occurrence is therefore considered to be **extremely unlikely**.

Significance of Risk

Overall, the severity of consequence is deemed to be moderate and the frequency of occurrence is considered to be extremely unlikely. The effect will, therefore, be of **broadly acceptable** adverse significance, which is **not significant** in EIA terms.

9.11.4 Reduced access to local ports

9.11.4.1 Construction Phase

There is the potential for reduced access to local ports due to construction works associated with the cable construction works, in particular close to the Landfall. Vessels visiting the Port of Mostyn access this port via the Welsh Channel, which is intersected by the proposed cable routes from Douglas to Point of Ayr.

The majority of vessels using the Welsh Channel to enter the Port of Mostyn are wind farm support vessels transiting to the Gwynt-y-Môr, North Hoyle and Rhyl Flats OWFs.

The installation of the proposed new cables are expected to be carried out in Q1-Q2 2026. Preparations for the shore approach of the power cables from Douglas to Point of Ayr are proposed to commence in Q2 2025. Cable laying works are expected to take up to two months. The spatial extent of construction areas where vessels may be required to deviate around vessels which are RAM is expected to be small at any given time.

Project vessels will be managed by marine coordination, will display appropriate marks and lights, broadcast on AIS and will be compliant with relevant Flag State regulations including the COLREGs, including rule 18 which applies to vessels which are RAM. Liaison with the Port of Mostyn will help to manage disruption. This impact was discussed during consultation with the Harbour Master of the Port of Mostyn and no issues were raised.

Severity of Consequence

Cable installation and Landfall construction works may result in some disruption to vessels using the Port of Mostyn, due to the presence of vessels which may be RAM, such as a cable laying vessel.

The severity of consequence is considered to be **minor**.

Frequency of Occurrence

The impact will be present during installation of the cables within the Welsh Channel. Cable laying is estimated to take up to two months, with works in the Welsh Channel lasting for a small proportion of this period.

An average of six vessels per day accessed the Port of Mostyn based on the AIS data, the majority of which were wind farm support vessels. It is noted that there may be additional small craft not broadcasting on AIS also requiring access to the Port of Mostyn.

However, due to the localised and temporary nature of cable installation works in the Welsh Channel, the disruption to port access is reduced. This impact will be mitigated by good communication with the Port of Mostyn during the construction phase.

The frequency of occurrence is therefore considered to be **remote**.

Significance of Risk

The severity of consequence is deemed to be minor and the frequency of occurrence in is considered to be remote. The effect will, therefore, be of **broadly acceptable** adverse significance, which is **not significant** in EIA terms.

9.11.4.2 Operation and maintenance phase

There is the potential for reduced access to local ports due to cable maintenance and repair works.

Severity of Consequence

The overall timescale for any maintenance/repair works is expected to be less than for construction works. Similarly to the construction phase, details of major maintenance activities including any advisory clearance zones, as defined by risk assessment, will be suitably promulgated to maximise awareness of ongoing major maintenance activities.

Such works may result in limited disruption to vessels accessing the Port of Mostyn via the Welsh Channel. However, any required maintenance in this area is expected to be temporary in nature.

In addition, maintenance vessels will be managed by marine coordination, will display appropriate marks and lights, broadcast on AIS and will be compliant with relevant Flag State regulations including the COLREGs, including rule 18 which applies to vessels which are RAM. Liaison with the Port of Mostyn will help to manage disruption.

The severity of consequence is therefore considered to be **negligible**.

Frequency of Occurrence

The reduction in access is decreased compared to the construction phase given the smaller scale of maintenance activities, although this is somewhat balanced by the much longer duration of the operation and maintenance phase.

The frequency of occurrence is therefore considered to be **extremely unlikely**.

Significance of Risk

Overall, the severity of consequence is deemed to be negligible and the frequency of occurrence is considered to be extremely unlikely. The effect will, therefore, be of **broadly acceptable** adverse significance, which is **not significant** in EIA terms.

9.11.4.3 Decommissioning phase

There may be potential for reduced access to local ports due to decommissioning works.

Severity of Consequence

Since the numbers and types of vessels used to remove the cables are expected to be similar to those used for installation, this impact is expected to be similar in nature to the equivalent construction phase impact.

The severity of consequence is therefore considered to be **minor**.

Frequency of Occurrence

The impact will be present throughout the decommissioning phase which is assumed to last for a similar timeframe as the construction period. Since the anticipated reduction in access to local ports and the volumes of vessel traffic accessing the ports are assumed to be the same as for the equivalent construction phase impact, and the appropriate embedded mitigation measures are in place, it is anticipated that the frequency of occurrence is similar to the construction phase.

The frequency of occurrence is therefore considered to be **remote**.

Significance of Risk

The severity of consequence is deemed to be minor and the frequency of occurrence is considered to be remote. The effect will, therefore, be of **broadly acceptable** adverse significance, which is **not significant** in EIA terms.

9.11.5 Anchor interaction with subsea cable

9.11.5.1 Construction phase

The preferred approach for cable burial is that the cable is laid on the seabed and then buried using a plough. Therefore, there may be a period of time after laying when the cables are exposed and not protected through burial or other means such as rock placement. This period represents a potentially higher risk of interaction from vessel anchors with the surface-laid cables.

There is a risk that a nearby anchored vessel will lose its holding ground and subsequently drag anchor over the cables. Vessels at anchor were mainly located within the charted anchorage areas located between the Gwynt y Môr and Burbo Bank wind farms, and around the boundaries of the two wind farms.

If a passing vessel suffers engine failure, there is a possibility that it may drop anchor to avoid drifting into an emergency situation such as a collision, allision or grounding. This is more likely to occur in areas closer to the coast or to other hazards (e.g. offshore developments). In open waters where depths are deeper and anchoring may not be feasible, the vessel is more likely to attempt to either fix the problem or await assistance.

Severity of Consequence

While exposed any vessel anchor could interact with the cables. If an anchor becomes snagged on the cable, there could be a risk of injury in trying to free it. If the anchor cannot be freed the safest action is to slip it, and not attempt to raise or cut the cable.

The most likely consequences are limited damage to property (anchoring vessel or subsea cable). The maximum adverse scenario may include damage to property including to the vessel's anchor or subsea cable.

The severity of consequence is therefore considered to be **moderate**.

Frequency of Occurrence

From the vessel traffic survey data, the majority of anchoring activity took place within the charted anchorage areas located between the Gwynt y Môr and Burbo Bank wind farms, and around the boundaries of the two wind farms. The deep water anchorage east of the Hamilton Gas Field is located 0.4 nm to the south of the Douglas to Lennox cable and may pose a higher risk from a vessel dragging anchor.

Areas where emergency anchoring risk is expected to be higher are where vessel density was highest (e.g. within the TSS lanes), within the Gwynt y Môr OWF and where there were high densities of traffic associated with ferry route. The maritime incident data showed that the most frequent incident type to be recorded was machinery failure, which could lead to emergency anchoring.

Mitigation includes circulation of information to make mariners aware of the exposed cable and use of guard vessels where cable exposures are considered to present significant risk to navigation.

The frequency of occurrence is considered to be **extremely unlikely.**

Significance of Risk

Overall, the severity of consequence is deemed to be moderate and the frequency of occurrence is considered to be extremely unlikely. The effect will, therefore, be of **broadly acceptable** adverse significance, which is **not significant** in EIA terms.

9.11.5.2 Operation and maintenance phase

There is a risk that a vessel anchor interacts with the cables due to an anchor dragging or emergency anchoring incident during the operation and maintenance phase.

High risk areas for an anchor dragging incident are where vessels routinely anchor close to the cable (e.g. within the charted anchorage areas located between the Gwynt y Môr and Burbo Bank wind farms, and around the boundaries of the two wind farms). The deep water anchorage east of the Hamilton Gas Field is located 0.4 nm to the south of the Douglas to Lennox cable and may pose a higher risk from a vessel dragging anchor.

For emergency anchoring, higher risk areas include areas where the density of vessels crossing the cables is higher and areas closer to the coast or to other hazards (e.g. offshore developments), which increases the likelihood of dropping anchor in an emergency. From the baseline assessment, passing vessel activity was significant across the Proposed Development, with higher density associated with the Liverpool Bay TSS lanes, vessels working at the Gwynt y Môr OWF and NW-SE routes used by the regular ferries running from Liverpool to Ireland.

During the operation and maintenance phase the cables will be marked on UKHO Admiralty Charts with associated note/warning about anchoring, trawling or seabed operations.

A CBRA will be undertaken to identify high risk areas along the cable routes and to determine suitable burial depths for the cables during the operation and maintenance phase. Burial is the preferred method for protecting the cables from vessel anchors. The cables are anticipated to be buried to between 2m and 3m for the whole length of the route, with external protection, (i.e. freshly quarried rock and concrete mattresses), used at the ten crossings. Target burial depths will be confirmed by the CBRA. Cable protection will be regularly monitored to confirm its integrity.

Severity of Consequence

Once the cables are protected, either through burial and/or other protection measures, larger vessels (e.g. cargo vessels and tankers) are more likely to threaten the cables as their anchors are able to penetrate deeper into the seabed and can cause greater damage than smaller anchors (fishing and recreational vessels) if contact is made. The anchors of smaller vessels (e.g. fishing and recreational craft) are unlikely to penetrate as deeply. Suitable target burial depths, defined in a CBRA, will mitigate the risk from vessel anchors. Periodic monitoring will be undertaken to confirm cable protection remains suitable.

The most likely consequences are limited damage to property (anchoring vessel or subsea cable). The maximum adverse scenario may include damage to property including to the vessel's anchor or subsea cable.

The severity of consequence is therefore considered to be **minor**.

Frequency of Occurrence

Protection of the cables via burial and/or external protection will reduce the frequency of occurrence of anchor interaction.

Although there may be limited decision-making time if a vessel is drifting towards a hazard, it is anticipated that the charting of infrastructure including all subsea cables will inform any decision to anchor, as per Regulation 34 of SOLAS.

The frequency of occurrence is considered to be **extremely unlikely**.

Significance of Risk

Overall, the severity of consequence is deemed to be minor and the frequency of occurrence is considered to be extremely unlikely. The effect will, therefore, be of **broadly acceptable** adverse significance, which is **not significant** in EIA terms.

9.11.6 Fishing gear interaction with subsea cable

9.11.6.1 Construction phase

Similar to the impact associated with vessel anchors, there is the potential for risk of interaction from fishing gear with surface-laid cables prior to burial by plough, as this may result in a period of time during which the cables are exposed (prior to burial or placement of external protection).

Severity of Consequence

Although fishers are advised to follow the current maritime industry guidance (MGN 661, the Mariner's and all Admiralty charts) and avoid demersal trawling (and anchoring) in the immediate vicinity of the cables, it is acknowledged that fishing may still occur over the cables either inadvertently, or at the discretion of fishing vessel operators.

There is higher risk of snagging from demersal gear if the cable is exposed. The response from the crew includes reducing/reversing the propulsive force, attempting to unfasten the equipment, or releasing the gear and therefore in the majority of snagging incidents, it should be possible to recover the situation without any serious consequences (e.g. injury or fatality to crew members). However, accident data from the MAIB indicates that safe recovery from a snagging incident is not always the outcome. Consequences of snagging therefore range from damage to gear and the cable, loss of stability due to lines being put under strain and in the worst case, capsize of the vessel, men overboard and risk of injury or fatality. For example, a risk of capsize could occur if the vessel attempted to free its gear by raising the cable rather than releasing the gear.

The severity of consequence is therefore considered to be **serious**.

Frequency of Occurrence

Fishing vessels carrying demersal gear that interacts with the seabed when deployed present the greatest risk of snagging on subsea cables. Static gear types (e.g. potters/whelkers and gill netters) are not considered to present a safety risk from snagging as they are able to carefully select the position of their gear, avoiding any subsea cables. Demersal gear types identified in the baseline assessment relative to the Proposed Development were mainly dredgers, which contributed 40% of gear types recorded on AIS in the area. The highest risk area of snagging is where vessels engaged in fishing with demersal gears are most active, mainly to the east and north of the Douglas Field. It is also noted that there is likely to be significant activity from small fishing vessels in coastal waters, which may be under-represented in the AIS data, although these are most likely to be using static gear which has lower snagging risk.

It is expected that mitigation including having a FLO in place and circulation of information (e.g. via Kingfisher and local communications) will help ensure fishers are aware of the exposed cable and avoid fishing directly over it. In addition, guard vessels will be used in any areas where cable exposures are considered to present significant risk to fishing gear snagging.

The frequency of occurrence during the period that the cables are surface-laid is considered to be **remote**.

Significance of Risk

Overall, the severity of consequence is deemed to be serious and the frequency of occurrence is considered to be remote. The effect will, therefore, be of **tolerable adverse** significance, which is **not significant** in EIA terms.

Additional mitigation to reduce this impact to ALARP is to minimise the amount of time between cable lying and installation of cable protection, (e.g. burial).

9.11.6.2 Operation and maintenance phase

There is a risk of fishing gear interaction with the cables due to fishing activity, which has been described previously under the description of this impact during the construction phase. High intensity areas for demersal fishing activity occurred mainly to the east and north of the Douglas Field.

During the operation and maintenance phase the cables will be marked on UKHO Admiralty Charts and KIS-ORCA with associated note/warning about anchoring, trawling or seabed operations.

A CBRA will be undertaken to provide a detailed assessment of fishing activity along the proposed cables and fishing gear penetration depths for the various soil conditions in order to determine suitable burial depths for the cables during the operation and maintenance phase. Burial is the preferred method for protecting the cables from fishing gear. The cables are anticipated to be buried to between 2m and 3m for the whole length of the route, with external protection, (i.e. freshly quarried rock and concrete mattresses), used at the ten crossings. Target burial depths will be confirmed by the CBRA. Cable protection will be regularly monitored to confirm its integrity.

Severity of Consequence

The planned cable protection is assumed to provide effective mitigation from fishing gear snagging, reducing the risk of serious consequences such as snagging, capsize of the vessel and PLL.

The severity of consequence is therefore considered to be **minor**.

Frequency of Occurrence

Once the cables are installed, the depiction of the cables on nautical and Kingfisher charts may discourage fishing in the vicinity of the cables; however evidence shows this is not always the case with installed cables as often it is assumed they are adequately protected against fishing gear interaction. The planned cable protection (through burial) is assumed to provide effective mitigation against the risk of demersal gear making contact with the installed cables. As discussed, it is the responsibility of the fishers to dynamically risk assess whether it is safe to undertake fishing activities in proximity to subsea cables and to make a decision as to whether or not to fish. Fishing activity is considered further in volume 2, chapter 10.

The frequency of occurrence is considered to be **extremely unlikely**.

Significance of Risk

Overall, the severity of consequence is deemed to be minor and the frequency of occurrence is considered to be extremely unlikely. The effect will, therefore, be of **broadly acceptable** adverse significance, which is **not significant** in EIA terms.

9.11.7 Vessel grounding due to reduced under keel clearance

9.11.7.1 Operation and maintenance phase

This impact refers to a vessel grounding due to reduced under keel clearance associated with external protection measures such as rock berms, in areas where cable burial is not feasible (e.g. due to cable crossings). This could lead to subsequent capsize, injury, loss of life, oil spill, etc. In general, the higher risk areas are coastal waters where existing water depths are shallower.

Cable burial is the preferred option of safeguarding the cables, and no external protection is planned, with the exception of the 42 anticipated cable crossings as outlined in Section 9.8.1.

Severity of Consequence

Should a vessel grounding occur, the most likely consequences are minor damage to property and minor reputational effects on business but no perceptible effect on people. The maximum adverse scenario may include the vessel foundering resulting in PLL and the environmental consequence of pollution.

The severity of consequence is therefore considered to be **moderate**.

Frequency of Occurrence

The likelihood of a grounding is greater for large commercial vessels with deeper draughts, noting that only a minority of vessels recorded in the vessel traffic survey data were deep draught. Areas where water depth is shallower (e.g. close to the Landfall), also present a higher risk of vessels grounding.

The maximum height of cable protection will be 0.8 m. The average draught of vessels crossing the Physical Work Area was 5.1 m, with a maximum draught of 14 m, recorded crossing the cable route within the Liverpool Bay TSS in approximately 25 m of water depth.

Cable protection is expected to be implemented only at the cable crossings. Water depth at crossings located in shallow water (less than 10m) are most likely to be significantly altered, with these typically associated with the wind farm export cables crossing the Douglas – Point of Ayr cable route. Vessels crossing the cable route in these areas tended to be shallower draught vessels such as wind farm crew transfer vessels, while deep draught vessels were typically recorded further offshore using the Liverpool Bay TSS.

AS part of the Scoping Opinion, the MCA noted the requirements of MGN 654 (MCA, 2021a). Where possible, the Applicant intends to follow the guidance provided in MGN 654, and in particular cable protection will not change the charted water depth by more than 5%. If rock protection at crossings are likely to lead to a water depth reduction exceeding 5%, a detailed draught assessment will be carried out post-consent to determine any safety risk to navigation, which will be discussed and agreed with the MCA and Trinity House post consent and prior to cable installation as per MGN 654.

When considered with the embedded mitigation of compliance with the requirements in MGN 654 and any change to water depth of more than 5% chart datum requiring further consultation and agreement with the MCA, the frequency is considered to be reduced to low for all vessel types.

The frequency of occurrence is therefore considered to be **remote**.

Significance of Risk

Overall, the severity of consequence is deemed to be moderate and the frequency of occurrence is considered to be remote. The effect will, therefore, be of **tolerable adverse** significance, which is **not significant** in EIA terms.

9.11.8 Interference with magnetic compasses

A magnetic compass is a navigational instrument for determining direction relative to the earth's magnetic poles. It consists of a magnetised pointer (usually marked on the north end) free to align itself with the earth's magnetic field. Like any magnetic device, compasses are affected by nearby ferrous materials as well as by local electromagnetic forces, such as magnetic fields emitted from power cables. The majority of commercial vessels use a non-magnetic gyrocompass as the primary means of navigation, which is unaffected by the earth's magnetic field. However, as the magnetic compass still serves as an essential means of navigation in the event of power loss or as a secondary source, it must not be affected to the extent that safe navigation is threatened.

The proposed cables will consist of an HVDC power cable with a bundled fibre optic cable. The HVDC cable may result in localised static EMF, with the potential to affect magnetic compasses.

The important mitigating factors to reduce EMF effects on magnetic compasses are listed below:

- Cable spacing;
- Water depth; and
- Burial depth.

The cables will be laid at approximately 30 m spacing and approximately 72% of the cables will be located in water depths greater than 10 m below Chart Datum (CD). Therefore, there will be significant vertical distance between the cables and surface vessels along the majority of the cables. The strength of the magnetic fields decreases exponentially with distance from the cables, and as such compass deviation will reduce with increasing water depth. Similarly, increasing burial depth also increases the vertical separation between a surface vessel and the cables in a given water depth.

Severity of Consequence

The majority of commercial vessel traffic uses non-magnetic gyrocompasses as the primary means of navigation, which are unaffected by EMF. Therefore, in general it is considered unlikely that any EMF interference created by the proposed cables will have a significant impact on vessel navigation near the Proposed Development. Nevertheless, since magnetic compasses can still serve as an essential means of navigation in the event of power loss, as a secondary source, or as some smaller craft (fishing or leisure) may rely on it as their sole means of navigation (noting that many smaller craft may use Global Positioning System (GPS), chart plotters, etc. as a further source), it has been assessed within this ES chapter. Vessels in shallower water should also be able to navigate visually using coastal features when conditions are suitable.

The most likely consequences associated with the maximum adverse scenario are anticipated to be limited, noting that 72% of the proposed cables are anticipated to be in water depths greater than 20 m.

The severity of consequence is therefore considered to be **minor.**

Frequency of Occurrence

Along the proposed cable routes vessel traffic is assumed to mainly transit perpendicular to the direction of the cables. For vessels transiting over the cables, time spent directly above the cables will be limited given the limited width of the cable corridor.

Given HVDC cables produce static magnetic fields which decrease with the horizontal distance from the cables, magnetic compass interference should only be experienced directly above or in direct proximity to the cables, noting again that effects decrease quickly with horizontal distance as the vessel moves away from the location of the cables.

The frequency of occurrence is therefore considered to be **extremely unlikely**.

Significance of the Effect

Overall, the severity of consequence is deemed to be minor and the frequency of occurrence is considered to be extremely unlikely. The effect will, therefore, be of **broadly acceptable** adverse significance, which is **not significant** in EIA terms.

9.11.9 Reduction of emergency response capability due to increased incident rates for SAR responders and increased demand on the available resources

9.11.9.1 All Phases

Increased vessel activity during the construction phase may reduce emergency response capability by increasing the number of incidents, or reducing access for the responders. As an unlikely worst case, the consequences of such a situation could include a failure of emergency response to an incident, resulting in a PLL and pollution.

However, with project vessels to be managed through marine coordination and compliant with Flag State regulations, the likelihood of an incident is minimised. Additionally, should an incident occur, project vessels will be well equipped to assist, either through self-help capability or – for an incident involving a nearby third-party vessel – through SOLAS obligations (IMO, 1974), all in liaison with the MCA.

During the operation and maintenance phase, there is not expected to be a notable increase in vessel numbers, however there may be a period of time when the new Douglas CCS platform and the existing Douglas Complex are in operation simultaneously, which could increase the likelihood of an incident occurring at the Douglas Complex. As the new Douglas CCS platform will be unmanned, any impact is considered to be minimal.

Severity of Consequence

The severity of consequence is considered to be **moderate**.

Frequency of Occurrence

Due to the limited number of vessels involved and temporary nature of the construction phase works, and given that the proposed new Douglas CCS platform will be unmanned and within the existing Douglas Complex, the frequency of occurrence is considered to be **negligible.**

Significance of Risk

Overall, the severity of consequence is deemed to be moderate and the frequency of occurrence is considered to be negligible. The effect will, therefore, be of **broadly acceptable** adverse significance, which is **not significant** in EIA terms.

9.12 Cumulative Impact Assessment

The Cumulative Impact Assessment takes into account the impact associated with the Proposed Development together with other relevant projects. Cumulative impacts are therefore impacts arising from the Proposed Development together with the impacts from a number of different developments, on the same receptor or resource. Please see Cumulative Effects Assessment – Screening Report (RPS Group, 2024) for detail on CEA methodology.

The specific projects scoped into the cumulative impact assessment for shipping and navigation are presented in Table 9.10.

Table 9.10: Cumulative Projects

Development	Status	Distance from Proposed Development (km)	Spatial/temporal overlap with Proposed Development			Start date	End date
			Spatial	Temporal (construction)	Temporal (Operation)		
Morecambe Offshore Windfarm Generation Assets	Pre-application	12	x	✓	✓	01/01/2026	Unknown
Morgan and Morecambe Offshore Windfarms Transmission Assets	Pre-application	3	x	✓	✓	Unknown	Unknown
Morgan Offshore Wind Project Generation Assets	Pre-application	39	x	✓	✓	Unknown	Unknown
Awel y Môr	Application submitted	2.1	✓	✓	✓	01/01/2020	01/01/2055
Mona Offshore Wind Farm	Pre-application	9.3	x	✓	✓	01/01/2028	31/12/2065
Prestatyn Coastal Defence	Consented /licensed	2	x	✓	x	31/07/2021	31/05/2025
Central Rhyl Coastal Defence Scheme	Consented /licensed	4	x	✓	x	31/03/2023	30/03/2024
Removal of Met Mast at Gwynt y Môr	Unknown	0	✓	✓	x	21/11/2022	30/11/2027
MaresConnect Interconnector	Permitted	0	✓	Unknown	✓	Unknown	Unknown

9.12.1 Vessel displacement leading to increased vessel to vessel collision risk between third-party vessels

9.12.1.1 Construction phase

There is the potential for increased collision risk if cumulative developments encourage third party vessels to deviate towards the areas of construction for the Proposed Development. Vessel movements in the area are expected to be impacted by the construction of the Mona, Morgan and Morecambe OWFs, however given the location of the Proposed Development relative to the OWFs, and the current vessel routeing in the area, any change in vessel routeing relative to the Proposed Development is expected to be minimal. Additional vessel movements in the area due to the construction of the OWFs or transmission assets may cause an increase in vessel-to-vessel collision risk, depending on the location of the transmission assets and routes taken by construction vessels and whether there is an overlap in construction phases.

There may also be an increase in vessel-to-vessel collision risk due to construction vessel movements associated with Awel y Môr OWF and construction of the MaresConnect interconnector if construction periods were to overlap and works were to take place in a similar geographical area at a similar time.

Details of construction activities, including any advisory safe passing distances, as defined by risk assessment, will be suitably promulgated via NtM, Kingfisher, Radio Navigational Warnings, NAVTEX and/or broadcast warnings to maximise awareness of ongoing construction activities. Guard vessels and temporary aids to navigation will be used to raise awareness of construction work to passing vessels (if required) to guide vessels around any areas of construction activities.

The appointment of an FLO will aid in ensuring local fishermen are made aware of construction works. Local Notices to Mariners as well as notifying local marinas and sailing clubs of the works will help to inform recreational users. All vessels will be expected to comply with international marine legislation, including the COLREGs and SOLAS.

Collision incidents are local in nature, occurring only when two (or more) vessels pass within a small distance of each other within the same sea area. Accounting for the distance between the Proposed Development and the cumulative developments, the temporary nature of the construction works and noting that there is a low likelihood that construction works for the Proposed Development and cumulative developments will be required within the same geographical area at the same time, the impact is as per the equivalent construction phase impact for the Proposed Development in isolation.

Severity of Consequence

The most likely consequences in the event of a collision incident between a Project vessel and third-party vessel are minor contact between the vessels resulting in minor damage to property and minor reputational effects on business but no perceptible effect on people. The worst-case scenario could involve one of the vessels foundering resulting in PLL and the environmental consequence of pollution. Such a scenario would be more likely if the third-party vessel involved was a small craft which may have weaker structural integrity than a commercial vessel.

The severity of consequence is therefore considered to be **moderate.**

Frequency of Occurrence

The impact will be present throughout the construction phase which will last up to six months. Given that third-party vessels are expected to be compliant with relevant Flag State regulations including the COLREGs, collision avoidance action ensure that the likelihood of an encounter developing into a collision incident is low. This is furthered by the promulgation of information which will maximise awareness of ongoing construction activities, thus allowing third-party vessels to passage plan in advance, if considered appropriate.

The frequency of occurrence is therefore considered to be **extremely unlikely**.

Significance of effect

Overall, the severity of consequence is deemed to be moderate and the frequency of occurrence is considered to be extremely unlikely. The cumulative effect will, therefore, be of **broadly acceptable** adverse significance, which is **not significant** in EIA terms.

9.12.1.2 Decommissioning phase

There may also be a risk of vessel displacement leading to increased vessel to vessel collision risk between third-party vessels created during the decommissioning phase if cumulative developments lead to further displacement of vessels around the developments.

Severity of consequence

Since the numbers and types of vessels used to remove the platform and cables are expected to be similar to those used for construction, this impact is expected to be similar in nature to the equivalent construction phase impact.

The severity of consequence is therefore considered to be **moderate.**

Frequency of Occurrence

The impact will be present throughout the decommissioning phase which is assumed to last for a similar timeframe as the construction period. Given that third-party vessels are expected to be compliant with Flag State regulations including the COLREGs, the likes of collision avoidance action ensure that the likelihood of an encounter developing into a collision incident is low. This is furthered by the promulgation of information which will maximise awareness of ongoing decommissioning activities, thus allowing third-party vessels to passage plan in advance.

The frequency of occurrence is therefore considered to be **extremely unlikely**.

Significance of the effect

Overall, the severity of consequence is deemed to be moderate and the frequency of occurrence is considered to be extremely unlikely. The cumulative effect will, therefore, be of **broadly acceptable** adverse significance for the Proposed Development, which is **not significant** in EIA terms.

9.12.2 Increased vessel to vessel collision risk between a third-party vessel and a project vessel

9.12.2.1 Construction phase

There is the potential for increased collision risk if cumulative developments encourage third party vessels to deviate towards the project vessels. Vessel movements in the area are expected to be impacted by the construction of the Mona, Morgan and Morecambe OWFs, however given the location of the Proposed Development relative to the OWFs, and the current vessel routeing in the area, any change in vessel routeing relative to the Proposed Development is expected to be minimal. Additional vessel movements in the area due to the construction of the OWFs or transmission assets may cause an increase in vessel-to-vessel collision risk, depending on the location of the transmission assets and routes taken by construction vessels and whether there is an overlap in construction phases.

There may also be an increase in vessel-to-vessel collision risk between a third-party vessel and a project vessel due to construction vessel movements associated with Awel y Môr OWF and construction of the MaresConnect interconnector if construction periods were to overlap and works were to take place in a similar geographical area at a similar time.

Project vessels, as managed by marine coordination, will display suitable marks and lights, will broadcast on AIS (where appropriate) and will be compliant with relevant Flag State regulations including the COLREGs and SOLAS.

Details of construction activities, including any advisory safe passing distances, as defined by risk assessment, will be suitably promulgated via NtM, Kingfisher, Radio Navigational Warnings, NAVTEX and/or broadcast warnings to maximise awareness of ongoing construction activities. Communication with the Port of Liverpool and Port of Mostyn about the construction work activities and appointment of an FLO will also help to raise awareness of the works and minimise collision risk. Guard vessels and temporary aids to navigation will be used to raise awareness of construction work to passing vessels (if required) to guide vessels around any areas of construction activities.

Collision incidents are local in nature, occurring only when two (or more) vessels pass within a small distance of each other within the same sea area. Accounting for the distance between the Proposed Development and the cumulative developments, the temporary nature of the construction works and noting that there is a low likelihood that construction works for the Proposed Development and cumulative developments will be required within the same geographical area at the same time, the impact is as per the equivalent construction phase impact for the Proposed Development in isolation.

Severity of Consequence

In the event of a collision incident between third-party vessels, the most likely consequences are minor contact between the vessels resulting in minor damage to property and minor reputational effects on business but no perceptible effect on people. The worst-case scenario could involve one of the vessels foundering resulting in PLL and the environmental consequence of pollution. Such a scenario would be more likely if one of the vessels involved was a small craft which may have weaker structural integrity than a commercial vessel.

The severity of consequence is therefore considered to be **moderate**.

Frequency of Occurrence

The impact will be present throughout the construction phase which will last up to four years, with cable laying works anticipated to take up to two months. The number of vessel movements to and from the Douglas Complex and satellite platforms are relatively low, the majority of which are associated with CTVs. With the embedded mitigation measures noted above implemented, it is considered unlikely that an encounter between a third-party vessel and a project vessel will occur. In the event that such an encounter does occur, collision avoidance action would be implemented by the vessels as per the COLREGs, thus ensuring that the likelihood of the encounter developing into a collision incident is very low.

The frequency of occurrence is therefore considered to be **extremely unlikely**.

Significance of effect

Overall, the severity of consequence is deemed to be moderate and the frequency of occurrence is considered to be extremely unlikely. The cumulative effect will, therefore, be of **broadly acceptable** adverse significance, which is **not significant** in EIA terms.

9.12.2.2 Operation and maintenance phase

As per the equivalent construction phase impact, there is the potential for increased collision risk if cumulative developments encourage third party vessels to deviate towards project vessels. During the operation and maintenance phase, there will be up to 15 return trips by jack-up vessels and 15 return trips by other vessels visiting the new Douglas CCS platform, which is significantly fewer visits than currently received by the Douglas Complex. There is therefore not expected to be any additional vessel to vessel collision risk associated with vessels visiting the new Douglas CCS platform.

There will be a requirement to undertake inspection surveys as well as the potential for unplanned repair works on the proposed cables, which could result in an increased collision risk between a third-party vessel and a survey/maintenance vessel. Similar to the construction phase, if inspection or maintenance works were to coincide with construction works on cumulative projects, there could be an increase in vessel-to-vessel collision risk with survey/maintenance vessels, however any inspection or maintenance works are expected to be smaller in scale than construction works.

As per the construction phase, project vessels will be managed by marine coordination, will display suitable marks and lights, will broadcast on AIS and be compliant with relevant Flag State and international regulations including the COLREGs and SOLAS.

Similar to the construction phase, details of major maintenance activities including any advisory safe passing distances, as defined by risk assessment, will be suitably promulgated via NtM, Kingfisher, Radio Navigational

Warnings, NAVTEX and/or broadcast warnings to maximise awareness of ongoing major maintenance activities.

As per the equivalent construction phase impact, collision incidents are local in nature, occurring only when two (or more) vessels pass within a small distance of each other within the same sea area.

Severity of Consequence

The most likely consequences in the event of a collision incident between a project vessel and third-party vessel are minor contact between the vessels resulting in minor damage to property and minor reputational effects on business but no perceptible effect on people. The maximum adverse scenario could involve one of the vessels foundering resulting in PLL and the environmental consequence of pollution. Such a scenario would be more likely if the third-party vessel involved was a small craft which may have weaker structural integrity than a commercial vessel.

The severity of consequence is therefore considered to be **moderate.**

Frequency of Occurrence

The impact will be present throughout the operation and maintenance phase which will last for up to 25 years. With implementation of the embedded measures noted above, it is considered unlikely that an encounter between a third-party vessel and a project vessel will occur. In the event that such an encounter does occur, collision avoidance action would be implemented by the vessels as per COLREGs, thus ensuring that the likelihood of the encounter developing into a collision incident is very low.

The likelihood of an encounter is decreased compared to the construction phase given the smaller scale of maintenance activities, although this is somewhat balanced by the much longer duration of the operation and maintenance phase.

The frequency of occurrence is therefore considered to be **extremely unlikely**.

Significance of effect

Overall, the severity of consequence is deemed to be moderate and the frequency of occurrence is considered to be extremely unlikely. The cumulative effect will, therefore, be of **broadly acceptable** adverse significance, which is **not significant** in EIA terms.

9.12.2.3 Decommissioning phase

There may also be an increased collision risk created during the decommissioning phase if decommissioning works were to overlap temporally with maintenance or decommissioning works associated with the cumulative developments.

Severity of Consequence

Since the numbers and types of vessels used to remove the platform and cables are expected to be similar to those used for construction, this impact is expected to be similar in nature to the equivalent construction phase impact.

The severity of consequence is therefore considered to be **moderate.**

Frequency of Occurrence

The impact will be present throughout the decommissioning phase which is assumed to last for a similar timeframe as the construction period. With the embedded mitigation measures previously noted implemented, it is considered unlikely that an encounter between a third-party vessel and a project vessel will occur. As per the equivalent construction phase impact, in the event that such an encounter does occur, collision avoidance action would be implemented by the vessels as per the COLREGs, thus ensuring that the likelihood of the encounter developing into a collision incident is very low.

The frequency of occurrence is therefore considered to be **extremely unlikely**.

Significance of the effect

Overall, the severity of consequence is deemed to be moderate and the frequency of occurrence is considered to be extremely unlikely. The cumulative effect will, therefore, be of **broadly acceptable** adverse significance for the Proposed Development, which is **not significant** in EIA terms.

9.12.3 Vessel to platform allision risk

9.12.3.1 Operation and maintenance phase

There is the potential for increased vessel to structure allision risk if cumulative developments encourage third party vessels to deviate towards the new Douglas CCS platform. Vessel movements in the area are expected to be impacted by the construction of the Mona, Morgan and Morecambe OWFs, however given the location of the Proposed Development relative to the OWFs, and the current vessel routeing in the area, any change in vessel routeing relative to the new Douglas CCS platform is expected to be minimal. Additional vessel movements in the area due to the construction of the OWFs or transmission assets may cause an increase in vessel-to-vessel collision risk, depending on the location of the transmission assets and routes taken by construction vessels and whether there is an overlap in construction phases.

However, due to the location of the platform within a 500 m Safety Zone and ATBA, any deviated vessels are expected to maintain a minimum distance from the new platform and therefore the impact is as per the equivalent operation and maintenance phase impact for the Proposed Development in isolation.

Severity of Consequence

The most likely consequences in the event of an allision incident between a third-party vessel and the new Douglas CCS platform are minor contact and damage to property and minor reputational effects on business, but no perceptible effect on people. The maximum adverse scenario could involve the vessel foundering resulting in PLL and the environmental consequence of pollution. Such a scenario would be more likely if the vessel involved was a small craft which may have weaker structural integrity than a commercial vessel.

The severity of consequence is therefore considered to be **moderate**.

Frequency of Occurrence

The impact will be present throughout the operation and maintenance phase which will last for up to 25 years. With implementation of the embedded mitigation measures outlined in Section 9.10, including the 500 m Safety Zone and ATBA, and the familiarity of vessels with the existing structures in the Douglas Complex, an allision incident is considered to be unlikely.

The frequency of occurrence is therefore considered to be **extremely unlikely**.

Significance of Risk

Overall, the severity of consequence is deemed to be moderate and the frequency of occurrence is considered to be extremely unlikely. The effect will, therefore, be of **broadly acceptable** adverse significance, which is **not significant** in EIA terms.

9.12.4 Reduced access to local ports

9.12.4.1 Construction Phase

There is the potential for increased disruption to port access due to cumulative developments, particularly if the coastal defence works at Prestatyn and Rhyl were to overlap temporally with the construction works on the cables or if any of the cumulative developments were to increase vessels movements in and out of the Port of Mostyn.

Project vessels will be managed by marine coordination, will display appropriate marks and lights, broadcast on AIS and will be compliant with relevant Flag State regulations including the COLREGs, including rule 18 which applies to vessels which are RAM. Liaison with the Port of Mostyn and wind farm operators will help to manage disruption.

With the designed in measures listed above, the effect due to the presence of cumulative developments is anticipated to be manageable.

Severity of Consequence

Construction of the cables within the Welsh Channel may result in some disruption to vessels accessing the Port of Mostyn, due to the presence of vessels which may be RAM, such as a cable laying vessel. Cable installation is estimated to take up to two months, with works in the Welsh Channel lasting for a small proportion of this period.

The severity of consequence is therefore considered to be **minor.**

Frequency of Occurrence

The impact will be present throughout the construction phase which will last for up to two months, with works in the Welsh Channel lasting for a small proportion of this period. An average of six vessels per day accessed the Port of Mostyn based on the AIS data, the majority of which were wind farm support vessels. It is noted that there may be additional small craft not broadcasting on AIS also requiring access to the Port of Mostyn. Cumulative developments may lead to an increase in the number of vessels accessing the Port of Mostyn.

However, due to the localised and temporary nature of cable installation works in the Welsh Channel, the disruption to port access is reduced. This impact will be mitigated by good communication with the Port of Mostyn during the construction phase.

The frequency of occurrence is therefore considered to be **remote.**

Significance of effect

The severity of consequence is deemed to be minor and the frequency of occurrence is considered to be remote. The cumulative effect will, therefore, be of **broadly acceptable** adverse significance, which is **not significant** in EIA terms.

9.12.4.2 Operation and maintenance phase

There is the potential for increased disruption to port access during the operational phase due to cumulative developments, for example if surveys or repairs within the Welsh Channel overlap temporally with other cumulative developments.

Similar to the construction phase, details of major maintenance activities including any advisory safe passing distances, as defined by risk assessment, will be suitably promulgated to maximise awareness of ongoing major maintenance activities.

Maintenance/repair vessels will be managed by marine coordination, will display appropriate marks and lights, broadcast on AIS and will be compliant with relevant Flag State regulations including the COLREGs, including rule 18 which applies to vessels which are RAM. Liaison with the Port of Mostyn and FLO will help to manage disruption. Therefore, the impact is as per the equivalent operation and maintenance phase impact for the Proposed Development in isolation.

Severity of Consequence

The overall timescale for any maintenance/repair works is expected to be less than for construction works. Such works may result in limited disruption to vessels crossing the offshore cables within the Welsh Channel to access the Port of Mostyn. Any required maintenance is expected to be localised in one area of the Proposed Development and temporary in nature.

The severity of consequence is therefore considered to be **negligible.**

Frequency of Occurrence

The reduction in access is decreased compared to the construction phase given the smaller scale of maintenance activities, although this is somewhat balanced by the much longer duration of the operation and maintenance phase.

The frequency of occurrence is therefore considered to be **extremely unlikely**.

Significance of the effect

Overall, the severity of consequence is deemed to be negligible and the frequency of occurrence is considered to be extremely unlikely. The effect will, therefore, be of **broadly acceptable** adverse significance, which is **not significant** in EIA terms.

9.12.4.3 Decommissioning phase

There may be potential for further reduced access to local ports during the decommissioning phase if maintenance or decommissioning works associated with cumulative developments were to overlap temporally with the decommissioning of the Proposed Development.

Project vessels will be managed by marine coordination, will display appropriate marks and lights, broadcast on AIS (where available) and will be compliant with relevant Flag State regulations including the COLREGs, including rule 18 which applies to vessels which are RAM. Liaison with the Port of Mostyn and FLO will help to manage disruption.

With the embedded mitigation measures listed above, the effect due to the presence of cumulative developments is anticipated to be manageable.

Severity of Consequence

Since the numbers and types of vessels used to remove the platform and cables are expected to be similar to those used for construction, this impact is expected to be similar in nature to the equivalent construction phase impact.

The severity of consequence is therefore considered to be **minor.**

Frequency of Occurrence

The impact will be present throughout the decommissioning phase which is assumed to last for a similar timeframe as the construction period. Cumulative developments may lead to an increase in the number of vessels crossing the offshore cables within the Welsh Channel.

However, due to the localised and temporary nature of decommissioning works, the disruption to port access is reduced.

The frequency of occurrence is therefore considered to be **remote.**

Significance of the effect

The severity of consequence is deemed to be minor and the frequency of occurrence is considered to be remote. The cumulative effect will, therefore, be of **broadly acceptable** adverse significance, which is **not significant** in EIA terms.

9.12.5 Anchor interaction with subsea cable

9.12.5.1 Construction Phase

The risk of anchor interaction with the proposed cables during the construction phase could be increased if cumulative developments are expected to lead to increased traffic across the cables. Vessel movements in the area are expected to be impacted by the construction of the Mona, Morgan and Morecambe OWFs, which could lead to a change in traffic across the cables if the construction periods were to overlap. However, given the location of the offshore cables relative to the OWFs, and the current vessel routeing in the area, any change in vessel routeing across the cables is expected to be minimal. Depending on the ports utilised by construction vessels, there may also be a slight increase in vessel numbers if construction phases were to overlap, however the overall impact is expected to be similar.

Severity of Consequence

While exposed any vessel anchor could interact with the cables. If an anchor becomes snagged on the cables, there could be a risk of injury in trying to free it. If the anchor cannot be freed the safest action is to slip it, and not attempt to raise or cut the cable.

The most likely consequences are limited damage to property (anchoring vessel or subsea cable). The maximum adverse scenario may include damage to property including to the vessel’s anchor or subsea cable.

The severity of consequence is therefore considered to be **moderate.**

Frequency of Occurrence

Mitigation includes circulation of information to make mariners aware of the exposed cable and use of guard vessels where cable exposures are considered to present significant risk to navigation.

The frequency of occurrence is considered to be **extremely unlikely.**

Significance of effect

Overall, the severity of consequence is deemed to be moderate and the frequency of occurrence is considered to be extremely unlikely. The cumulative effect will, therefore, be of **broadly acceptable** adverse significance, which is **not significant** in EIA terms.

9.12.5.2 Operation and maintenance phase

The risk of anchor interaction with the proposed cables during the operational phase could be increased if cumulative developments are expected to lead to increased traffic across the cables. In particular, there may be deviations in vessel movements and increases in vessel numbers caused by the construction of the Mona, Morgan and Morecambe OWFs, depending on the preferred ports used during the construction and/or operational phases of these OWFs.

During the operation and maintenance phase the cables will be marked on UKHO Admiralty Charts with associated note/warning about anchoring, trawling or seabed operations.

Severity of Consequence

Once the cables are protected, either through burial and/or other protection measures, larger vessels (e.g. cargo vessels and tankers) are more likely to threaten the cables as their anchors are able to penetrate deeper into the seabed and can cause greater damage than smaller anchors (fishing and recreational vessels) if contact is made. The anchors of smaller vessels (e.g. fishing and recreational craft) are unlikely to penetrate as deeply. Suitable target burial depths, defined in a CBRA, will mitigate the risk from vessel anchors. Periodic monitoring will be undertaken to confirm cable protection remains suitable.

The most likely consequences are limited damage to property (anchoring vessel or subsea cable). The maximum adverse scenario may include damage to property including to the vessel's anchor or subsea cable.

The severity of consequence is therefore considered to be **minor.**

Frequency of Occurrence

Protection of the cables via burial will reduce the frequency of occurrence of anchor interaction.

Although there may be limited decision-making time if a vessel is drifting towards a hazard, it is anticipated that the charting of infrastructure including all subsea cables will inform any decision to anchor, as per Regulation 34 of SOLAS (IMO, 1974).

The frequency of occurrence is considered to be **extremely unlikely**.

Significance of effect

Overall, the severity of consequence is deemed to be minor and the frequency of occurrence is considered to be extremely unlikely. The cumulative effect will, therefore, be of **broadly acceptable** adverse significance, which is **not significant** in EIA terms.

9.12.6 Fishing gear interaction with subsea cable

9.12.6.1 Construction Phase

The risk of fishing gear interaction with the cables during the construction phase could be increased if cumulative developments are expected to lead to increased fishing activity across the cables. Construction of the Mona OWF could cause vessels to be displaced towards the proposed cables, however any displacement is expected to be minimal compared to the current fishing levels across the cables.

Therefore, the impact is as per the equivalent construction phase impact for the Proposed Development in isolation.

Mitigation measures including having an FLO in place and circulation of information (e.g. via Kingfisher and local communications) will help ensure any displaced fishermen are aware of the exposed cable and avoid fishing directly over it. In addition, guard vessels will be used in any areas where cable exposures are considered to present significant risk to fishing gear snagging.

Severity of Consequence

The most likely consequences are as per the equivalent impact for the Proposed Development in isolation.

The severity of consequence is therefore considered to be **serious.**

Frequency of Occurrence

The frequency of occurrence during the period that the cables are surface-laid is considered to be **remote.**

Significance of effect

Overall, the severity of consequence is deemed to be serious and the frequency of occurrence is considered to be remote. The cumulative effect will, therefore, be of **tolerable adverse** significance, which is **not significant** in EIA terms.

Additional mitigation to reduce this impact to ALARP is to minimise the amount of time between cable lying and installation of cable protection, (e.g. burial).

9.12.6.2 Operation and maintenance phase

The risk of fishing gear interaction with the proposed cables during the operational phase could be increased if cumulative developments are expected to lead to increased fishing activity across the cables. Any displacement is expected to be minimal compared to the current fishing levels across the cables.

Therefore, the impact is as per the equivalent operational phase impact for the Proposed Development in isolation.

During the operation and maintenance phase the cables will be marked on UKHO Admiralty Charts and KIS-ORCA charts with associated note/warning about anchoring, trawling or seabed operations.

A CBRA will be undertaken to provide a detailed assessment of fishing activity along the Proposed Development and fishing gear penetration depths for the various soil conditions in order to determine suitable protection measures for the cables during the operation and maintenance phase.

Severity of Consequence

The planned cable protection is assumed to provide effective mitigation from fishing gear snagging, reducing the risk of serious consequences such as snagging, capsize of the vessel and PLL.

The severity of consequence is therefore considered to be **minor.**

Frequency of Occurrence

The frequency of occurrence is considered to be **extremely unlikely**.

Significance of effect

Overall, the severity of consequence is deemed to be minor and the frequency of occurrence is considered to be extremely unlikely. The cumulative effect will, therefore, be of **broadly acceptable** adverse significance, which is **not significant** in EIA terms.

9.12.7 Vessel grounding due to reduced under keel clearance

9.12.7.1 Operation and maintenance phase

There could be an increased risk of vessel grounding due to reduced under keel clearance if cumulative projects were to lead to additional vessel movements over the proposed cables, particularly in areas where water depths are shallow.

This is particularly relevant if there is an increase in wind farm crew transfer vessels using the Port of Mostyn.

Severity of Consequence

Should a vessel grounding occur, the most likely consequences are minor damage to property and minor reputational effects on business but no perceptible effect on people. The maximum adverse scenario may include the vessel foundering resulting in PLL and the environmental consequence of pollution.

The severity of consequence is therefore considered to be **moderate.**

Frequency of Occurrence

When considered with the embedded mitigation of compliance with the requirements in MGN 654 and any change to water depth of more than 5% chart datum requiring further consultation and agreement with the MCA, the frequency is considered to be reduced to low for all vessel types.

The frequency of occurrence is therefore considered to be **remote**.

Significance of the Effect

Overall, the severity of consequence is deemed to be moderate and the frequency of occurrence is considered to be remote. The cumulative effect will, therefore, be of **tolerable adverse** significance, which is **not significant** in EIA terms.

9.12.8 Interference with magnetic compasses

Interference with magnetic position fixing equipment is local in nature, occurring only when a vessel is located in proximity to a subsea cable. Accounting for the distance between the proposed cables and the cumulative developments, it is not anticipated that the presence of the cumulative developments will result in any change to this impact.

Severity of Consequence

The severity of consequence is considered to be **minor.**

Frequency of Occurrence

The frequency of occurrence is considered to be **extremely unlikely**.

Significance of the Effect

Overall, the severity of consequence is deemed to be minor, and the frequency of occurrence is considered to be extremely unlikely. The cumulative effect will, therefore, be of **broadly acceptable** adverse significance, which is **not significant** in EIA terms.

9.12.9 Reduction of emergency response capability due to increased incident rates for SAR responders and increased demand on the available resources

9.12.9.1 All Phases

If construction works for the Proposed Development were to overlap with construction or operational phases of the cumulative developments, there could be increased reduction in emergency response capability. However, due to the temporary nature of the construction works, this impact is expected to be minimised.

Project vessels will be managed through marine coordination and compliant with Flag State regulations. Additionally, should an incident occur, project vessels will be well equipped to assist, either through self-help capability or – for an incident involving a nearby third-party vessel – through SOLAS obligations (IMO, 1974), all in liaison with the MCA.

During the operation and maintenance phase of the Proposed Development, there is not expected to be a notable increase in vessel numbers, however there may be a period of time when the new Douglas CCS platform and the existing Douglas Complex are in operation simultaneously. If this coincides with the construction or operational phases of cumulative projects, this could further reduce emergency response capability. As the new Douglas CCS platform will be unmanned, any impact is considered to be minimal.

Severity of Consequence

The severity of consequence is considered to be **moderate**.

Frequency of Occurrence

Due to the limited number of vessels involved and temporary nature of the construction phase works, and given that the proposed new Douglas CCS platform will be unmanned and within the existing Douglas Complex, the frequency of occurrence is considered to be **negligible.**

Significance of Risk

Overall, the severity of consequence is deemed to be moderate and the frequency of occurrence is considered to be negligible. The effect will, therefore, be of **broadly acceptable** adverse significance, which is **not significant** in EIA terms.

9.13 Additional Mitigation

Proposed additional mitigation measures to ensure tolerable risks are reduced to ALARP are as follows:

- The period during which the cables are surface laid and not yet buried or protected should be reduced so far as practicable. This reduces the risk of vessel anchors and fishing gear snagging on surface-laid cables

9.14 Transboundary effects

Transboundary effects arise when impacts from a development within one European Economic Area (EEA) state's territory affects the environment of another EEA state(s).

Since international shipping has been included in the baseline assessment, there is no potential for transboundary impacts upon shipping and navigation receptors due to construction, operation and maintenance and decommissioning of the Proposed Development. Therefore, transboundary effects for shipping and navigation receptors do not need to be considered further.

9.15 Inter-related effects

Inter-related effects are the potential effects of multiple impacts affecting one receptor or a group of receptors. Inter-related effects include interactions between the impacts of the different stages of the Proposed Development (i.e. interaction of impacts across construction, operation and maintenance and decommissioning), as well as the interaction between impacts on a receptor within a project stage. A description of the likely inter-related effects arising from the Proposed Development on shipping and navigation is provided below.

Displacement of commercial fishing vessels from fishing grounds may lead to an increase in vessel-to-vessel collision risk between third-party vessels. However as this is already considered within the shipping and navigation chapter these inter-related effects are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phases. Therefore, these inter-related effects would not be significant in EIA terms.

9.16 Conclusion

Information on shipping and navigation within the Shipping and Navigation Study Area was collected through desktop review of a number of data sources and through consultation with both national and local stakeholders.

The impacts assessed include:

- Vessel displacement leading to increased vessel to vessel collision risk between third-party vessels

- Increased vessel to vessel collision risk between a third-party vessel and a project vessel
- Vessel to platform allision risk
- Reduced access to local ports
- Anchor interaction with subsea cable
- Fishing gear interaction with subsea cable
- Vessel grounding due to reduced under keel clearance
- Reduction of emergency response capability due to increased incident rates for SAR responders and increased demand on the available resources.

Overall, it is concluded that there will be no significant effects arising from the Project during the construction, operational and maintenance *or* decommissioning phases.

The cumulative impacts assessed include all of those assessed for the Proposed Development in isolation. Overall, it is concluded that there will be no significant cumulative effects from the Project alongside other projects/plans.

No potential transboundary impacts have been identified regarding effects of the Project.

9.17 References

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Liverpool Bay CCS Ltd

HYNET CARBON DIOXIDE TRANSPORTATION AND STORAGE PROJECT - OFFSHORE

Environment Statement
Volume 2, chapter 10: Commercial Fisheries

EHE7228B
Liverpool Bay CCS Limited
Final
February 2024
Offshore ES
Commercial Fisheries

rpsgroup.com

Glossary

Term	Meaning
Cumulative effects assessment	Assessment of the likely effects arising from the offshore components of the HyNet CO_2 Transportation and Storage System ('Proposed Development') alongside the likely effects of other development activities in the vicinity of the Proposed Development.
Effect	The consequence of an impact.
Environmental Impact Assessment	A statutory process by which certain planned projects must be assessed before a formal decision to proceed can be made. It involves the collection and consideration of environmental information, which fulfils the assessment requirements of the EIA Directive and EIA Regulations, including the publication of an Environmental Statement (ES).
Impact	A change that is caused by an action.
Magnitude	Size, extent, and duration of an impact.
Maximum Design Scenario	The maximum design parameters of each Proposed Development asset (both on and offshore) considered to be a worst case for any given assessment but within the range of the Project Description Envelope.
Mitigation Measure	Measure which would avoid, reduce, or remediate an impact.
Non-statutory stakeholder	Organisations with whom the regulatory authorities may choose to engage who are not designated in law but are likely to have an interest in a proposed development.
Project	The HyNet Carbon Dioxide Transportation and Storage Project.
Proposed Development	The offshore components of the Project which are subject of this Environmental Statement, as described in volume 1, chapter 3.
Residual Impact	Residual impacts are the final impacts that occur after the proposed mitigation measures have been put into place, as planned.
Scoping Opinion	Sets out the Secretary of State's response to the Applicants Scoping Report and contains the range of issues that the Secretary of State, in consultation with statutory stakeholders, has identified should be considered within the EIA.
The Applicant	This is Liverpool Bay CCS Ltd.
Transboundary effects	Impacts from a project within one state affect the environment of another state(s).

Acronyms and Initialisations

Acronym/Initialisation	Description
AIS	Automatic Information System
CAA	Civil Aviation Authority
CBRA	Cable Burial Risk Assessment
CCS	Carbon capture and storage
CEA	Cumulative Effects Assessment
CSIP	Cable Specification and Installation Plan
DCF	Data Collection Framework
Defra	The Department for Environment, Food & Rural Affairs
DESNZ	The Department for Energy Security and Net Zero, preceded by the Department for Business, Energy, and Industrial Strategy (2016 to 2023) and the Department of Energy and Climate Change (2008 to 2016)
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EMF	Electromagnetic Field
EMSA	European Maritime Safety Agency

Acronym/Initialisation	Description
ES	Environmental Statement
EU	European Union
FIR	Fishing Industry Representative
FLCP	Fisheries Liaison and Coexistence Plan
FLO	Fisheries Liaison Officer
FLOWW	Fisheries Liaison with Offshore Wind and Wet Renewables group
FMP	Fisheries Management Plan
FO	Fibre Optic
GPS	Global Positioning System
HRA	Habitats Regulations Appraisal
ICES	International Council for the Exploration of the Sea
IFCA	Inshore Fisheries and Conservation Authority
JFS	Joint Fishery Statement
MCA	Maritime and Coastguard Agency
MCZ	Marine Conservation Zone
MDS	Maximum Design Scenario
MHWS	Mean High Water Springs
MMO	Marine Management Organisation
MPA	Marine Protected Area
MSC	Marine Stewardship Council
NPPF	National Planning Policy Framework
NPS	National Policy Statement
NtM	Notice to Mariners
O&M	Operations and Maintenance
OP	Offshore Platform
OPRED	Offshore Petroleum Regulator for Environment & Decommissioning
PoA	Point of Ayr
RBS	Registration of Buyers and Sellers
RIAA	Report to Inform Appropriate Assessment
SAC	Special Area of Conservation
SAR	Swept Area Ratio
SPA	Special Protection Area
STECF	Scientific, Technical and Economic Committee for Fisheries
TCA	Trade and Cooperation Agreement
UK	United Kingdom
UKFEN	United Kingdom Fisheries Economic Network
UXO	Unexploded Ordnance
VMS	Vessel Monitoring System
WNMP	Welsh National Marine Plan

Units

Unit	Description
“	Inch (distance; equal to 0.0254 m)
%	Percent
£	Pound (currency)
km	Kilometres (distance)
km^2	Kilometres squared (area)
m	Metres (distance)
NM	Nautical Mile (distance; equal to 1.852 km)

Contents

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Figures

10 COMMERCIAL FISHERIES

10.1 Introduction

This chapter of the Offshore Environmental Statement (ES) presents the assessment of the likely significant effects (as per the 'EIA Regulations') on the environment of the Proposed Development on commercial fisheries. Specifically, this chapter considers the potential impacts from the construction, operation, and maintenance, and decommissioning of the offshore and intertidal components (seaward of the Mean High Water Springs (MHWS) mark) of the development area, which includes the pipelines and cables leading to MHWS.

Likely significant effect is a term used in both the 'EIA Regulations' and the Habitat Regulations. Reference to likely significant effect in this Offshore ES refers to 'likely significant effect' as used by the 'EIA Regulations'. This Offshore ES is accompanied by a Report to Inform Appropriate Assessment (RIAA) which uses the term as defined by the Habitats Regulations Assessment (HRA) Regulations.

The assessment should be read in conjunction with following linked ES chapters and supporting documentation:

- volume 2, chapter 7: Marine Biodiversity: where impacts on the ecology of fish and shellfish, including species of commercial interest, are assessed;
- volume 2, chapter 9: Shipping and Navigation: where impacts on the navigational safety aspects of fishing activity are assessed; and
- volume 2, chapter 12: Infrastructure and Other Users: where impacts on charter angling businesses are assessed.

Additional information on the baseline environment to support the commercial fisheries assessment includes:

- Commercial Fisheries Technical Report (Poseidon, 2023).

10.2 Purpose of this chapter

The primary purpose of the Offshore ES is outlined in volume 1, chapter 1. It is intended that the Offshore ES will provide the statutory and non-statutory stakeholders, with sufficient information to determine the likely significant effects of the Proposed Development on the receiving environment.

In particular, this commercial fisheries ES chapter:

- presents the existing environmental baseline established from desk studies, analysis of available fisheries data and consultation with stakeholders;
- identifies any assumptions and limitations encountered in compiling the environmental information;
- presents the likely significant environmental impacts on commercial fisheries arising from the Proposed Development and reaches a conclusion on the likely significant effects on commercial fisheries, based on the information gathered and the analysis and assessments undertaken; and
- highlights any necessary monitoring and/or mitigation measures which recommended to prevent, minimise, reduce or offset the likely significant adverse environmental effects of the Proposed Development on commercial fisheries.

This assessment has been undertaken with specific reference to the relevant legislation and guidance, of which the primary sources are the National Policy Statements (NPSs). Details of these, and the methodology used for the Environmental Impact Assessment (EIA) and Cumulative Effects Assessment (CEA), are presented in in volume 1, chapter 5: Environmental Impact Assessment Methodology and section 10.9 of this chapter.

10.3 Study area

The Proposed Development is located within the eastern portion of the International Council for the Exploration of the Sea (ICES) Division 7a (Irish Sea) statistical area; within the United Kingdom (UK) Exclusive Economic Zone (EEZ) waters. For the purpose of recording fisheries landings, ICES Division 7a is divided into statistical rectangles which are consistent across all Member States operating in the Irish Sea.

The Proposed Development is located within ICES rectangles 35E6 and 36E6, which represent the commercial fisheries study area for the EIA, as shown in Figure 10.1. Note that the Eni development area, area of project physical work and proposed infrastructure occupy only a portion of these ICES rectangles in terms of surface areal overlap.

In total, the development area of the Proposed Development (shown as red line boundary in Figure 10.1) overlaps with 12.5% of the commercial fisheries study area, and the area of Proposed Development physical work (shown as the black dashed line) overlaps with 1.43% of the commercial fisheries study area.

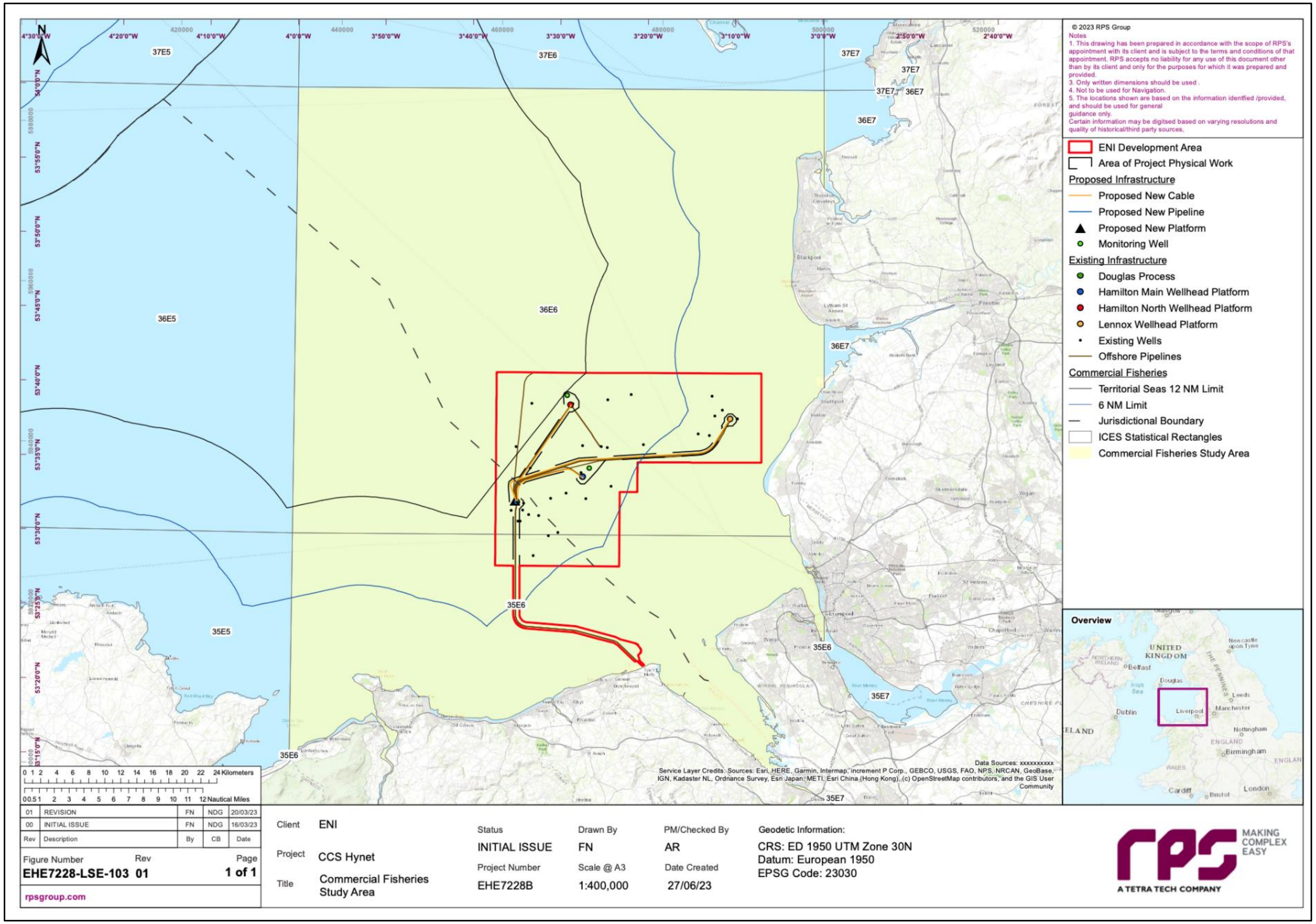

Figure 10.1: Commercial Fisheries Study Area (ICES Rectangles 35E6 And 36E6)

10.4 Policy and Legislative Context

The policy context for the HyNet Carbon Dioxide Transportation and Storage Project - Offshore is set out in volume 1, chapter 2. The Department for Energy and Climate Change (now the Department for Energy Security and Net Zero (DESNZ)) published a number of NPSs in relation to energy infrastructure, which were designated by the Secretary of State for Energy and Climate Change in July 2011.

In the case of the Proposed Development, none of the energy NPSs directly apply. Where this is the case, section 105 of the PA2008 applies and applications will be tested against 'important and relevant' matters, which are typically local adopted planning policies and the National Planning Policy Framework (NPPF).

However, the following NPSs may still be important and relevant considerations in assessing the Proposed Development:

- Overarching National Policy Statement for Energy (EN-1); and
- National Policy Statement for Gas Supply Infrastructure and Gas and Oil Pipelines (EN-4).

NPS EN-4 applies to nationally significant infrastructure pipelines which transport natural gas or oil. However, it is noted that NPS EN-4 may also be useful in identifying impacts to be considered in applications for pipelines intended to transport other substances and therefore it has been reviewed for relevance to commercial fisheries.

The North West Inshore and North West Offshore Marine Plan (Defra, 2021) supports maximising possibilities for the co-existence and co-operation of marine sectors. The Plan includes policies relevant to aquaculture (NW-AQ-1), commercial fisheries (NW-FISH-2, NW-FISH-3) and co-existence (NW-CO-1).

Table 10.1 presents a summary of legislation and policies of relevance for the commercial fisheries and aquaculture assessment.

Table 10.1: Summary Of Legislation And Policy Provisions Relevant To Commercial Fisheries

Relevant Legislation and Policy	Relevance to the assessment
UK Fisheries Act (2020)	The UK Fisheries Act (2020) (23 Nov 2020) sets out a series of objectives for management of commercial fisheries as follows — (a) the sustainability objective, (b) the precautionary objective, (c) the ecosystem objective, (d) the scientific evidence objective, (e) the bycatch objective, (f) the equal access objective, (g) the national benefit objective, and (h) the climate change objective. The Joint Fishery Statement (JFS) was published in November 2022 and outlines commitments for delivery of Fisheries Management Plans (FMPs) for delivery by UK fisheries administrators. Of particular note for the region is the development of FMPs for English and Welsh waters for the following species: brown crab and lobster, whelk, king scallop and bass. The JFS defines which fisheries administrator is responsible for the delivery of the FMPs, including development of co-management groups with the industry. Delivery of the FMPs is expected by 2024.
UK Marine Policy Statement (2011)	The UK Marine Policy Statement sets out high-level objectives for the UK marine space, including achieving a sustainable marine economy and identifies a wide range of relevant marine uses. It requires the marine environment and its resources to be used to maximise sustainable activity, prosperity and opportunities for all.

Relevant Legislation and Policy	Relevance to the assessment
	It explicitly expresses support for the fishing sector, and with regard to displacement, advocates 'seeking solutions such as co-location of activity wherever possible '. Specifically, paragraphs 3.8.1, 3.8.2, and 2.3.1.5 stipulate that the process of marine planning should 'enable the co-existence of compatible activities wherever possible' and supports the reduction of real and potential conflict as well as maximising compatibility and encouraging co-existence of activities.
The Welsh National Marine Plan (WNMP; 2019)	Policy SAF-01b seeks to 'enable established activities to continue and thrive wherever possible' (paragraph 404). The Policy also recognises that much of Wales' fishing activity is often very localised and dependent upon a particular area or habitat. Unlike larger, more nomadic vessels with mobile gears, Welsh inshore vessels cannot easily relocate to other areas where the available space and catch opportunity is likely to be limited. The WNMP supports development proposals that will support and enhance sustainable fishing activities.
EC Directive (92/43/EEC) on the Conservation of Natural Habitats and of Wild Fauna and Flora (1992) **EC Directive (2009/147/EC) on the Conservation of Wild Birds (2009)** **Conservation of Offshore Marine Habitats and Species Regulations (2017)**	Defines the species, habitats and types of sites that receive legal protection and describes the protection that is afforded.
NW Inshore and Offshore Marine Plan: commercial fisheries policy NW-FISH-2	Commercial fisheries Policy NW-FISH-2: Proposals that may have significant adverse impacts on access for fishing activities must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate adverse impacts so they are no longer significant. If it is not possible to mitigate significant adverse impacts, proposals should state the case for proceeding. NW-FISH-2 supports enhanced access for sustainable fishing activities and seeks to limit significant adverse impacts from other marine activities on access for fishing activities, enabling continued sustainable marine resource use and generating prosperous, resilient, and cohesive coastal communities. This policy covers not only fishing activity, but also the transit routes to and from sites and any berthing/beaching or landing/loading points.
NW Offshore Marine Plan: commercial fisheries policy NW-FISH-3:	Commercial fisheries Policy NW-FISH-3: Proposals that may have significant adverse impacts on essential fish habitat, including spawning, nursery and feeding grounds, and migratory routes, must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate adverse impacts so they are no longer significant. NW-FISH-3 enables sustainable use of marine resources within environmental limits, alongside productive fisheries, by requiring proposals to avoid impacts on essential fish habitats or, if avoidance of impacts is not possible, to manage impacts on essential fish habitats.
NW Offshore Marine Plan: co-existence policy NW-CO-1	Co-existence Policy NW-CO-1: Proposals that optimise the use of space and incorporate opportunities for co-existence and co-operation with existing activities will be supported. Proposals that may have significant adverse impacts on, or displace, existing activities must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate adverse impacts so they are no longer significant. If it is not possible to mitigate significant adverse impacts, proposals must state the case for proceeding.
NW Offshore Marine Plan: aquaculture policy NW-AQ-1	Aquaculture Policy NW-AQ-1: Proposals within existing or potential strategic areas of sustainable aquaculture production must demonstrate consideration of and compatibility with sustainable aquaculture production.

10.4.1 Other Relevant Information and Guidance

In addition to the planning policy guidance listed above, the following guidance documents have been used to inform the assessment of potential impacts on commercial fisheries:

- Fisheries Liaison Guidelines - Issue 6 (UK Oil and Gas, 2015);
- Fishing and Submarine Cables - Working Together (International Cable Protection Committee, 2009).
- Best Practice Guidance for Fishing Industry Financial and Economic Impact Assessments (United Kingdom Fisheries Economic Network (UKFEN) and Seafish, 2012);
- Fisheries Liaison with Offshore Wind and Wet Renewables group (FLOWW) Recommendations for Fisheries Liaison: Best Practice guidance for offshore renewable developers (FLOWW, 2014 and BERR, 2008);
- FLOWW Best Practice Guidance for Offshore Renewables Developments: Recommendations for Fisheries Disruption Settlements and Community Funds (FLOWW, 2015);
- Options and opportunities for marine fisheries mitigation associated with wind farms (Blyth-Skyrme, 2010a);
- Developing guidance on fisheries Cumulative Impact Assessment for wind farm developers (Blyth-Skyrme, 2010b);
- Cumulative impact assessment guidelines, guiding principles for cumulative impacts assessments in offshore wind farms (RenewableUK, 2013); and
- Guidelines for data acquisition to support marine environmental assessments of offshore renewable energy projects. Contract report: ME5403 (Cefas, 2012).

FLOWW guidance has been particularly important in shaping the process and procedures in establishing disruption settlements, when required. While the Proposed Development is not categorised as part of the FLOWW group, the FLOWW guidance is considered relevant in this instance due to the type of infrastructure (cables, offshore platforms and associated safety zones), together with well established procedures in the region that have been developed through of significant offshore windfarm development.

10.5 Consultation

Consultation in regard to commercial fisheries has been undertaken in line with the general process described in volume 1, chapter 5: Environmental Impact Assessment Methodology. The key elements to date for commercial fisheries have included scoping (Scoping Opinion from the Offshore Petroleum Regulator for Environment & Decommissioning (OPRED) received on 27 January 2023) and ongoing consultation with fishing industry representatives and other fisheries stakeholders via the Fisheries Liaison Officer (FLO).

The feedback received throughout this process, including the Scoping Opinion received from OPRED, has been considered in preparing the ES chapter. The key elements to date pertinent to commercial fisheries are shown in, and details how the Applicant has had regard to the comments and how these have been addressed within this chapter.

Table 10.2: Summary Of Key Consultation Of Relevance To Commercial Fisheries

Consultee	Comment	Response
OPRED	The following potential impact pathways for marine water and sediment quality which are not currently scoped-in, but which will require further consideration have been identified: bacterial release from sediments due to the proximity of designated bathing and shellfish waters; pipeline contents temperature effects; and impacts to Dissolved Oxygen and Phytoplankton as a result of elevated suspended sediment concentrations.	The potential impact pathways have been reviewed for consideration within volume 2, chapter 7: Marine Biodiversity. The potential impact on aquaculture receptors is assessed in section 10.11.
OPRED	Should trenching take place in the intertidal area, it is advised that bacterial release from sediments is assessed due to the potential proximity to designated bathing and shellfish waters.	The potential for bacteria release from sediments displaced due to trenching has been reviewed for consideration within volume 2, chapter 7: Marine Biodiversity.
OPRED	It is recommended that potential impacts of Electromagnetic Fields (EMFs) from the cables are scoped into the assessment for fish and shellfish receptors.	Embedded mitigation includes MM2 Suitable implementation and monitoring of Cable Protection and MM3 Development and adherence to a Cable Specification and Installation Plan post consent which will include cable burial where possible (in accordance with the specific policies set out in the North West Inshore and North West Offshore Coast Marine Plans (Defra, 2021)) and cable protection, as necessary. See volume 3, Enhancement, Mitigation and Monitoring Commitments (RPS Group, 2023). The significance of this effect is considered to be negligible, and this impact remains scoped out of assessment.
OPRED	Section 3.4.1.1: Pipeline Contents Temperature Increase, the intention to undertake further studies to understand the effects of heat from the Proposed Development is noted. It is advised that the potential effects on fish receptors are also considered and that this impact is scoped into the assessment for fish and shellfish receptors.	The potential for temperature increase and effects of pipeline heat has been reviewed for consideration within volume 2, chapter 7: Marine Biodiversity.
OPRED	Section 3.5: Offshore Construction Phase - Offshore Power and Fibre Optic (FO) Cables. Clarification regarding the target cable burial depth is requested. It is advised that, if a minimum cable burial depth cannot be met due to ground condition, the cable should (generally) be protected by rock armouring in order to reduce the risk of navigational hazards.	Embedded mitigation includes MM2 Suitable implementation and monitoring of Cable Protection and MM3 Development and adherence to a Cable Specification and Installation Plan post consent which will include cable burial where possible (in accordance with the specific policies set out in the North West Inshore and North West Offshore Coast Marine Plans (Defra, 2021)) and cable protection, as necessary. See volume 3, Enhancement, Mitigation and Monitoring Commitments (RPS Group, 2023). The locations of rock placement (where employed) will be communicated to the commercial fishing industry.

10.6 Methodology to Inform the Baseline

10.6.1 Data Sources

The data sources that have been collected and used to inform this commercial fisheries assessment are summarised in Table 10.3. As well as UK data sources, data has been sourced from European fisheries bodies. Relevant literature from a number of additional sources has also been reviewed and are referenced throughout as appropriate.

Table 10.3: Key Sources Of Commercial Fisheries Data

Source, Author, and Year	Summary	Coverage of the commercial fisheries study area
UK annual fisheries landings statistics Marine Management Organisation (MMO), 2011 to 2021	Fisheries landings data for registered fishing vessels landing to their home nation ports.	UK national dataset providing full coverage of the commercial fisheries study area.
UK Vessel Monitoring System (VMS) data MMO, 2016 to 2020	VMS data for fishing vessels greater than 15 m in length. Note that UK vessels ≥12 m in length have VMS on board, however, to date, the MMO provide amalgamated VMS datasets for ≥15 m vessels only. VMS data sourced from MMO displays the first sales value (£) of catches. Note that the most recent data has been presented in this Scoping Report, but that longer term datasets will be analysed within the ES.	UK national dataset providing full coverage of the commercial fisheries study area.
European Union (EU) annual fisheries landings statistics Scientific, Technical and Economic Committee for Fisheries (STECF), 2004 to 2016	Fisheries landings data for registered fishing vessels landing to their home nation ports.	European-wide dataset providing full coverage of the commercial fisheries study area.
EU VMS data ICES, 2016 to 2020	VMS data for fishing vessels greater than 12 m in length. VMS data sourced from ICES displays the surface Swept Area Ratio (SAR) of catches by different gear types and covers EU (including UK) registered vessels 12 m and over in length. Surface SAR indicates the number of times in an annual period that a demersal fishing gear makes contact with (or sweeps) the seabed surface. Surface SAR provides a proxy for fishing intensity.	European-wide dataset providing full coverage of the commercial fisheries study area.
Fishing vessel route density data European Maritime Safety Agency (EMSA), 2021	Fishing vessel route density, based on vessel Automatic Information System (AIS) positional data. AIS is required to be fitted on fishing vessels ≥15 m length. Note that the most recent data has been presented in this Scoping Report, but that longer term datasets will be analysed within the ES.	European-wide dataset providing full coverage of the commercial fisheries study area.
Key species stock assessments ICES, various publication dates	Assessments of the status of commercially targeted fish and shellfish stocks.	Varying spatial coverage, in most cases providing full coverage of the commercial fisheries study area.
ICES, 2019	Scallop dredge grounds in the Irish Sea mapped by ICES Working Group on Scallops	Irish Sea dataset providing full coverage of the commercial fisheries study area

Source, Author, and Year	Summary	Coverage of the commercial fisheries study area
FishMap Môn project, 2013	Fishing intensity for nine gear types in a defined project area off the north Wales coastline.	Welsh dataset providing partial coverage of the commercial fisheries study area.
Welsh Government, 2019	Fishing activity for mobile and static gear in Welsh waters.	Welsh dataset providing partial coverage of the commercial fisheries study area.
Defra, 2023	Marine planning tool to explore aquaculture production and strategic areas of sustainable aquaculture production.	English and Welsh dataset providing full coverage of the commercial fisheries study area.

10.6.2 Data Analysis

Landings statistics for UK registered vessels were obtained from the MMO with the following parameters: year; month; gear type; ICES rectangle; species; live weight (tonnes) and first sales value (£) across a six-year period (2016 to 2021); a longer period was analysed for queen scallop landings (2011 to 2021) to allow any cyclical trends to be identified. Landing statistics have been analysed through excel.

Landings data for all species are collected via the European Union (EU) logbooks scheme and recorded by ICES statistical rectangle and stored in the EU Data Collection Framework (DCF) database, accessible through the EU Joint Research Committee. Landings data has been collated for all EU Member States for the ICES statistical rectangle that overlap the commercial fisheries study area. Landing statistics were collated across five years (2012 to 2016). Landing statistics include all landings by that country's nationally registered vessels into all ports. The following parameters were examined: year; season (quarter); gear type; ICES rectangle; species; effort (hours fished); and live weight (tonnes).

Vessel Monitoring System (VMS) is a form of satellite tracking using transmitters on board fishing vessels. Annual VMS data are collated by the MMO for all vessels ≥15 m registered to the UK, including all gear types. VMS data for UK vessels have been analysed for 2016 to 2020. VMS and other spatial data sources have been analysed through ArcMap v10.8.4.

10.6.3 Data Limitations

Limitations of landings data include the spatial size of ICES rectangles which can misrepresent actual activity across the Proposed Development and care is therefore required when interpreting the data. A further limitation of landings data is the potential under-reporting of landings associated with potting vessels, which may occur as a result of estimating catches (as opposed to accurate weighing) and not reporting catches that fall below the acceptable limit as defined within the UK Registration of Buyers and Sellers (i.e. when purchases of first sale fish direct from a fishing vessel are wholly for private consumption, and less than 30 kg is bought per day). Registered buyers are legally required to provide sales notes of all commercially sold fish and shellfish due to the 2005 Registration of Buyers and Sellers of First-Sale Fish Scheme (RBS legislation) (MMO, 2021). The RBS legislation is applicable to licenced fishing vessels of all lengths and requires name and PLN of the vessel which landed the fish to be recorded in relation to each purchase. For the 10 m and under sector, landing statistics are recorded on sales notes provided by the registered buyers (MMO, 2021). Information that may not be formally recorded on the sales note, such as gear and fishing area, is added by coastal staff based on local knowledge of the vessels they administer - for example, from observations of the vessel during inspections at ports or from air and sea surveillance activities as well as discussions with the owner and/or operator of the vessel (MMO, 2021).

In addition to RBS sales notes data, the Catch App was implemented in early 2022 for under 10 m vessels registered in England and Wales. The Catch App requires vessel owners / skippers to submit catch records for under 10 m vessels operating in UK waters. Data from 2022 onwards is being incorporated into the MMO iFISH database to form a more robust and verified record of landings by the under 10 m fleet. This data is expected to be incorporated into the 2022 annual fisheries statistics, published in autumn 2023.

Lack of recent landings statistics for EU (non-UK) fleets is also recognised as a data limitation; based on the most recent European Commission data call, more recent landings data is no longer available by ICES rectangle. Data at a scale of ICES division (i.e. the whole of the Irish Sea) is less useful to understand fishing activity specific to the area overlapping the study area.

Limitations of VMS data are primarily focused on the coverage being limited to vessels ≥15 m for MMO data. It is important to be aware that where mapped VMS data may appear to show inshore areas as having lower (or no) fishing activity compared with offshore areas, this is not necessarily the case because VMS data does not include vessels typically operating in inshore areas (i.e. which typically comprises of vessels <15 m in length).

Data limitations have been managed by ensuring accurate interpretation of the data and clear understanding of its scope, together with cross-referencing between data sources. As data form only part of the evidence base, the limitations identified are not considered to significantly affect the certainty or reliability of the impact assessment.

10.6.4 Potential receptors

The fishery receptors identified that may experience likely significant effects for commercial fisheries are outlined in Table 10.4. These receptors have been identified based on desktop analysis of baseline data.

Table 10.4: Receptors Requiring Assessment For Commercial Fisheries

Fishery/fleet group	Receptors included within group
Potting fleet (i.e. vessels fishing with pots and traps)	Welsh and English vessels targeting whelk, brown crab, lobster, and common prawn
Passive netting fleet (i.e. vessels fishing with nets), including fixed and drift netting	Welsh and English vessels targeting mixed demersal species including bass, flounder, and thornback ray
Dredging fleet (i.e. vessels fishing with dredges)	English, Scottish, Northern Irish, and Welsh vessels targeting king scallop and queen scallop

10.7 Existing baseline description

This section presents the existing baseline for commercial fisheries, using the most recent datasets available at the time of writing (2012 to 2016 for EU DCF data; 2016 to 2021 for MMO data; 2016 to 2020 for MMO VMS data).

This section provides an overview of all landings from the commercial fisheries study area (i.e. ICES rectangles 35E6 and 36E6) followed by analysis on a fishery-by-fishery basis, where details on the nationality of vessels, species caught, and location of fishing activity is provided.

This section should be read in conjunction with Commercial Fisheries Technical Report (Poseidon, 2023), which provides an extended description of baseline conditions, including fishing gear and vessel characteristics, profiles of fishing activity on a country basis and spatial activity mapping of fishing activity across the study area.

10.7.1 Overview of landings data from the study area

An annual average value of £4.8 million was landed by all UK vessels for the years 2016 to 2021 from the study area ICES rectangles 35E6 and 36E6 (based on data from MMO, 2022). Data are presented for the annual (2016 to 2021) landed weight and value by UK vessels in Figure 10.2 and Figure 10.3 respectively, indicating that landings are dominated by shellfish species. A longer timeline of landings data is available in Commercial Fisheries Technical Report (Poseidon, 2023) for specific species that show cyclical trends in catches, specifically scallop species.

Landings data sourced from the EU DCF database indicates that the only non-UK fishery present in the study area is Irish vessels dredging for scallop and Belgian beam trawlers targeting sole and plaice. The data suggests that landings by Irish and Belgian vessels from the study area are small and predominately occur outside the 12 NM boundary and therefore outside the area of project physical work.

MMO landings data for ICES rectangles 36E6 and 36E5 indicates that landings are dominated by shellfish species, namely whelk *Buccinum undatum*, queen scallop *Aequipecten opercularis*, king scallop *Pecten maximus*, and lobster *Homarus gammarus*.

Landings by ICES rectangle and UK country are depicted in Figure 10.4, indicating that for 36E6, landings are predominately by Scottish and English vessels, and for 35E6 landings are predominately by Welsh and English vessels. that landings from the study area have historically been dominated by shellfish species. Landings for Scottish vessels peaked in 2016, associated with a peak in queen scallop landings. For English vessels, a peak is seen in 2019, associated with whelk landings. Local fleets and landings by each nation are described in more detail in Commercial Fisheries Technical Report (Poseidon, 2023).

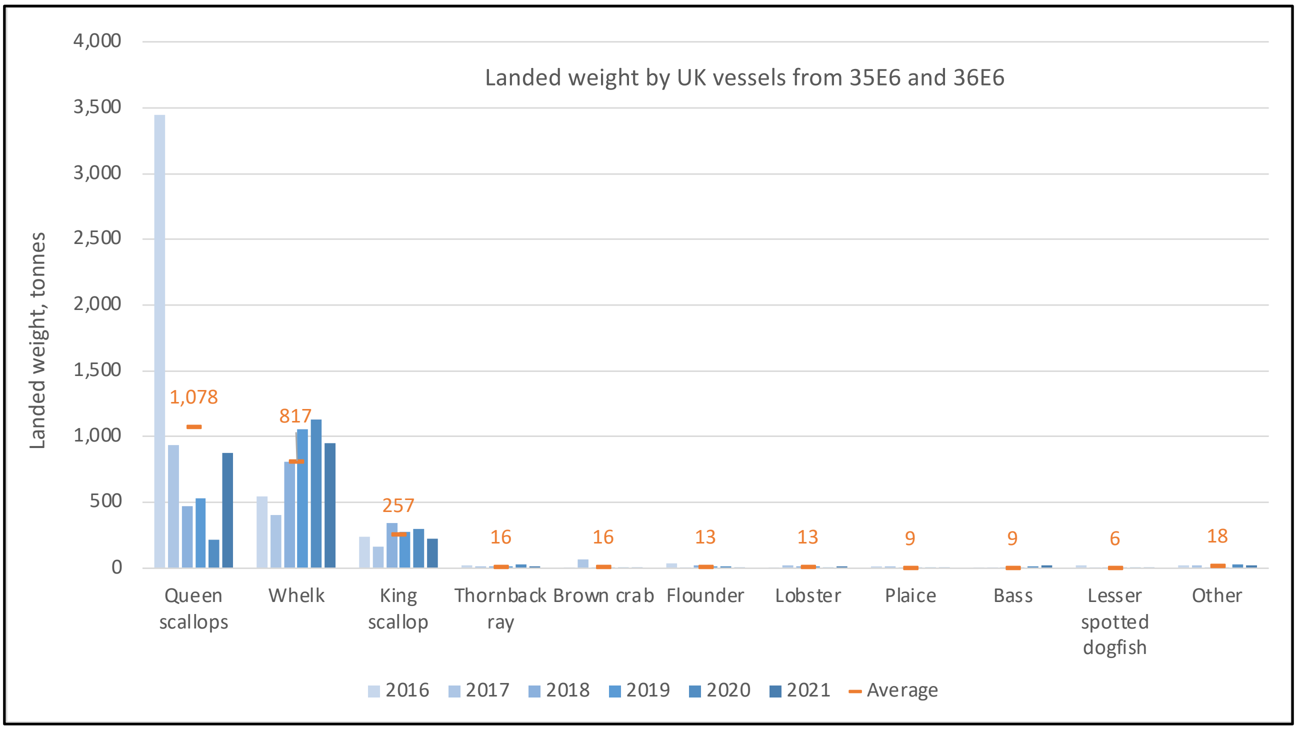

Figure 10.2: Key Species By Annual Landed Weight (Tonnes) (2016 To 2021) From The Commercial Fisheries Study Area (ICES Rectangles 35E6 And 36E6) (Data Source: MMO, 2022)

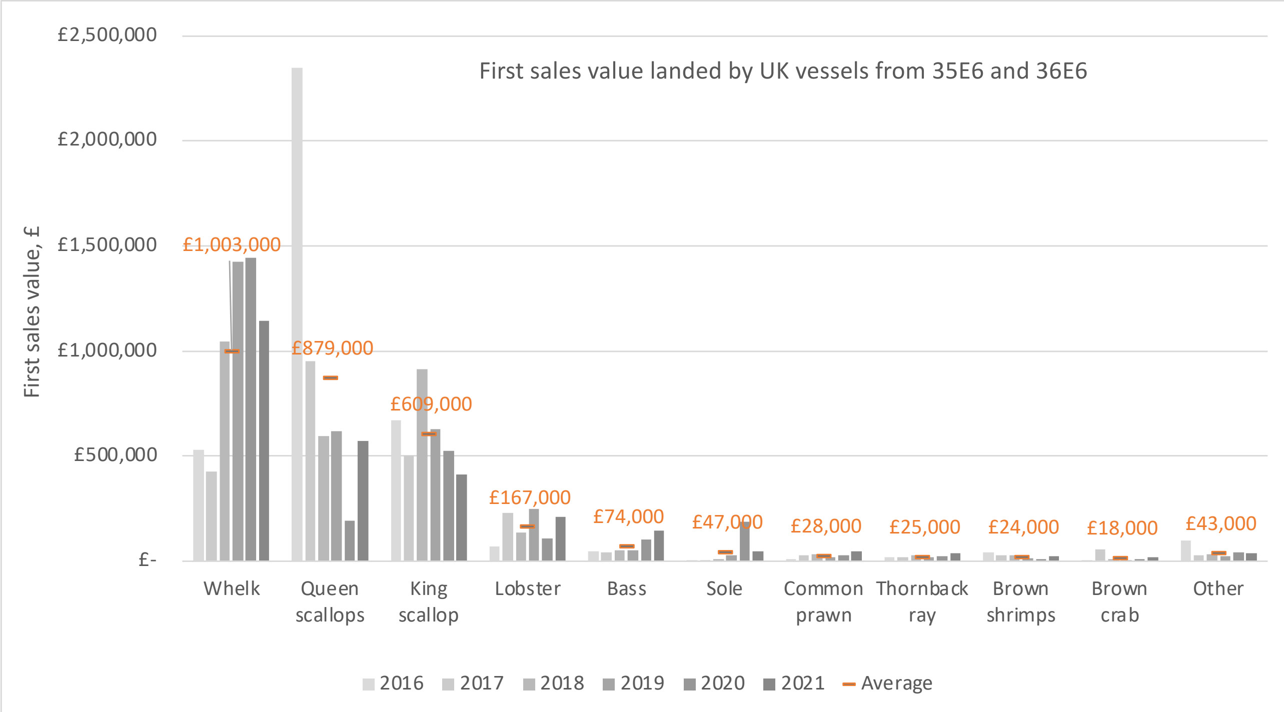

Figure 10.3: Key Species By Annual Landed Value (GBP) (2016 To 2021) From The Commercial Fisheries Study Area (ICES Rectangles 35E6 And 36E6) (Data Source: MMO, 2022)

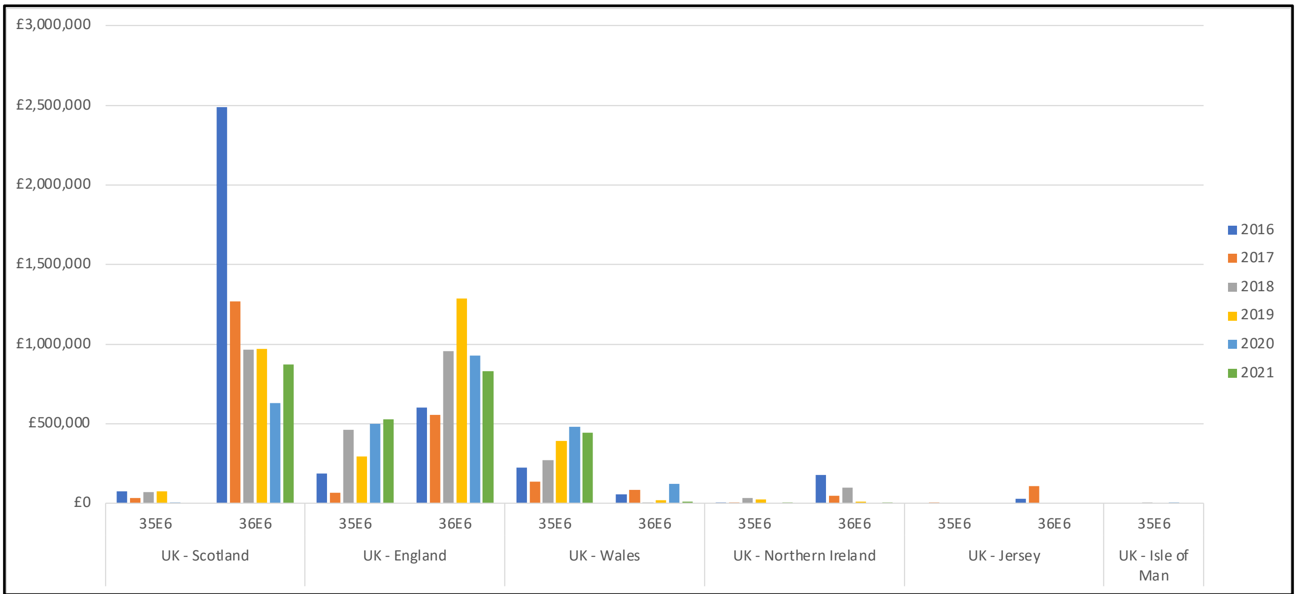

Figure 10.4: Annual Landed Value (GBP) 2010 To 2020 By Species Group From The Study Area (35E6 And 36E6) (MMO, 2021)

10.7.2 Potting fishery

In the commercial fisheries study area (35E6 and 36E6), landings by vessels using pots and traps are exclusively undertaken by the UK fleet, primarily by English and Welsh vessels (Figure 10.5). An average of 615 tonnes of whelk are landed annually from the study area, and whelk are also the most valuable species targeted by the potting fishery, with an annual average landed value of £770,000. The potting fishery also targets lobster, landing an average of 8 tonnes per year, crab *Cancer pagurus* landing 5 tonnes per year, and common prawn *Palaemon serratus* landing just over 1 tonne per year from the study area. The value of landings targeted by the potting fleet have increased across recent years, reflecting both an increase in the volume of shellfish species landed from the study area, and increases in shellfish prices.

Landings statistics indicate that the majority of landings from the study area are made by potting vessels over 10 m length. It is understood that the majority of potting vessels targeting whelk are over 10 m in length, which is corroborated by the landings' statistics. Vessels under 10 m deploying pots typically target lobster in the study area. VMS data showing activity by vessels ≥ 15 m length actively fishing using pots and traps is presented in Commercial Fisheries Technical Report (Poseidon, 2023) for 2016 to 2020 and indicates potting activity in the northern portion of the Development Area and in inshore areas, around the 6 NM boundary. The mapping also indicates static gear activity across the study area, outside of the Development Area and specifically in the northern portion of ICES rectangle 36E6.

Figure 10.5: Potting Fishery Landings Profile From The Commercial Fisheries Study Area (ICES Rectangles 35E6 And 36E6) (Data Source: MMO, 2022)

10.7.3 Dredge fishery

In the commercial fisheries study area landings by vessels using dredges are almost exclusively undertaken by the UK fleet, in this case comprised primarily of Scottish vessels over 10 m length, as well as landings by vessels registered to Northern Ireland, Isle of Man, England and Wales (Figure 10.6). The dredge fishery targets scallops – primarily king scallop but also lesser volumes of queen scallop – with minimal landings of other commercial species.

Annual landings by the dredge scallop fishery are highly variable, with lower catches from the study area from 2019 to 2021, compared with a relative peak in 2016, which had a total first sales value of £7 million. This variability reflects the somewhat cyclable nature of king and queen scallop fisheries, where certain grounds are more productive in certain years and are therefore targeted on a cyclable basis.

Scallop dredging is an activity which is generally engaged by larger (>10 m vessel length) vessels due to the engine capacity required to tow this heavy fishing gear. VMS data showing activity by vessels ≥ 15 m length actively fishing using dredge is presented in Commercial Fisheries Technical Report (Poseidon, 2023) for 2016 to 2020 and indicates significant activity within the western portion of the Development Area for all years analysed. Scallop grounds are widespread throughout much of the eastern Irish Sea, with the VMS data indicating distinct fishing grounds to the west and north-west of the Proposed Development.

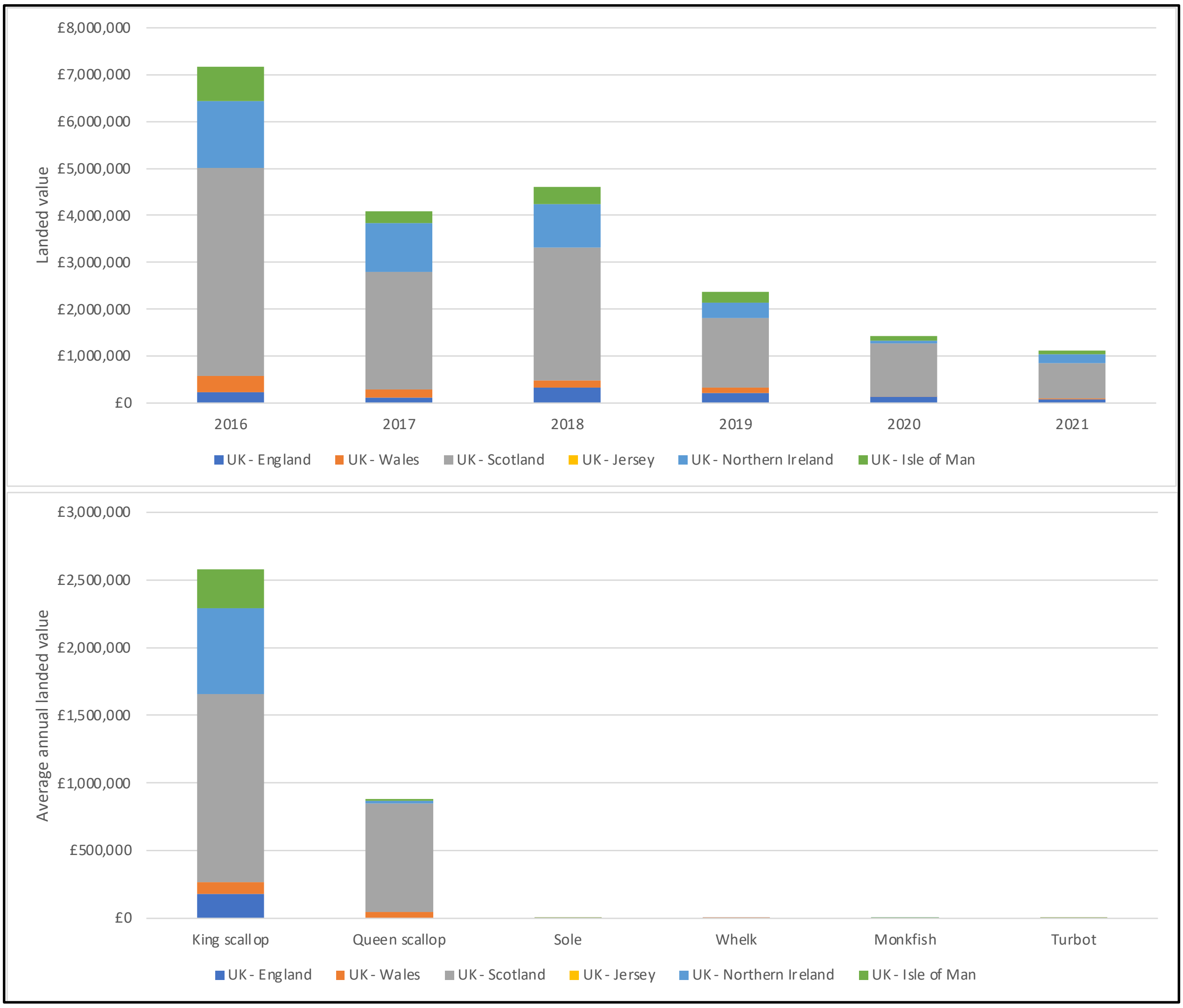

Figure 10.6: Dredge Fishery Landings Profile From The Commercial Fisheries Study Area (ICES Rectangles 35E6 And 36E6) (Data Source: MMO, 2022)

10.7.4 Otter trawl fishery

In the commercial fisheries study area landings by vessels using otter trawl are comprised primarily of Northern Irish and Manx vessels over 10 m length. The Northern Irish otter trawl fishery has targeted herring, likely by pelagic otter trawl, as well as demersal otter trawl for queen scallop, king scallop and nephrops (Figure 10.7). The demersal otter trawl fishery by Manx vessels targets queen scallop over sandy / muddy areas, using tickler chains to encourage queen scallops to swim up into the water column (out of the sediment) to enable capture within the trawl net.

Landings are relatively lower value that the dredge fishery, at an average annual first sales value of £170,000. VMS data corroborates this, with minimal activity within the area of project physical work (see Commercial Fisheries Technical Report (Poseidon, 2023)).

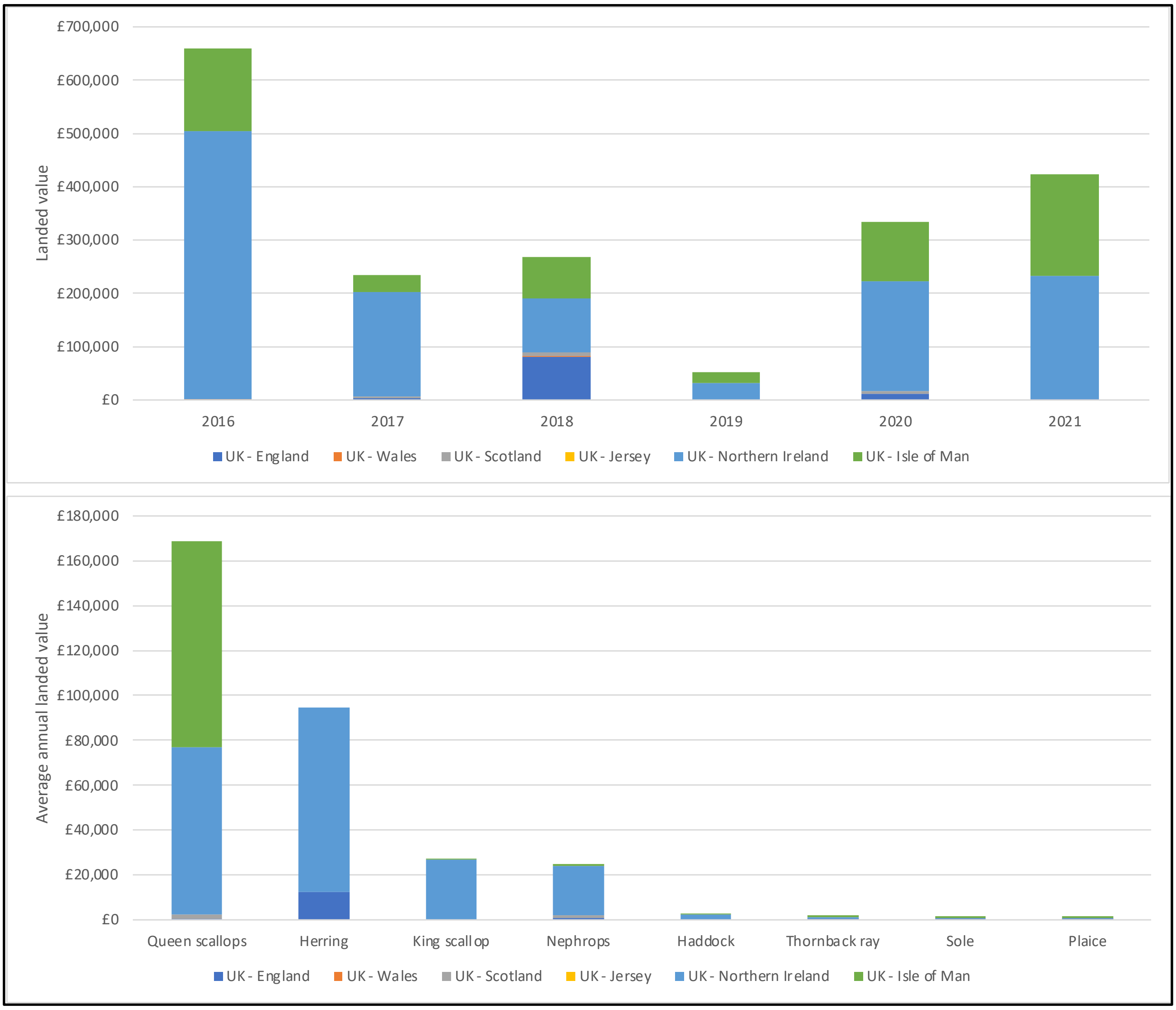

Figure 10.7: Otter Trawl Fishery Landings Profile From The Commercial Fisheries Study Area (ICES Rectangles 35E6 And 36E6) (Data Source: MMO, 2022)

10.7.5 Beam trawl fishery

In the commercial fisheries study area landings by vessels using beam trawl are comprised of English and Belgian vessels. Landings by The English fleet have been low from 2016 to 2018, but increased in 2020 and 2021 to an average of £130,000 in first sales value (Figure 10.8). The English beam trawlers travel from the south-west coast of England to target grounds that run along the 12 NM boundary for sole and plaice. The Belgian beam trawlers fish a similar area. Sole is the most value species caught by beam trawlers in this area, followed by thornback ray *Raja clavata*.

VMS data indicates activity within ICES rectangle 36E6, primarily to the north of the Proposed Development. Notable activity is seen within the Development Area by UK beam trawling vessels in 2020 (See Commercial Fisheries Technical Report (Poseidon, 2023)).

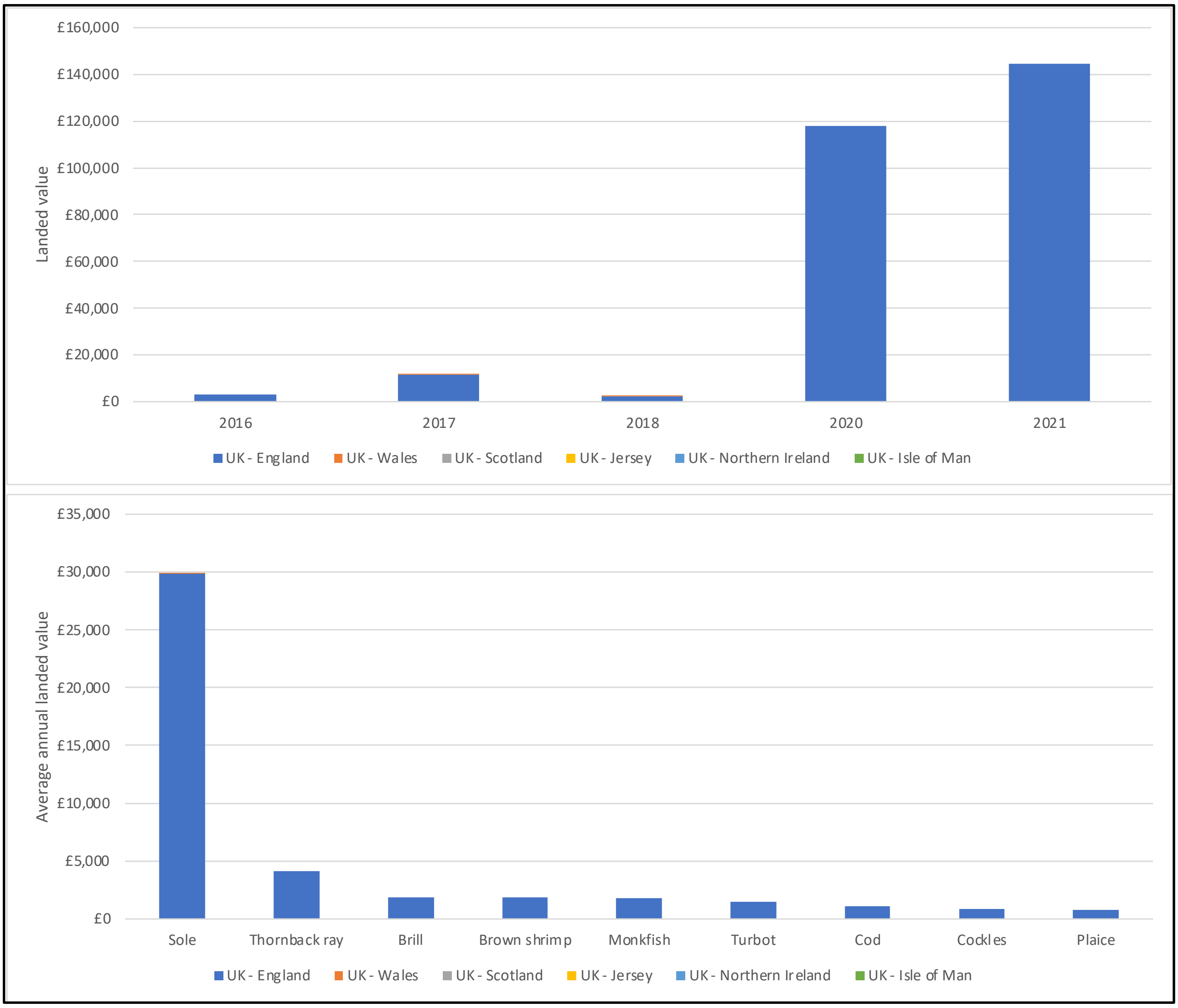

Figure 10.8: Beam Trawl Fishery Landings Profile From The Commercial Fisheries Study Area (ICES Rectangles 35E6 And 36E6) (Data Source: MMO, 2022)

10.7.6 Passive netting fishery

In the commercial fisheries study area, landings by vessels using fixed and drift nets are exclusively undertaken by the UK fleet, primarily by Welsh vessels (Figure 10.9), the majority of which are under 10 m length.

European sea bass *Dicentrarchus labrax* are the most valuable species landed from the study area by the passive netting fishery, with an annual average landed value of £29,000. An average of 1.3 tonnes of bass are landed annually from the study area, the majority of which are expected to have been caught close to shore. The passive netting fishery also targets thornback ray, landing an annual average of 4 tonnes, and flounder *Platichthys flesus,* landing an annual average of 6 tonnes.

Figure 10.9: Passive Netting Fishery Landings Profile From The Commercial Fisheries Study Area (ICES Rectangles 35E6 And 36E6) (Data Source: MMO, 2022)

10.7.7 Hook fishery

Based on MMO landing statistics, landings are made by gears using hooks, including handline, hook and line and long line gears. An average value of £17,000 is landed by gears using hooks. Primarily by English and Welsh vessels, under 10 m in length. The key species landed is bass, flounder and pollack. This fishery has developed since 2018, with a peak in value of £40,000 in 2021.

10.7.8 Aquaculture

Strategic areas of sustainable aquaculture production which have been identified for potential future aquaculture development overlap with the Commercial Fisheries Study Area, as shown in Figure 1.42 of Commercial Fisheries Technical Report (Poseidon, 2023). These strategic areas have been defined to take into account existing infrastructure and therefore avoid the infrastructure already *in situ* within the Proposed Development.

The strategic areas of sustainable aquaculture production support the implementation of the AQ-1 policies in the North West Inshore and North West Offshore Marine Plan and have been selected based on consideration of:

- Biological constraints; environmental conditions that influence growth of key species.
- Technical constraints; physical conditions that act as constraints on siting of aquaculture infrastructure.
- Planning constraints; other uses of the marine area.
- Additional considerations such as distance from shore.

The sustainable aquaculture production areas have been defined through consideration of the above criteria with the intention to identify areas in which conditions are most suitable for aquaculture, while minimising the potential for conflicts with other uses of the marine area.

Studying Figure 1.42 (Commercial Fisheries Technical Report (Poseidon, 2023)), it is clear that the strategic aquaculture areas are adjacent to, but do not overlap any of the Proposed Development infrastructure.

Shellfish classification zones and bivalve classification areas are further described in Commercial Fisheries Technical Report (Poseidon, 2023), and do not overlap with the Proposed Development infrastructure.

10.7.9 Evolution of the baseline

Commercial fisheries patterns change and fluctuate based on a range of natural and management-controlled factors. This includes the following:

- market demand: commercial fishing fleets respond to market demand, which is impacted by a range of factors, including changes to the export market due to the UK exit from the EU and the COVID pandemic;
- market prices: commercial fishing fleets respond to market prices by focusing effort on higher value target species when prices are high and markets in demand;
- stock abundance: fluctuation in the biomass of individual species stocks in response to status of the stock, recruitment, natural disturbances (e.g. due to storms, sea temperature etc.), changes in fishing pressure etc.;
- fisheries management: including development of Fisheries Management Plans for crab and lobster, whelk, king scallop and bass, changes in Inshore Fisheries and Conservation Authority (IFCA) Byelaws, new management for specific species where overexploitation has been identified, or changes in Total Allowable Catches leading to the relocation of effort, and/or an overall increase/decrease of effort and catches from specific areas;
- environmental management: including the potential restriction of certain fisheries within protected areas;

- improved efficiency and gear technology: with fishing fleets constantly evolving to reduce operational costs e.g. by moving from beam trawl to demersal seine; and
- sustainability: with seafood buyers more frequently requesting certification of the sustainably of fish and shellfish products, such as the Marine Stewardship Council (MSC) certification, industry is adapting to improve fisheries management and wider environmental impacts.

The variations and trends in commercial fisheries activity are an important aspect of the baseline assessment and forms the principal reason for considering up to six years of key baseline data, and up to 10 years for certain species (see Commercial Fisheries Technical Report (Poseidon, 2023)). Given the time periods assessed, the future baseline scenario would typically be reflected within the current baseline assessment undertaken. However, in this case, existing baseline data do not capture all potential changes in commercial fisheries activity resulting from the withdrawal of the UK from the EU.

Following the withdrawal of the UK from the EU, the UK and the EU have agreed to a Trade and Cooperation Agreement (TCA), applicable on a provisional basis from 1 January 2021. The TCA sets out fisheries rights and confirms that from 1 January 2021 and during a transition period until 30 June 2026, UK and EU vessels will continue to access respective Exclusive Economic Zones (EEZs, 12 to 200 NM) to fish. In this period, EU vessels will also be able to fish in specified parts of UK waters between 6 to 12 NM.

25% of the EU's fisheries quota in UK waters will be transferred to the UK over the five-year transition period; the first 15% of this has already been transferred and distributed across the four nations of the UK with Wales receiving uplift for a variety of demersal and pelagic quota species (Defra, 2021). After the five-year transition there will be annual discussions on fisheries opportunities. Either party will be able to impose tariffs on fisheries where one side reduces or withdraws access to its waters without agreement. A party can suspend access to waters or other trade provisions where the other party is in breach of the fisheries provisions.

Across the wider Irish Sea it is not yet understood to what extent EU vessels currently fishing in the region will lose access to these grounds at a future point. In the Proposed Development study area, where there is limited activity by non-UK fishing vessels, it is also not fully clear how a future baseline scenario may evolve as a result of Brexit. Given the uplift in Welsh quota described above, it is possible that Welsh vessels will seek to exploit additional quota-species opportunities, including potential for future growth in trawling opportunities, though it is not clear to what extent this may become relevant to the study area where fleets primarily target non-quota shellfish species; without quota holdings, these vessels would be unlikely to be impacted by quota changes. Changes in access to waters are also unlikely to impact local fishing fleets.

10.8 Key Parameters for Assessment

10.8.1 Maximum Design Scenario

This section identifies the Maximum Design Scenario (MDS) upon which the commercial fisheries impact assessment is based. The assessment of the MDS for each receptor establishes the maximum potential adverse impact and as a result impacts of greater adverse significance would not arise should any other development scenario to that assessed within this Chapter be taken forward in the final scheme design.

The design parameters that have been identified to be relevant to commercial fisheries are outlined in Table 10.5.

Table 10.5: Maximum Design Scenario For Commercial Fisheries

Potential Effect	Maximum Adverse Scenario Assessed	Justification
Construction		
Loss or restricted access to fishing grounds	**Construction duration**: 2 years **Safety Zones**: • 500 m Safety Zones around construction activities = 0.79 km^2 per structure under construction at any one time. • Roaming 500 m safe passing distance for mobile installation vessels. **Eni Development Area** • 600.6 km^2 **Area of Project Physical Work** • 68.62 km^2 **<u>Construction and/or repurpose of following infrastructure:</u>** **Offshore platforms (OP)** • Douglas OP: topside length: 76.7 m and width: 45.6 m; • Lennox Wellhead OP: topside length: 33.9 m and width: 29.6 m; • Hamilton Main Wellhead OP: topside length: 27.8 m and width: 23.9 m; • Hamilton North Wellhead OP: topside length: 27.8 m and width: 23.9 m. **Wells** • CO_2 Injection Wells; • Monitoring Wells; and • Sentinel Wells. **Point of Ayr (PoA) Terminal-Douglas cable** • TOTAL: 34 km • 10% cable protection • Number of crossings: 8, each of 200 m length	This represents the maximum duration and extent of fishing exclusion throughout the construction phase and hence the greatest potential to restrict access to fishing grounds. The construction footprint comprises the full permanent seabed area of structures, cable crossings and cable protection. The impact area also incorporates exclusion zones around major activities. It is important to note that the temporal aspect of temporary works will not apply in full throughout the 2-year offshore construction phase, as activities will be completed sequentially.

Potential Effect	Maximum Adverse Scenario Assessed	Justification
	• Cable protection and crossing dimensions: height: 1 m; width: 5 m. • Material: freshly quarried rock and concrete mattresses • Burial depth: min: 2 m; max: 3 m • Burial technique: preferred method is plough. **Inter-OP Cables** • Douglas to Hamilton (12 km); • Douglas to Hamilton North (15 km); • Douglas to Lennox (35 km). • TOTAL: 62 km • Burial depth: min: 2 m; max: 3 m • Burial technique: preferred method is plough. • No cable protection anticipated. • Number of crossings: up to 10, each of 200 m length; height: 1 m; width: 5 m • Material: freshly quarried rock and concrete mattresses **Existing pipelines being reutilised and requalified.** • PL1030 (32.12 km) - Existing 20” sales gas pipeline between PoA and the Douglas OP; • PL 1039 (11.46 km) - Existing 20” gas pipeline between Douglas OP and Hamilton Main OP; • PL 1035 (32.05 km)- Existing 16” oil pipeline between Douglas OP and Lennox OP; • PL 1036A (31.58 km) - Existing 12” gas pipeline between Douglas OP and Lennox OP; and • PL 1041 (14.56 km)- Existing 14” gas pipeline between Douglas Process OP and Hamilton North OP. TOTAL: 121.77 km	
Impacts on commercially valuable fish and shellfish species/resources	See fish and shellfish ecology maximum design scenario presented in volume 2, chapter 7: Marine Biodiversity.	The scenarios presented in fish and shellfish ecology provide for the greatest disturbance to fish and shellfish species and therefore the greatest knock-on effect to commercial fisheries. Importantly, this considers the impacts as a whole on

Potential Effect	Maximum Adverse Scenario Assessed	Justification
		commercially important species as considered in the maximum design scenario for the fish and shellfish chapter, rather than any one impact in particular.
Interference with fishing activity	**OPs and wells** • Maximum number of return trips for OPs and wells: 177 • Maximum number of vessels on site at any time: 23 **Cables and pipelines** • Maximum number of return trips for support vessels per year: 14 • Maximum number of vessels on site at any time: 17	This represents the highest level of construction vessel round trips. The maximum number of vessel transits and the maximum duration of the construction would result in the greatest potential for interference.
Temporary increases in steaming distances to fishing grounds	As for 'Loss or restricted access to fishing grounds' (see above).	This represents the maximum duration and extent of fishing exclusion throughout the construction phase and hence the greatest potential for additional steaming to alternative grounds.
Supply chain opportunities for local fishing vessels	As for 'Loss or restricted access to fishing grounds' (see above).	
Operation and maintenance		
Loss or restricted access to fishing grounds	**Safety Zones:** • 500 m Safety Zones around Ops = 0.79 km^2 per structure. • Temporary 500 m Safety Zones around infrastructure undergoing major maintenance. • 50 m radius pipeline corridor. **Infrastructure:** **Offshore platforms (OP)** • Douglas OP: topside length: 76.7 m and width: 45.6 m; • Lennox Wellhead OP: topside length: 33.9 m and width: 29.6 m; • Hamilton Main Wellhead OP: topside length: 27.8 m and width: 23.9 m; • Hamilton North Wellhead OP: topside length: 27.8 m and width: 23.9 m. **Wells** • CO_2 Injection Wells;	This represents the maximum duration and extent of fishing exclusion throughout the operation and maintenance phase and hence the greatest potential to restrict access to fishing grounds. It comprises the maximum footprint of infrastructure on the seabed plus maintenance activities throughout the operational and maintenance phase and associated operational and temporary safety zones. The assessment assumes that fishing will resume within the Development Area where possible, with the exception of operational safety zones and temporary safety zones around infrastructure undergoing major maintenance or replacement.

Potential Effect	Maximum Adverse Scenario Assessed	Justification
	• Monitoring Wells; and • Sentinel Wells. **Point of Ayr (PoA) Terminal-Douglas cable** • TOTAL: 34 km buried with 10% cable protection and 8 crossings using freshly quarried rock and concrete mattresses **Inter-OP Cables** • TOTAL: 62 km buried with no cable protection and 10 crossings using freshly quarried rock and concrete mattresses **Maintenance procedures including:** **Cables and pipelines** • Inspections of the cable and pipelines and any cable protection, including at their entry into J-tubes on offshore structures. • Survey of seabed and cable protection (if present) • Repair and replacement of cable section. • Reburial of exposed cable section. **OP and foundations** • Inspections of foundations, above and below sea level. • Survey of seabed and assets. • Removal of marine growth from foundations, transition pieces, or access ladders. • Remove and replace anodes required for corrosion protection. • Application of paint or other coatings to protect the foundations from corrosion (internal/external), including surface preparation. • Removal and replacement of ancillary structures (e.g. access ladders and boat landings). • Modifications to/ replacement of J-tubes e.g. during inter-OP cable repair works. • Operational design life of 25 years	

Potential Effect	Maximum Adverse Scenario Assessed	Justification
Impacts on commercially valuable fish and shellfish species/resources	See fish and shellfish ecology maximum design scenario presented in Volume 2, Chapter 6.	The scenarios presented in fish and shellfish ecology provide for the greatest disturbance to fish and shellfish species and therefore the greatest knock-on effect to commercial fisheries. Importantly, this considers the impacts as a whole on commercially important species as considered in the maximum design scenario for fish and shellfish chapter, rather than any one impact in particular.
Interference with fishing activity	**Vessel activity:** • Total Operations and Maintenance (O&M) Vessel Movements (Return Trips) (TOTAL per year): 30 • Total O&M Vessel Numbers (max on site at any one time): 4	The maximum number of turbines and associated infrastructure will lead to the highest level of operation and maintenance activities and therefore highest level of operation and maintenance vessel round trips.
Temporary increases in steaming distances to fishing grounds	As for 'Loss or restricted access to fishing grounds' (see above).	This represents the maximum duration and extent of fishing exclusion throughout the operation and maintenance phase and hence the greatest potential for additional steaming to alternative grounds.
Loss or damage to fishing gear due to snagging gear on Proposed Development infrastructure	As for 'Loss or restricted access to fishing grounds' (see above).	This represents the maximum potential for interactions between infrastructure and fishing gear.
Supply chain opportunities for local fishing vessels	As for 'Loss or restricted access to fishing grounds' (see above).	
Decommissioning		
Loss or restricted access to fishing grounds	In the absence of detailed methodologies and schedules, decommissioning works and associated implications for commercial fisheries are considered analogous with those assessed for the construction phase.	As per construction
Impacts on commercially valuable fish and shellfish species/resources		
Interference with fishing activity		
Temporary increases in steaming distances to fishing grounds		
Supply chain opportunities for local fishing vessels		

10.8.2 Impacts scoped out of the Assessment

On the basis of the baseline environment and the Proposed Development Description outlined in chapter 3 of the Offshore ES, two impacts are proposed to be scoped out of the assessment for Commercial Fisheries and Aquaculture. This was either agreed with key stakeholders through consultation as discussed in chapter 5, or otherwise, the impact was proposed to be scoped out in the HyNet Carbon Dioxide transportation and Storage Project - Offshore Scoping Report (Eni, 2022) and no concerns were raised by key consultees. These impacts are outlined, together with a justification for scoping it out, in Table 10.6.

Table 10.6: Impacts Scoped Out Of The Assessment For Commercial Fisheries And Aquaculture (Tick Confirms The Impact Is Scoped Out)

Potential Impact	Phase			Justification
	C	O&M	D	
Displacement of fishing activity into other areas	✓	✓	✓	**All phase** Given that Liverpool Bay has historically been a site for offshore oil and gas, the displacement of fishing activities into other surrounding areas is unlikely. The Proposed Development will utilise pre-existing infrastructure and essentially turn the oil and gas OPs into a novel Carbon Capture and Storage (CCS) site, with little change to the surrounding marine environment. Where new infrastructure is being installed, it is being done so either within the existing operational footprint, or in proximity to the alignment of existing linear infrastructure.
Long-term increased steaming distances to fishing grounds during operation and maintenance	-	✓	-	**Operation and maintenance phase** Following construction of the Proposed Development, fishing vessels will be able to transit through and around the site as they have done so in the past. The presence of the CCS infrastructure and the associated development area should not have a direct effect on steaming distances to/from adjacent fishing grounds in the area.

10.9 Methodology for Assessment of Effects

The assessment methodology for commercial fisheries is consistent with the assessment methodology used for the assessment of likely significant environmental effects of the Proposed Development as set out in volume 1, chapter 5: Environmental Impact Assessment Methodology.

The method for determining the significance of effects is a two-stage process that involves defining the magnitude of the impacts and the sensitivity of the receptors. This section describes the criteria applied in this chapter to assign values to the magnitude of potential impacts and the sensitivity of receptors.

10.9.1 Magnitude

In assessing the magnitude of the impact, the value and vulnerability of the receptor, i.e. the fishing fleet under assessment, together with the reversibility of the impact, are considered. Due to the range in scale, value (in terms of both landings and income/profit) and operational practises, within the commercial fishing fleets assessed, specific economic criteria were not set for defining value within the categories of high, medium, or low. Instead, these classifications were based on judgement informed by the baseline characterisation. The definitions employed in assigning the magnitude of change are provided in Table 10.7.

Table 10.7: Magnitude Of Change Definitions

Magnitude	Definition
High	**Adverse** Impact is of long-term duration (e.g. greater than 8 years duration) and/or is of extended physical extent; and Impact is expected to result in one or more of the following: • substantial loss of target fish or shellfish biological resource (e.g. loss of substantial proportion of resource within commercial fisheries study area); and • substantial loss of ability to carry on fishing activities (e.g. substantial proportion of effort within commercial fisheries study area).
	Beneficial Impact is expected to result in one or more of the following: • large scale or major improvement of resource quality, measurable against biomass reference points; and • extensive restoration or enhancement of habitats supporting commercial fisheries resources.
Medium	**Adverse** Impact is of medium-term duration (e.g. less than 8 years) and/or is of moderate physical extent; and Impact is expected to result in one or more of the following: • partial loss of target fish or shellfish biological resource (e.g. moderate loss of resource within commercial fisheries study area); and • partial loss of ability to carry on fishing activities (e.g. moderate reduction of fishing effort within commercial fisheries study area).
	Beneficial Impact is expected to result in one or more of the following: • moderate improvement of resource quality; and • moderate restoration or enhancement of habitats supporting commercial fisheries resources.
Low	**Adverse** Impact is of short-term duration (e.g. less than 2 to 3 years) and/or is of limited physical extent; and Impact is expected to result in one or more of the following: • minor loss of target fish or shellfish biological resource (e.g. minor loss of resource within commercial fisheries study area); and • minor loss of ability to carry on fishing activities (e.g. minor reduction of fishing effort within commercial fisheries study area).
	Beneficial Impact is expected to result in one or more of the following: • minor benefit to or minor improvement of resource quality; and • minor restoration or enhancement of habitats supporting commercial fisheries resources.
Negligible	**Adverse** Impact is of very short-term duration (e.g. less than 1 year) and/or physical extent of impact is negligible; and Impact is expected to result in one or more of the following: • slight loss of target fish or shellfish biological resource (e.g. slight loss of resource within commercial fisheries study area); and • slight loss of ability to carry on fishing activities (e.g. slight loss of fishing effort within commercial fisheries study area).
	Beneficial Impact is expected to result in one or more of the following: • very minor benefit to or very minor improvement of resource quality; and • very minor restoration or enhancement of habitats supporting commercial fisheries resources.

10.9.2 Sensitivity

In assessing the sensitivity of the receptor, the operational range of the fishing fleets, together with the availability of alternative fishing grounds are considered. The definitions employed in assigning receptor sensitivity are provided in Table 10.8.

Table 10.8: Sensitivity Of Receptor To Change

Sensitivity	Definition
High	Receptor is highly vulnerable to impacts that may arise from the Proposed Development and recoverability is long term or not possible. And/or: No alternative fishing grounds are available.
Medium	Receptor is generally vulnerable to impacts that may arise from the Proposed Development and recoverability is slow and/or costly. And/or: Low levels of alternative fishing grounds are available and/or fishing fleet has low operational range.
Low	Receptor is somewhat vulnerable to impacts that may arise from the Proposed Development and has moderate levels of recoverability. And/or: Moderate levels of alternative fishing grounds are available and/or fishing fleet has moderate operational range.
Negligible	Receptor is not generally vulnerable to impacts that may arise from the Proposed Development and/or has high recoverability. And/or: High levels of alternative fishing grounds are available and/or fishing fleet has large to extensive operational range; fishing fleet is adaptive and resilient to change.

10.9.3 Significance

The significance of the effect upon commercial fisheries is determined by correlating the magnitude of the impact and the sensitivity of the receptor. The method employed for this assessment is presented in Table 10.9.

Table 10.9: Matrix To Determine Impact Significance

		Sensitivity of Receptor / Receiving Environment to Change			
		High	**Medium**	**Low**	**Negligible**
Magnitude of Change	**High**	Major	Major to Moderate	Moderate	Negligible
	Medium	Major to Moderate	Moderate	Minor to Moderate	Negligible
	Low	Moderate	Minor to Moderate	Minor	Negligible
	Negligible	Negligible	Negligible	Negligible	Negligible

10.10 Embedded Mitigation

A number of embedded mitigation measures have been included to reduce the potential for impacts on commercial fisheries. These embedded mitigation measures will evolve over the development process and in response to consultation, as appropriate.

Mitigation measures that were identified and adopted as part of the evolution of the Proposed Development design (embedded into the Proposed Development design) and that are relevant to commercial fisheries are listed in Table 10.10. The assessment of impacts takes account of these measures.

Table 10.10: Embedded Mitigation Relating To Commercial Fisheries

Parameter	Mitigation Measures Embedded into the Proposed Development Design
Fisheries liaison	The Applicant is committed to ongoing liaison with fishermen throughout all stages of the Proposed Development, including the following: • Appointment of a company FLO and/or Fishing Industry Representatives (FIRs) to maintain effective communications between the Applicant and fishermen. • Appropriate liaison with relevant fishing interests to ensure that they are fully informed of development planning and any offshore activities and works. • Timely issue of notifications including Notice to Mariners (NtMs), Kingfisher Bulletin notifications and other navigational warnings to the fishing community to provide advance warning of Proposed Development activities and associated Safety Zones and advisory safety distances. • Development, prior to construction, of a Fisheries Liaison and Coexistence Plan (FLCP), setting out in detail the planned approach to fisheries liaison and means of delivering any other relevant mitigation measures.
Marking and lighting	The Applicant is committed to marking and lighting the Proposed Development in accordance with relevant industry guidance and as advised by relevant stakeholders including the Maritime and Coastguard Agency (MCA), Civil Aviation Authority (CAA) and Trinity House. The Applicant will also ensure the Proposed Development is adequately marked on nautical charts. It is expected that a lighting and marking plan will be secured within a Marine Licence condition.
Dropped objects	A dropped objects plan will be developed for reporting and recovery of dropped objects where they pose a potential hazard to other marine users and is anticipated to be secured within a Marine Licence condition.
Cable burial	The Applicant is committed to: • Suitable implementation and monitoring of cable protection informed by a Cable Burial Risk Assessment (CBRA). The cable will only be protected using external protection (e.g. rock berms) at third-party crossings. This minimises the risk of underwater allision with cable protection, anchor or fishing gear interaction with subsea cables and interference with magnetic position fixing equipment. • Development and adherence to a Cable Specification and Installation Plan (CSIP) post consent which will include cable burial where possible (in accordance with the specific policies set out in the North West Inshore and North West Offshore Coast Marine Plans (Defra, 2021)) and cable protection, as necessary. The CSIP will set out appropriate cable burial depth in accordance with industry good practice, minimising the risk of cable exposure. The CSIP will also ensure that cable crossings are appropriately designed to mitigate environmental effects, these crossings will be agreed with relevant parties in advance of CSIP submission. The CSIP will include a detailed Cable Burial Risk Assessment (CBRA) to enable informed judgements regarding burial depth to maximise the chance of cables remaining buried whilst limiting the amount of sediment disturbance to that which is necessary. Measures will seek to reduce the amount of EMF which benthic and fish and shellfish receptors are exposed to during the operations and maintenance phase by increasing the distance between the seabed surface and the surface of the cables.

10.11 Assessment of Significance

The principal receptors with respect to commercial fisheries are the fishing fleets operating in the Eni Development Area and commercial fisheries study area, defined as: country of vessel registration; fishing gear;

and target species. The specific features defined within these receptors as requiring further assessment are listed in Table 10.11.

Table 10.11: Commercial Fisheries Receptors Relevant To The Proposed Development

Receptor group (National fishing fleet)	Receptor (fishing fleet/gear)	Relevant features (main target species)	Operational area
UK and Crown Dependencies	Potting	Whelk, lobster, and brown crab	Operate in the Eni Development Area and commercial fisheries study area
	Dredge	Scallop and queen scallop	
	Fixed nets	Bass, thornback ray and flounder	
	Gear with hooks	Bass, pollack, mackerel	
	Beam trawl	Sole, thornback ray, plaice, and brown shrimp	
	Demersal otter trawl	Nephrops, thornback ray and plaice	Operate in the commercial fisheries study area
Irish	Dredge	Scallop and queen scallop	
Belgian	Beam trawl	Sole and thornback ray	
UK	Aquaculture	Strategic areas of aquaculture production and shellfish classified waters	The Eni Development Area and commercial fisheries study area

The potential impacts being assessed for the commercial fisheries receptors are outlined in Table 10.12 for the different phases of the Proposed Development: construction, operation and maintenance and decommissioning. These impacts align with those listed in the maximum design scenario (Table 10.5).

Table 10.12: Potential Impact Being Assessed For Commercial Fisheries

Potential impact	Phase		
	C	O&M	D
Loss or restricted access to fishing grounds	✓	✓	✓
Impacts on commercially valuable fish and shellfish species/resources	✓	✓	✓
Interference with fishing activity	✓	✓	✓
Temporary increases in steaming distances to fishing grounds	✓	✓	✓
Supply chain opportunities for local fishing vessels	✓	✓	✓
Loss or damage to fishing gear due to snagging gear on Proposed Development infrastructure		✓	

10.11.1 Loss or restricted access to fishing grounds

10.11.1.1 Construction

During construction of the Proposed Development, commercial fisheries will be prevented from fishing where construction and repurpose activities are taking place. In addition, Safety Zones of 500 m diameter will be sought around infrastructure undergoing construction/repurpose activities and a roaming 500 m safe passing distance will be recommended for mobile installation vessels. The total offshore construction duration will be up to two years, with a number/range of construction activities being undertaken simultaneously across the Proposed Development as described in Table 10.5. The assessment assumes that fishing would not be restricted from activities within the entirety of the Eni Development Area (600 km^2) at any one time. The assessment assumes that fishing access restrictions would be specific to the area of project physical work (68.6 km^2) plus Safety Zones and roaming safe passing distances.

Magnitude

This impact will lead to a localised loss of access to fishing grounds and the fish and shellfish resources within these grounds for a range of fishing opportunities during the period of construction, which will directly affect fleets over a short-term duration (i.e. less than 5 years). The impact is predicted to be intermittent with localised exclusion surrounding construction activities.

The impact is of relevance to national fishing fleets and is described below on a fleet-by-fleet basis.

UK potting fishery: the UK potting fleet targets whelk and other shellfish species across a wide area from inshore grounds extending out into and beyond the Eni development area and commercial fisheries study area. VMS data indicates that vessels ≥15 m length, understood to be primarily targeting whelk, are active in the windfarm site and across extensive grounds to the north and north-west of the Proposed Development (see Figures 1.22 and 1.23 in Commercial Fisheries Technical Report (Poseidon, 2023)). Of note, VMS data for 2020 indicates an important area for UK potting vessels ≥15 m in the inshore area from approximately 3 to 6 NM and overlapping with the proposed new cable infrastructure.

An average annual first sales value of just over £1.2 million landings is taken from the commercial fisheries study area by UK potting vessels, predominantly made up of whelk (82% by value). Noting that the project area of physical work overlaps with approximately 1.43% of the commercial fisheries study area (35E6 and 36E6), and the Development Area overlaps with 12.5%; this equates to a pro-rata value of approximately £17,000 for the physical works area and £152,000 for the Development Area (based on uniform landings across the entire study area). While such a simplistic calculation brings higher level of uncertainty to the resulting figure, it does demonstrate the scale of the opportunity to fishing interests in the study area. During construction, potting vessels will be required to remove pots from areas under construction and either relocate or bring to shore depending on available grounds and fishing preferences. Potting fishermen will therefore experience loss of earnings for the time taken to relocate gear, and a loss of earnings associated with not being able to fish the specific grounds under construction (e.g. if alternative grounds are either not available, or not as productive). Potting typically involves a number of fleets of pots being deployed across a range of areas, and while it is unlikely that 100% of pots deployed by a single vessel will be impacted at any one time, it is understood that in this area specific potting grounds are targeted by specific operators. In this case, individual fishing businesses that routinely target the site will be impacted to a higher extent and this is accounted for within the assessment. Furthermore, the value of the fishery described above is relative to the number of fishing businesses active in the area i.e. the total is split across relatively few fishing vessel owner businesses. Overall, the impact during construction is predicted to be of short-term duration, directly affecting a medium-value fishery and the magnitude is considered to be medium adverse for potting fisheries.

UK passive netting fishery: the UK passive netting fleet targets bass, thornback ray and variety of other demersal species using fixed nets. An average annual first sales value of ~£74,000 landings is taken specifically within the study area by English netting vessels. Limited spatial data is available for netting activity, though the majority of passive netting vessels are under 10 m length and expected to predominantly operate in inshore waters, from 0 to 12 NM. The pro-rata calculation relates to £1,000 from the area of physical work and £9,000 from the Development Area. Overall, the impact during construction is predicted to be of short-term duration, to directly affect the fishery which has a low value within the local study area and therefore, the magnitude is considered to be low adverse.

UK gear with hooks fishery: (including handline, gears with hooks and longline, where catch is sold for taxable profit) UK vessels deploying gear with hooks commercially target bass, with an average annual first sales value of ~£40,000 landings is taken specifically within the study area. The pro-rata calculation relates to £500 from the area of physical work and £5,000 from the Development Area. Limited spatial data is available for this activity, though the majority of vessels deploying hooks are under 10 m length and expected to predominantly operate in inshore waters, from 0 to 12 NM. Overall, the impact during construction is predicted to be of short-term duration, to directly affect the fishery which has a low-medium value within the study area and therefore, the magnitude is considered to be low adverse.

UK dredge fishery: the UK dredging fleet target scallop and queen scallop across a relatively wide area offshore (outside 12 NM), and inshore (from 6 to 12 NM). An average annual first sales value of ~£1.5 million landings is taken specifically within the study area by UK dredging vessels. The pro-rata calculation relates to £20,000 from the area of physical work and £186,000 from the Development Area. VMS data from 2016 to 2020 consistently indicate dredging activity within the western section of the Development Area, between 6 to 12 NM, though the same data indicates that scallop grounds to the north-west of the Proposed Development are highly important to this fleet. Overall, the impact during construction is predicted to be of short-term duration, directly affecting a medium-value fishery in the regional scale, but a relatively low-value fishery within area of physical work and the magnitude is considered to be low adverse for UK dredge fisheries.

Irish dredge fishery: EU VMS data and ICES Scallop Working Group mapping indicate that Irish vessels do not routinely operate within or adjacent to the Proposed Development. Overall, the impact during construction is predicted to be of short-term duration, to directly affect the fishery which has a low value within the study area and therefore, the magnitude is considered to be low adverse for the Irish dredge fishery.

UK demersal otter trawl: activity for this fleet is very low in the study area (35E6 and 36E6), with annual landings of approximately £4,000 from the study area and no fishing visible within the Development Area for ≥12m, evidenced by VMS data (see Figure 1.24 in Commercial Fisheries Technical Report (Poseidon, 2023)). Areas with low levels of activity from demersal otter trawlers are noticed to the north and west of the Development Area, well outside the Proposed Development boundaries. Overall, the impact during construction is predicted to be of short-term duration, to directly affect the fishery which has a low value within the local study area and therefore, the magnitude is considered to be low adverse.

UK beam trawl: some activity for this fleet is noticed across the study area, with annual landings of £68,000 from the study area and UK beam trawlers from the south-west of England known to be entering the region and fishing between the 6 and 12 NM boundaries to target sole. This is evidenced by UK VMS data for 2020, which indicates activity from UK beam trawlers in the centre of the Development Area (see Figure 1.26 in Commercial Fisheries Technical Report (Poseidon, 2023)). The pro-rata calculation relates to £1,000 from the area of physical work and £8,500 from the Development Area. Beam trawlers are highly mobile, and operate across wide distances throughout the UK. In this area, sole is targeted in the spring months. Overall, the impact during construction is predicted to be of short-term duration, to directly affect the fishery which has a low value within the local study area and therefore, the magnitude is considered to be low adverse.

Belgian beam trawl: activity for this fleet is evidenced by VMS data to predominately occur north of the study area, with low levels recorded within the Eni Development Area (see Figure 1.25 in Commercial Fisheries Technical Report (Poseidon, 2023)). Overall, the impact during construction is predicted to be of short-term duration, to directly affect the fishery which has a low value within the local study area and therefore, the magnitude is considered to be low adverse.

Aquaculture production: the Proposed Development infrastructure does not overlap Strategic Areas of Sustainable Aquaculture Production, which are areas that have been identified for possible future aquaculture development. The Proposed Development does not overlap shellfish classified waters, or areas identified for mussel, pacific and native oyster production. Overall, the impact during construction is predicted to be of short-term duration, to not directly affect aquaculture production which has a low value within the local study area and therefore, the magnitude is considered to be low adverse.

Sensitivity

Inshore vessels including the UK potting, gear with hooks and passive netting fleets are typically <15 m in length and operate across more distinct areas of ground, typically 0 to 12 NM from shore. The operational range of these vessels is lower relative to larger, more transient vessels, such as scallop dredgers and beam trawlers that typically operate across a wide range of grounds. The inshore vessels operating potting, passive netting and hook gear are typically day boats, often single handed and with a more limited operational range from home port. There are a number of UK potters active in this area that are >15 m in length and are represented within the VMS datasets. Similarly, these vessels operate within the local region and land to local home ports, typically undertaking three two-day trips per week, with up to five crew including skipper. Overall, the UK potting, gear with hooks and passive netting fleets are deemed to be of medium vulnerability, medium recoverability, with a relatively limited operational range within the region. The sensitivity of the receptors is therefore, considered to be medium**.**

The dredge fishery includes vessels that are operating across many distinct scallop grounds throughout the Irish Sea, primarily based from Scottish ports (including Kirkcudbright), as well as Welsh, Manx, and Irish ports. While this fleet is comprised of vessels typically >12m in length, operating across a moderate range with moderate to high levels of alternative grounds, the distinct patches of scallop grounds characterised by sandy gravel habitat and evidenced by VMS data can make this fleet less resilient to incremental loss of fishing grounds. The dredge fleets are deemed to be of medium vulnerability and medium recoverability, with relatively wide operational ranges and wide alternative fishing grounds within the region. The sensitivity of the receptors is therefore, considered to be low**.**

The other mobile fleets including beam trawl and demersal otter trawl targeting fish and shellfish resources across the study area are typically >15 m in length and operate across large areas of the Irish Sea, as well as waters around the UK (e.g. English Channel, West of Scotland, and the North Sea). Given adequate notification, it is expected that these vessels will be in a position to avoid construction areas. The beam trawl and demersal otter trawl fleets are considered to have a medium to large operational range; medium to high levels of alternative fishing grounds; and are deemed to be of low vulnerability and high recoverability. The sensitivity of these receptors is therefore, considered to be low**.**

The Proposed Development does not overlap areas of aquaculture production, or areas identified for future aquaculture production and therefore the sensitivity of this receptor is considered to be low.

Significance of effect

UK potting fishery: overall, it is predicted that the sensitivity of the receptor is medium, and the magnitude is medium. The effect is of **moderate adverse** significance, which is significant in EIA terms.

UK dredge fishery: overall, it is predicted that the sensitivity of the receptor is medium, the value is low (within the Proposed Development), and the magnitude is low. The effect is of **minor adverse** significance, which is not significant in EIA terms.

UK gears with hooks and passive netting: overall, it is predicted that the sensitivity of the receptors is medium, the value is low, and the magnitude is low. The effect is of **minor adverse** significance, which is not significant in EIA terms.

UK demersal otter trawl, UK and Belgian beam trawl and Irish dredge: overall, it is predicted that the sensitivity of the receptors is low, the value is low, and the magnitude is low. The effect is of **minor adverse** significance, which is not significant in EIA terms.

UK aquaculture: overall, it is predicted that the sensitivity of the receptors is low, the value is low, and the magnitude is low. The effect is of **minor adverse** significance, which is not significant in EIA terms.

Additional mitigation

UK potting fleet: with respect to any justifiable disturbance payment, the procedures as outlined in the FLOWW guidance documents (2014 and 2015) will be followed and further defined within a FLCP. Specifically, this will consist of the provision of evidence and data, examples of which include (FLOWW 2015):

- Copy of certificate of registry for each vessel for which a claim is being made.
- Copy of a valid MCA certification or equivalent.
- Copy of the relevant vessel fishing licenses and entitlements for each vessel for which a claim is being made.
- Sight of vessels fishing charts and Global Positioning System (GPS) plotter records to provide clear historic evidence of potential disruption in the area of the operations.
- Evidence of sales notes where available for an agreed time period.
- Fishing accounts of the vessels concerned for an agreed time period.
- Fishing vessel or and/or fisheries landings data held by fisheries authorities. Due to the requirements of the Data Protection Act, for access to individual records a declaration will need to be completed in order for records to be released.
- It may be appropriate to validate sources of evidence not obtained directly from claimants in order to verify accuracy (for example, transcription errors may exist in official landings data).

Through the application of the FLCP, together with justifiable disturbance payments where relevant, the residual effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

10.11.1.2 Operation and maintenance phase

The assessment assumes that commercial fisheries will be prevented from actively fishing within the footprint of installed infrastructure within the Proposed Development and locations where areas of cable protection prevent fishing (i.e. for areas of cable where target burial was not possible and for cable crossings). The assessment assumes that safety zones of 500 m will be in place for surface infrastructure and subsurface wells during the operation phase, as well as for major maintenance activities, as set out in Table 10.5. Out with this footprint area of Proposed Development infrastructure and safety zones, the assessment assumes that fishing will be possible within the Eni Development Area.

Magnitude

This impact will lead to very localised loss of access to fishing grounds and the fish and shellfish resources within these grounds for a range of fishing opportunities during the operational and maintenance phase, which will directly affect fleets over a long-term duration, noting an operational design life of 25 years. The impact is predicted to be continuous with low reversibility for the lifetime of the Proposed Development and is of relevance to national fishing fleets.

Embedded mitigation relevant to commercial fisheries is outlined in Table 10.10, including measures to promote co-existence with fishers during the operation and maintenance phase. The FLCP will provide a framework for information dissemination and detail requirements for dropped object retrieval, cable burial and lighting and marking with the intention to ensure access to the Development Area during operational phase, with the exception of infrastructure and safety zones.

The description of the value and importance of the Proposed Development area to commercial fishing fleets presented for the construction phase is also applicable to the operational and maintenance phase.

It is expected that potting activity will resume within the Proposed Development during the operation and maintenance phase, with very localised loss of access related to safety zones and Proposed Development infrastructure. The overall magnitude is assessed as low adverse.

It is expected that all other commercial fishing receptors will resume fishing within the Proposed Development during the operation and maintenance phase, with very localised loss of access related to safety zones, Proposed Development infrastructure and cable protection. This localised loss of access is not expected to restrict the baseline operation of these commercial fisheries receptors. The overall magnitude is assessed as low adverse.

Sensitivity

The sensitivity of the commercial fisheries receptors is the same as that presented for construction summarised as medium for potting, passive netting and gears with hooks and low for all other fleets.

Significance of effect

UK potting, gear with hooks and passive netting fisheries: overall, it is predicted that the sensitivity of the receptor is medium, and the magnitude is low. The effect is of **minor adverse** significance, which is not significant in EIA terms.

All other fleets: overall, it is predicted that the sensitivity of the receptor is low, and the magnitude is low. The effect is of **minor adverse** significance, which is not significant in EIA terms.

10.11.1.3 Decommissioning

Significance of effect

The effects of decommissioning activities are expected to be the same or similar to the effects from construction. The residual significance of effect is therefore minor adverse for all fleets, which is not significant in EIA terms.

10.11.2 Impacts on commercially valuable fish and shellfish species/resources

Temporary noise and seabed disturbances during construction activities may displace commercially important fish and shellfish populations from the area. This section assesses the potential temporary subsequent impact for the owners of fishing vessels, where commercially important stocks may be disturbed or displaced to a point where normal fishing practices would be affected.

10.11.2.1 Construction phase

Magnitude

Detailed assessments of the following potential construction impacts on fish and shellfish receptors have been undertaken in volume 2, chapter 7 Marine Biodiversity:

- Temporary habitat loss and/or disturbance;
- Subsea noise impacting fish and shellfish receptors;
- Increased suspended sediment concentrations and associated deposition;
- Long-term subtidal habitat loss; and
- Introduction of artificial habitat and colonisation of hard structures.

The following impacts have been scoped out of the fish and shellfish assessment:

- Effects of subsea noise on marine biodiversity from Unexploded Ordnance (UXO) detonation;
- Subsea noise from marine vessels during construction, operation and maintenance and decommissioning phases;
- Impacts to fish and shellfish ecology due to electromagnetic fields (EMFs); and

- Accidental pollution during construction, operation and maintenance, and decommissioning phases.

With respect to the magnitude of this impact on commercial fisheries, the overall significance of the effect on fish and shellfish species is considered (i.e. both the magnitude and sensitivity of fish and shellfish species are considered to assess the magnitude on commercial fishing fleets). This is because the overall effect on the fish and/or shellfish species relates directly to the availability and amount of exploitable resource. For instance, where an effect of negligible significance is assessed for a species, a negligible magnitude is assessed for commercial fishing; where an effect of minor adverse significance is assessed for a species, a low magnitude is assessed for commercial fishing, i.e. the overall significance for fish and shellfish ecology helps to determine the magnitude of the impact for commercial fishing fleets.

Details of the fish and shellfish ecology assessment are summarised in Table 10.13; justifications for this assessment will not be repeated in this chapter. Evidence, modelling and justifications for these assessments are provided in volume 2, chapter 7: Marine Biodiversity.

Table 10.13: Significance Of Effects Of Construction Impacts On Fish And Shellfish Species Relevant To Commercial Fisheries Receptors

Potential impact	Significance of effect
Temporary habitat loss and/or disturbance	Low adverse/negligible
Subsea noise impacting fish and shellfish receptors	Low adverse/negligible
Increased suspended sediment concentrations and associated deposition	Low adverse/negligible

The significance of effect is considered to be negligible to low adverse for all potential impacts on fish and shellfish resources. The magnitude of impact on commercial fisheries receptors is predicted to be of very localised spatial extent, of short-term duration and to relate to a low to negligible loss of commercial resources. The magnitude of impact to all commercial fisheries and aquaculture receptors is assessed to be low adverse.

Sensitivity

There is potential for fishing grounds beyond the immediate construction activities to be affected by these impacts, albeit at a localised scale. While exposure to the impact is likely during the short-term period of construction activities and commercial fleets targeting key species will be affected, including those targeting whelk and other shellfish species, the localised nature of these Proposed Development related construction activities will minimise the extent of the impact. It is also recognised that commercial fleets are not limited to grounds specifically within the project area of physical work, and a range of alternative fishing grounds are expected to be fishable, that would not experience any resource impacts.

Given the reliance on fishing grounds across the Eni Development area, together with the relatively low mobility of whelk, lobster and brown crab target species, the potting fleet is deemed to be of medium vulnerability and medium recoverability; the sensitivity is considered to be medium.

For all other fleets, due to the range of alternative areas targeted and the distribution of key commercial species throughout the Irish Sea, fleets are deemed to be of low vulnerability and high recoverability. The sensitivity of the receptor for all other fleets is therefore considered to be low.

For aquaculture production, given that the Proposed Development infrastructure does not overlap with the areas identified as potential future production areas, the sensitivity is considered to be low.

Significance of effect

All fleets: overall, it is predicted that the sensitivity of the receptor is medium for potting and low for all other fleets, and the magnitude is low. The effect is **minor adverse**, which is not significant in EIA terms.

10.11.2.2 Operation and maintenance phase

Magnitude

Permanent and temporary impacts from operation of the Proposed Development and maintenance activities may displace commercially important fish and shellfish populations from the area. This section assesses the potential subsequent impact for the owners of fishing vessels, where commercially important stocks may be disturbed or displaced to a point where normal fishing practices would be affected.

The approach to this assessment follows that outlined for construction above, with details of the fish and shellfish ecology assessment summarised in Table 10.14.

Table 10.14: Significance Of Effects Of Construction Impacts On Fish And Shellfish Species Relevant To Commercial Fisheries Receptors

Potential impact	Significance of effect
Temporary habitat loss and/or disturbance	Low adverse/negligible
Long-term subtidal habitat loss	Low adverse/negligible
Introduction of artificial habitat and colonisation of hard structures	Low adverse/negligible

The significance of effect is considered to be negligible to low adverse for all potential impacts on fish and shellfish resources. The magnitude of impact on commercial fisheries receptors is predicted to be of very localised spatial extent, of short-term duration and to relate to a low to negligible loss of commercial resources. The magnitude of impact to all commercial fisheries and aquaculture receptors is assessed to be low adverse.

Sensitivity

The sensitivity of the commercial fisheries receptors is the same as that presented for construction summarised as medium for potting and low for all other fleets.

Significance of effect

All fleets: overall, it is predicted that the sensitivity of the receptor is medium for potting and low for all other fleets, and the magnitude is low. The effect is **minor adverse**, which is not significant in EIA terms.

10.11.2.3 Decommissioning

Significance of effect

The effects of decommissioning activities are expected to be the same or similar to the effects from construction. The effect is **minor adverse** for all fleets, which is not significant in EIA terms.

10.11.3 Interference with fishing activity

10.11.3.1 Construction phase

Magnitude

This assessment focuses on the potential impact of Proposed Development-related vessel traffic and changes to shipping patterns as a result of navigational routes leading to interference with fishing activity (i.e. reduced access) during construction.

Vessel movements (i.e. construction vessels transiting to and from areas undergoing construction works) related to the construction of the Proposed Development will add to the existing level of shipping activity in the regional study area (see volume 2, chapter 9 Shipping and Navigation for a full assessment of additional vessel movements). The maximum number of vessels return trips per year during the construction phase is estimated to be 191, with a maximum of 40 vessels on site at any time.

As part of the embedded mitigation measures, continuous liaison with the fishing industry will be undertaken including location and duration of construction activities; further details will be provided in a FLCP.

All fishing fleets are considered to be able to avoid vessel movements related to the Proposed Development construction. The impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. The magnitude is therefore considered to be low adverse for all fishing fleets.

Sensitivity

Construction traffic is likely to constrain most potting and passive netting activity across established construction supply routes due to the vulnerability of the marker buoys (for gears left *in situ*) to the propellers of passing construction vessels. It is noted that shipping routes do currently exist in the vicinity of the Proposed Development, and that the construction vessels are likely to follow these existing routes where possible. The UK potting and passive netting fisheries are deemed to be of medium vulnerability and high recoverability. The sensitivity of these receptors is therefore, considered to be low-medium.

All other fishery fleets are expected to be in a position to avoid the Proposed Development construction traffic. Dredge, beam trawl and demersal trawl fisheries are deemed to be of negligible vulnerability and high recoverability. The sensitivity of the receptor is therefore, considered to be low for dredge, beam trawl, demersal trawl and hook fisheries.

Significance of effect

UK potting and passive netting fisheries: overall, it is predicted that the sensitivity of the receptor is low-medium, and the magnitude is low. The effect is of **minor adverse** significance, which is not significant in EIA terms.

All other fleets: overall, it is predicted that the sensitivity of the receptor is low, and the magnitude is low. The effect is of **minor adverse** significance, which is not significant in EIA terms.

10.11.3.2 Operation and maintenance phase

Significance of effect

The maximum number of vessels return trips per year during the operation and maintenance phase is estimated to be 30, with a maximum of 4 vessels on site at any time. While this is lower that the construction phase (191 return trips and maximum of 40 vessels at any time), the magnitude of effects is expected to be in the same or similar range to the effects described during construction. The significance of effect is therefore **minor adverse** for all fleets, which is not significant in EIA terms.

10.11.3.3 Decommissioning

Significance of effect

The effects of decommissioning activities are expected to be the same or similar to the effects from construction. The effect is **minor adverse** for all fleets, which is not significant in EIA terms.

10.11.4 Temporary increases in steaming distances to fishing grounds

10.11.4.1 Construction phase

Magnitude

Consideration of commercial fishing vessels is assessed in volume 2, chapter 9 Shipping and Navigation (including from a collision and allision perspective). This assessment focuses on the potential impact of longer steaming distances to alternative fishing grounds while construction processes are ongoing.

Details of the Proposed Development's construction activities will be promulgated in advance of, and during construction via the usual means (e.g. Notice to Mariners, Kingfisher bulletin) to ensure mariners are aware of the ongoing works. Construction works will only necessitate minor deviations for fishing vessels transiting through the site during the construction phase. Localised impacts are anticipated but will be limited to the immediate area of construction activity and associated construction vessels. The magnitude is therefore, considered to be low adverse for all fishing fleets.

Sensitivity

The UK potting and passive netting fleets active in the study area operate across a range of grounds to haul and re-set different fleets of traps/pots/nets on a daily basis. Their normal operating range is expected to extend well beyond the 500 m exclusion zones that will be in place around active construction works and advisory safety distances around construction vessels. Given adequate notification it is expected that these vessels will be in a position to avoid construction areas with limited impact upon steaming times.

The UK dredge fleet targeting the local study area is expected to operate across wider areas of the Irish Sea and in the case of larger vessels, beyond this range. Given adequate notification it is expected that these vessels will be in a position to avoid construction areas with limited impact upon steaming times.

In relation to ground within the area of project physical work, all commercial fisheries fleets are considered to have medium to high availability of alternative fishing grounds and an operational range that is not limited to this Eni Development area. The sensitivity of the receptor is therefore, considered to be low for UK potting, gear with hooks and passive netting fishing fleets and negligible for all other fisheries.

Significance of effect

UK potting, gear with hooks and passive netting fisheries: overall, it is predicted that the sensitivity of the receptor is low, and the magnitude is low adverse. The effect is **minor adverse**, which is not significant in EIA terms.

All other fleets: overall, it is predicted that the sensitivity of the receptor is negligible, and the magnitude is low adverse. The effect is **negligible adverse**, which is not significant in EIA terms.

10.11.4.2 Decommissioning

Significance of effect

The effects of decommissioning activities are expected to be the same or similar to the effects from construction. The effect is **minor adverse** for UK potting, gear with hooks and passive netting fisheries, which is not significant in EIA terms and negligible adverse for all other fleets, which is not significant in EIA terms.

10.11.5 Supply chain opportunities for local fishing vessels

10.11.5.1 Construction phase

Magnitude

A range of employment opportunities may arise related to the Proposed Development construction, maintenance, and decommissioning activities, which require skill sets that align with the expertise, vessels and equipment owned by local fishing vessel businesses. Potential roles and supply chain opportunities include (but are not limited to):

- provision of guard vessel(s);
- skipper / Master of guard vessel;
- offshore FLO;
- onshore FLO;
- FIR;
- liaison management;
- scouting surveys;
- survey escort duties; and
- survey works (vessel and/or personnel).

These activities have a range of safety requirements for vessels and crew, including external vessel audits and compliance with vessel and crew certification schemes.

The opportunity exists for local fishing vessel owners to apply for specific roles or positions within the Proposed Development. Whether an appropriate position or role can be filled by a local fishing vessel owner would be determined on a case-by-case basis and would comply with competition law.

Overall, for all fleets, it is considered that the potential for supply chain opportunities for local fishing vessel owners would constitute a low (positive) magnitude.

Sensitivity

It is considered that all fishing vessel owners would have equal opportunity to decide whether the provision of supply chain related activities is a viable route for their business. The sensitivity of all commercial fisheries receptors is therefore, considered to be low (positive).

Significance of effect

All fleets: overall, it is predicted that the sensitivity of the receptor is low, and the magnitude is low. The effect is of **minor beneficial** significance, which is not significant in EIA terms.

10.11.5.2 Operation and maintenance phase

Significance of effect

The effects of operation and maintenance activities are expected to be similar or somewhat lower than construction, given the number of vessels expected to be on site at any one time, and the range of maintenance activities that are ongoing. Overall, the effect is **minor beneficial** for all fleets, which is not significant in EIA terms.

10.11.5.3 Decommissioning

Significance of effect

The effects of decommissioning activities are expected to be the same or similar to the effects from construction. The effect is **minor beneficial** for all fleets, which is not significant in EIA terms.

10.11.6 Loss or damage to fishing gear due to snagging gear on Proposed Development infrastructure

10.11.6.1 Operation and maintenance phase

Magnitude

The presence of cables and pipelines and associated cable protection, together with offshore platforms and wells (and associated scour protection) on the seabed represent potential snagging points for fishing gear and could lead to damage to, or loss of, fishing gear. The safety aspects including potential loss of life as a result of snagging risk during the operation and maintenance phase are beyond the scope of this commercial fisheries assessment.

The Proposed Development embedded mitigation measures include adherence to FLOWW guidance, Safety Zones during maintenance, a commitment to cable burial as the preferred option for cable protection, and appropriate marking and charting of infrastructure.

In the instance that snagging does occur, the Applicant will work to the protocols laid out within the guidance produced by the FLOWW group and ''Recommendations for Fisheries Liaison: Best Practice'' guidance for offshore renewable developers, in particular section 9: Dealing with claims for loss or damage of gear.

Snagging poses a risk to fishing equipment and in extreme cases may potentially lead to capsize of vessel and crew fatalities, as well as damage to subsea infrastructure. Three phases of interaction are possible:

- initial impact of gear and subsea infrastructure;
- pullover of gear across subsea infrastructure; and
- snagging or hooking of gear on the subsea infrastructure. The snagging or hooking of fishing gear with infrastructure/cables on the seabed is the most hazardous to the vessel and crew due to the possibility of capsizing.

It is considered likely that fishermen will operate appropriately (i.e. avoiding the indicated infrastructure and cable protection at the defined location) given adequate notification of the locations of any snagging hazards; and are highly likely to avoid the infrastructure and cable protection within safety zones.

Embedded mitigation details cable burial where possible, and a detailed Cable Burial Risk Assessment, the results of which will be communicated to fisheries stakeholders. Furthermore, the Applicant commits to follow standard protocols should snagging occur, the details of which will be provided in the FLCP. Maintenance will include regular monitoring of cable burial integrity and condition of cable protection, with reburial of exposed cable sections and repair/replacement of cable sections as necessary. Overall, given the relatively low area impacted by the Proposed Development, together with the embedded measures including safety zones, the magnitude is considered to be low adverse for all fleets.

Sensitivity

Due to the nature and operation of mobile demersal gear (i.e. it is actively towed and directly penetrates the seabed with near continuous contact) there is increased vulnerability to this impact and the sensitivity is therefore considered to be **medium** for all mobile demersal fisheries.

UK potters, gear with hooks and netters show a low vulnerability as the gear is placed, not towed and is less likely to penetrate the seabed. The sensitivity of UK potters, netters and gears with hooks is considered to be low.

Significance of effect

UK potting, passive netting and gear with hooks fisheries: overall, it is predicted that the sensitivity of the receptor is low, and the magnitude is low adverse. The effect is **minor adverse**, which is not significant in EIA terms.

UK and Irish dredge, UK demersal otter trawl, UK, and Belgian beam trawl: overall, it is predicted that the sensitivity of the receptor is medium, and the magnitude is low adverse. The effect is **minor adverse**, which is not significant in EIA terms.

10.12 Cumulative Impact Assessment

There is potential for cumulative loss of access to fishing grounds as a result of activities associated with the Proposed Development and other plans and projects in the region.

All other impacts (related to disruption of resource, interference, snagging and additional steaming times) are considered to be highly localised with minimal pathway for cumulative effects.

Tier 1

For the potential cumulative loss of access to fishing grounds the following offshore windfarms (that are in various stages of the consenting process) are considered:

- Awel y Môr Offshore Windfarm
- Morecambe Offshore Windfarm
- Morgan Offshore Windfarm
- Mona Offshore Windfarm
- Morgan and Morecambe Offshore Wind Farms Transmission Assets
- Isle of Man Offshore Windfarm (Tier 2)
- Minesto Deep Green Phase1 Single DGU Unit
- Morlais renewable energy

Wind farms that are currently operational, but may continue to cause an impact to commercial fisheries are also included within the assessment, namely:

- Rhyl Flats Offshore Windfarm and associated maintenance works
- Gwynt y Mor Offshore Windfarm and associated maintenance works including pontoon at Mostyn

All of the offshore windfarms are considered to be Tier 1 projects, with exception of Isle of Man Offshore Windfarm which is Tier 2. The Isle of Man offshore Windfarm is Tier 2 because while the Scoping Report is not yet available in the public domain, the location of the array area is available and an understanding of the fisheries in operation across the Isle of Man Offshore Windfarm is possible based on the baseline characterisation undertaken for this Proposed Development. Given the similar nature of the effects of offshore wind farms, it is considered appropriate to assess the only Tier 2 project (Isle of Man Offshore Windfarm), together with the Tier 1 projects.

Landing statistics and VMS data indicate the importance of the Morgan, Mona, and Isle of Man offshore windfarm sites to the UK (including Isle of Man) scallop dredge fleets. UK potting vessels are known to operate across the Awel y Môr and Morecambe offshore windfarm sites. The installation of the Morgan and

Morecambe Offshore Wind Farms Transmission Assets offshore export cable route is likely to affect UK potting fleets operating within the 12 and 6 NM boundaries across a short-term period.

Overall, the above windfarms, together with the Morgan and Morecambe Offshore Wind Farms Transmission Assets are expected to affect UK (including Isle of Man) fishing fleets that have already accommodated existing operational windfarms. This region contains a high level of existing offshore windfarms and a fishing sector that has undergone numerous mitigations and have repeatedly adapted their operations around expanding developments.

Potential cumulative effects are identified due to existing and potential Tier 1 and Tier 2 offshore wind farms that may affect all fishing fleets under assessment. However, the extremely localised and short-term impacts of the Proposed Development are predicted to add a **negligible** amount to the overall cumulative effects of offshore wind farms in the region for the fleets assessed.

Other projects included in the Tier 1 cumulative assessment are as follows:

- disposal sites at the following locations: Holyhead North, Broughton, Mostyn Breakwater, Shell Lagoon, Llanbedr, Burbo Bank Extension.
- Project Seagrass: Seagrass restoration;
- Ancala Water: Tidal Flap Valve Clearance;
- Hochtief UK Ltd: Boreholes; and
- Amalgamated Construction Ltd: Ground Investigation works

The localised, small-scale, temporary, and short duration of the above Tier 1 projects do not increase the level of cumulative impact significance. To conclude, the extremely localised and short-term impacts of the Proposed Development are predicted to add a **negligible** amount to the overall cumulative effects of Tier 1 projects in the region for the fleets assessed.

Tier 2

In addition to offshore windfarms, Marine Protected Areas (MPAs) have the potential to add to cumulative loss of access where management measures that restrict fishing are implemented to protect features within the designated site. The following MPAs are considered:

- West of Walney Marine Conservation Zone (MCZ);
- West of Copeland MCZ;
- Fylde MCZ;
- Luce Bay and Sands Special Area of Conservation (SAC);
- Liverpool Bay Special Protection Area (SPA);
- South Rigg MCZ; and
- North Channel SAC.

At present, it is not known whether additional management measures for any gear interaction with the other aforementioned SACs, SPAs or MCZs have been implemented, and therefore these designations are considered as part of the Tier 2 assessment.

Given that the MCZs and SACs cover a range of habitat features and based on a maximum design scenario for commercial fisheries; it is assumed that all mobile trawling and dredge gear with seabed contact will be subject to some form of restrictions in relation to MCZ and SAC sites protected for habitat features. Management measures for mobile gear in sites protected for mobile species, such as birds (SPA) or harbour porpoise (SAC) are considered less likely based on the limited risk these gears present to the feature species.

Potential cumulative effects are identified due to MPAs that may affect all fishing fleets under assessment. However, the extremely localised and short-term impacts of the Proposed Development are predicted to add a **negligible** amount to the overall cumulative effects of Tier 2 projects in the region for the fleets assessed.

10.13 Transboundary effects

Transboundary effects arise when impacts from a development within one state affect the environment of other states outside of the UK EEZ.

Due to the localised nature of any potential impacts and very limited foreign fishing fleet activity (some potential for Irish and Belgian vessels outside of 12 NM, but not specifically within the Proposed Development area of physical works), transboundary impacts are unlikely to occur.

Effects on biological resources could occur over a range of 10's of kilometres and therefore potential for interaction is not expected to extend into the EEZs of the Isle of Man or the Republic of Ireland. Therefore, the potential transboundary impact of effects on commercial fish stocks in the waters of other states on commercial fisheries is concluded to be of negligible adverse significance and is therefore considered to be not significant in EIA terms.

Effects on commercial fishing fleets from the Republic of Ireland and Belgium, in terms of reduction in access to grounds within the Proposed Development, are unlikely given the lack of vessel activity within the Proposed Development area. The potential transboundary impact of constraints on foreign commercial fishing activities is concluded to be of negligible adverse significance and is therefore considered to be not significant in EIA terms.

10.14 Inter-related effects

There are clear inter-relationships between the commercial fisheries topic and several other topics that have been considered within this EIA. Table 10.15 provides a summary of the principal inter-relationships and signposts to where those issues have been addressed.

Table 10.15: Commercial Fisheries Inter-relationships

Topic and description	Related chapter	Where addressed in this chapter
Loss or restricted access to fishing grounds	N/A	
Impacts on commercially valuable fish and shellfish species/resources	Impact magnitude informed by the assessment in volume 2, chapter 7 Marine Biodiversity	Section 10.11.2
Interference with fishing activity	Impact magnitude informed by the assessment in volume 2, chapter 9 Shipping and Navigation	Section 10.11.3
Temporary increases in steaming distances to fishing grounds	Impact magnitude informed by the assessment in volume 2, chapter 9 Shipping and Navigation	Section 10.11.4
Supply chain opportunities for local fishing vessels	N/A	
Loss or damage to fishing gear due to snagging gear on Proposed Development infrastructure	Impact magnitude informed by the assessment in volume 2, chapter 9 Shipping and Navigation	Section 10.11.6

10.15 Conclusion

Information on commercial fisheries within the commercial fisheries study area was collected through desk studies, analysis of available fisheries data and consultation with stakeholders.

The key commercial fisheries fleet métiers operating across the study area include (in no particular order):

- UK (primarily Scottish, but also some Northern Irish, English and Welsh) and Irish dredgers targeting king and queen scallops;
- UK (primarily English and Welsh) potters targeting shellfish, primarily whelk offshore, but also lobster and brown crab;
- UK (primarily English) and Belgian beam trawlers targeting sole, plaice and other demersal species, with localised inshore trawling targeting brown shrimp;
- UK inshore vessels (English) under 10 m length targeting a variety of demersal species (e.g. bass) using passive netting (fixed and drift) and gear with hooks; and
- UK strategic areas of sustainable aquaculture production, which have been identifed for potential future production.

Based on analysis of landings and spatial data, fishing activity across the Proposed Development is expected to be dominated by larger vessels potting for whelk, smaller inshore potting vessels targeting lobster and larger vessels dredging for king and queen scallops, with potential for occasional beam trawl activity.

During the construction and decommissioning phases the commercial fisheries assessment found moderate significant effects for the UK potting fleet related to the loss or restricted access to fishing grounds. Additional mitigation following FLOWW guidance, including justifiable, evidence-based disturbance payments lowers the residual impact to minor adverse and not significant in EIA terms.

During the construction and decommissioning phases the commercial fisheries assessment found all other impacts to all fleets to be minor adverse or lower and not significant in EIA terms.

During the operation and maintenance phase the commercial fisheries assessment found all impacts to all fleets to be minor adverse or lower and not significant in EIA terms.

The cumulative impact assessment found that the extremely localised and short-term impacts of the Proposed Development were predicted to add a negligible amount to the overall cumulative effects of offshore wind farms and MPAs in the region for the fleets assessed.

Transboundary effects related to the impact on biological resources in the Isle of Man and Republic of Ireland EEZs; and the impact of reduced access to grounds within the Proposed Development for non-UK fleets were concluded to be of negligible adverse significance.

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A TETRA TECH COMPANY

Liverpool Bay CCS Ltd

HYNET CARBON DIOXIDE TRANSPORTATION AND STORAGE PROJECT - OFFSHORE

Environmental Statement
Volume 2, chapter 11: Marine Archaeology

EHE7228B
Liverpool Bay CCS Limited
Final
February 2024
Offshore ES
Marine Archaeology

Glossary

Term	Meaning
Bathymetry	The measurement of water depth in oceans, seas and lakes.
"Do Nothing" Scenario	The environment as it would be in the future should the proposed project not be developed.
Effect	The consequence of an impact.
Environmental Impact Assessment	A statutory process by which certain planned projects must be assessed before a formal decision to proceed can be made. It involves the collection and consideration of environmental information, which fulfils the assessment requirements of the EIA Directive and EIA Regulations, including the publication of an Environmental Impact Assessment (EIA) Report.
Gazetteer	A geographical index or dictionary
Impact	A change that is caused by an action.
Magnitude	Size, extent and duration of an impact.
Mitigation Measure	Measure which would avoid, reduce, or remediate an impact
Non-statutory stakeholder	Organisations with whom the regulatory authorities may choose to engage who are not designated in law but are likely to have an interest in a proposed development.
Palaeochannel	A geological term describing a remnant of an inactive river or stream channel that has been filled or buried by younger sediment
Palaeoenvironmental	An environment of a past geological age
Project	The HyNet Carbon Dioxide Transportation and Storage Project.
Project Design Envelope	Also known as the Rochdale Envelope, the PDE concept is routinely utilised in both onshore and offshore planning applications to allow for some flexibility in design options, particularly offshore, and more particularly for foundations and turbine type, where the full details of the project are not known at application submission but where sufficient detail is available to enable all environmental impacts to be appropriately considered during the EIA.
Proposed Development	The offshore components of the Project which are subject of this Environmental Statement, as described in volume 1, chapter 3.
Residual Impact	Residual impacts are the final impacts that occur after the proposed mitigation measures have been put into place, as planned.
Scoping Opinion	Sets out the Secretary of State's response to the Applicants Scoping Report and contains the range of issues that the Secretary of State, in consultation with statutory stakeholders, has identified should be considered within the EIA.
The Applicant	This is Liverpool Bay CCS Ltd.

Acronyms

Acronym	Description
AD	Anno Domini
ALSF	Aggregate Levy Sustainability Fund
AEZ	Archaeological Exclusion Zone
BC	Before Christ
BGS	British Geological Survey
BP	Before Present
CCS	Carbon Capture and Storage
CEA	Cumulative Effects Assessment
CLV	Cable Lay Vessel
CPAT	Clwyd-Powys Archaeological Trust

Acronym	Description
ED50	European Datum 1950
EIA	Environmental Impact Assessment
ES	Environmental Statement
HE	Historic England
HER	Historic Environment Record
HDD	Horizontal Directional Drilling
HSC	Historic Seascape Character
JFS	James Fisher Subtech
JNAPC	Joint Nautical Archaeology Policy Committee
LAT	Lowest Astronomical Tide
MMO	Marine Management Organisation
MASA	Marine Archaeology Study Area
MPS	Marine Policy Statement
MHWS	Mean High Water Springs
NLO	Named Location
NRHE	National Record of the Historic Environment
NMRW	National Monuments Record Wales
NSC	Non-Submarine Contact
O&M	Operation and Maintenance
OP	Oil Platform
OPRED	Offshore Petroleum Regulator for Environment and Decommissioning
OWF	Offshore Wind Farm
PAD	Protocol for Archaeological Discoveries
PDE	Project Design Envelope
PoA	Point of Ayr
RCAHMW	Royal Commission on the Ancient and Historic Monuments of Wales
ROV	Remotely Operated Vehicle
TAEZ	Temporary Archaeological Exclusion Zone
UKHO	United Kingdom Hydrographic Office
UNESCO	United Nations Educational, Scientific and Cultural Organization
UTM	Universal Transverse Mercator
UXO	Unexploded Ordnance
WCPS	West Coast Palaeoandcape Survey
WIS	Western Irish Sea
WNMP	Welsh National Marine Plan
WSI	Written Scheme of Investigation
WWII	World War II

Units

Unit	Description
%	Percentage
cm	Centimetre (distance)
dB	Decibel (unit used to measure the intensity of sound)
ft	Feet (distance)
Hz	Hertz (frequency)
KHz	Kilohertz (frequency)
km	Kilometres (distance)
km^2	Square kilometres (area)
m	Meters (distance)
mm	Millimetres (distance)
mg/l	Milligrams per litre
nm	Nautical miles (distance; 1nm = 1.852km)
nT	Nanotesla (magnetic flux density)

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11 MARINE ARCHAEOLOGY

11.1 Introduction

This Marine Archaeology Environmental Statement (ES) provides an assessment of the potential impacts of the HyNet Carbon Dioxide Transportation and Storage Project (hereafter referred to as "the Project") and the offshore components of the project (hereafter referred to as "the Proposed Development"). on marine archaeology. Specifically, this chapter considers the potential impact of the Proposed Development seaward of Mean High Water Springs (MHWS) during the construction, operations and maintenance, and decommissioning phases.

The chapter draws upon information contained within the Marine Archaeology Technical Report (MSDS Marine, 2023b).

11.2 Purpose of this chapter

In summary, the primary purpose of an Environmental Statement is to support applications for the Proposed Development under the relevant legislation, set out in volume 1, chapter 2. In particular this ES chapter:

- presents the existing environmental baseline established from desk studies, site-specific surveys and consultation;
- identifies any assumptions and limitations encountered in compiling the environmental information;
- sets out embedded mitigation measures;
- presents the potential environmental effects, including culminative effects, on marine archaeology arising from the Proposed Development, based on the information gathered and the analysis and assessments undertaken; and
- highlights any necessary monitoring and/or mitigation measures which could prevent, minimise, reduce or offset the possible environmental effects of the Proposed Development on marine archaeology.

11.3 Study area

The Proposed Development area which has been considered by this assessment for offshore can be broken down into three parts:

- the Area of Project Physical Work;
- the Eni Proposed Development Area; and
- the wider Marine Archaeology Study Area (MASA).

The Area of Project Physical Work covers a restricted area in which Proposed Development activities and the insertion of new infrastructure including cable laying, well drilling and platform construction, as well as associated activities such as sand wave clearance are to be focused.

The Eni Development Area covers a wider area. While the main Proposed Development impacts will be focused within the Area of Project Physical Work associated impacts such as vessel anchoring may occur within the Eni Development Area. As such both areas have been treated as the 'Site', and all archaeological remains within have been assessed.

The wider MASA forms a 2 km buffer around the Eni Development Area, up to MHWS and has been defined to better characterise the archaeological resource within the offshore parts of the site.

11.4 Policy and legislative context

11.4.1 National policy statements and regional marine plans

The Proposed Development spans both English and Welsh waters and therefore policy and legislation from both areas is relevant to this assessment. Key policy relevant to this ES chapter includes the Marine Policy Statement (MPS), Welsh National Marine Plan (WNMP) and North West Inshore and North West Offshore Coast Marine Plans. A full review of relevant legislation and policy is set out within volume 1, chapter 2.

The MPS, in paragraph 2.6.6.3, states that heritage assets in the marine environment "s*hould be conserved through marine planning in a manner appropriate and proportionate to their significance*", adding that, "opportunities should be taken to contribute to our knowledge and understanding of our past by capturing evidence from the historic environment and making this publicly available, particularly if a heritage asset is to be lost".

With reference to non-designated heritage assets in the UK marine environment the MPS states, in paragraph 2.6.6.5, that the "Many heritage assets with archaeological interest in these areas are not currently designated as scheduled monuments or protected wreck sites but are demonstrably of equivalent significance. The absence of designation…does not necessarily indicate lower significance and the marine plan authority should consider them subject to the same policy principles as designated heritage assets…based on information and advice from the relevant regulator and advisors".

When considering possible damage to or destruction of heritage assets by development proposals, the MPS states in paragraph 2.6.6.9 that "the marine plan authority should identify and require suitable mitigating actions to record and advance understanding of the significance of the heritage asset before it is lost".

The WNMP (Table 11.1) includes Policy SOC_05 relating to Heritage Assets which recognises the importance of protecting the underwater historic environment and as such proposals should demonstrate appropriate consideration of the potential impacts of developments in order to prevent substantial loss or harm. It also highlights that development proposals should consider opportunities to better understand and promote the historic environment.

The WNMP Implementation Guidance (Welsh Government, 2020) highlights that the absence of designated historic assets should not suggest that non designated heritage assets are of less importance and points out that given the difficulties with investigating underwater heritage, the significance of many marine historic assets has not as yet been established and so all such assets should be considered by proposals.

The guidance advises that all proposals should demonstrate compliance with relevant national and regional legislation and guidance. The relevant regional Welsh archaeological trust should be consulted for the historic environment records and the Royal Commission on the Ancient and Historic Monuments of Wales (RCAHMW) or their extensive database of marine historic assets. Any assessment should also be undertaken in accordance with guidelines set out by the Chartered Institute for Archaeologists and best practise guidance notes for the marine historic environment.

The guidance highlights that proposals should demonstrate the potential impact on relevant historic assets and that there should be a general presumption in favour of preservation or enhancement of historic assets.

Further advice in relation specifically to the Proposed Development has been sought through consultation with archaeological curators including the RCAHMW and Historic England (HE).

Table 11.1 sets out how the ES chapter has responded to the specifications of the MPS and WNMP, detailing commitments in relation to each specification.

Table 11.1: Summary Of The MPS And WNMP

Summary of key points in MPS and WNMP relevant to marine archaeology	How and where considered in the ES chapter
Heritage assets in the marine environment "should be conserved through marine planning in a manner appropriate and proportionate to their significance" and "opportunities should be taken to contribute to our knowledge and understanding of our past by capturing evidence from the historic environment and making this publicly available, particularly if a heritage asset is to be lost" (paragraph 2.6.6.3 of MPS)	The ES has considered the significance of all known and potential heritage assets within the MASA. This is discussed further in section 11.7 below. The mitigation measures adopted as part of the Proposed Development including any future geophysical and geotechnical surveys undertaken will produce new archaeological data and understandings of the historic marine environment of the area. The results of these investigations will ultimately be made publicly available. This is discussed further within the outline Written Scheme of Investigation (WSI) which accompanies this ES chapter.
The absence of designation…does not necessarily indicate lower significance and the marine plan authority should consider them [non designated heritage assets] subject to the same policy principles as designated heritage assets…based on information and advice from the relevant regulator and advisors (paragraph 2.6.6.5 of MPS)	The ES has considered the significance of all known and potential heritage assets within the MASA. This is discussed further in sections 11.10 and 11.11 of this report. Consultation to date with the relevant regulator and advisors is set out in Table 11.3 and will be ongoing.
The marine plan authority should identify and require suitable mitigating actions to record and advance understanding of the significance of the heritage asset before it is lost (paragraph 2.6.6.9 of MPS)	The mitigation measures adopted as part of the Proposed Development include archaeological input into any future geophysical and geotechnical surveys and review of the resulting data. This will produce new archaeological data and understanding of the historic marine environment of the area. The results of these investigations will ultimately be made publicly available. This is discussed further in the outline WSI, which has also been prepared to support the Environmental Impact Assessment (EIA) which will set out the high-level mitigation strategy for approval by the regulator and advisors.
WNMP SOC_05: Historic Assets Proposals should demonstrate how potential impacts on historic assets and their settings have been taken into consideration and should, in order of preference: a. avoid adverse impacts on historic assets and their settings; 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. Opportunities to enhance historic assets are encouraged.	The ES has considered the significance of all known and potential heritage assets within the MASA. This is discussed further in sections 11.10 and 11.11 of this report. The mitigation measures adopted as part of the Proposed Development include archaeological input into any future geophysical and geotechnical surveys and review of the resulting data. This will produce new archaeological data and understanding of the historic marine environment of the area. The results of these investigations will ultimately be made publicly available. This is discussed further in section 11.7 below. An outline WSI has also been prepared to support the EIA which will set out the high-level mitigation strategy for approval by the regulator and advisors.
The absence of designated historic assets should not suggest that non designated heritage assets are of less importance and so all such assets should be considered by proposals (paragraph 95 of WNMP Implementation Guidance) Proposals should demonstrate compliance with relevant national and regional legislation and guidance. The relevant regional Welsh archaeological trust should be consulted for the historic environment records and the RCAHMW for their extensive database of marine historic assets. Any assessment should also be undertaken in accordance with guidelines set out by the Chartered Institute for Archaeologists and best practise guidance notes for the marine historic environment (paragraph 96 of WNMP Implementation Guidance)	The ES has considered the significance of all known and potential heritage assets within the MASA and has consulted the RCAHMW and HER datasets as specified. This is discussed further in section 11.4. Table 11.1 and Table 11.2 demonstrate how the ES has complied with National and Regional Policy Statements. Marine Archaeology Technical Report (MSDS Marine, 2023b), confirms the baseline methodology and section 11.4 confirms that the baseline assessment was undertaken in accordance with relevant legislation and guidance.

Summary of key points in MPS and WNMP relevant to marine archaeology	How and where considered in the ES chapter
Proposals should demonstrate the potential impact on relevant historic assets and that there should be a general presumption in favour of preservation or enhancement of historic assets (paragraph 98 and 100)	

The assessment of potential changes to marine archaeology has also been made with consideration to the specific policies set out in the North West Inshore and North West Offshore Coast Marine Plans (Marine Management Organisation (MMO, 2021). Key provisions are set out in Table 11.2 along with details as to how these have been addressed within the assessment.

Table 11.2: North West Inshore And North West Offshore Marine Plan Policies Relevant To Marine Archaeology

Policy	Summary of key points in Marine Plans relevant to marine archaeology	How and where considered in the ES chapter
NW-HER-1	This policy aims to conserve and enhance marine and coastal heritage assets by considering the potential for harm to their significance. This consideration will not be limited to designated assets and extends to those non-designated assets that are, or have the potential to become, significant. The policy will ensure that assets are considered in the decision-making process and will make provisions for those assets that are discovered during developments.	The potential for harm to the significance of marine heritage assets by the Proposed Development has been assessed in section 11.11, which includes the assessment of designated and non-designated marine heritage assets identified within the MASA. Mitigation measures have been adopted as part of the Proposed Development to protect the known archaeological assets and make provisions for those assets that are discovered during the Proposed Development in the form of the production of an outline WSI and Protocol for Archaeological Discoveries (PAD) which accompany this ES.

11.4.2 Legislation

Relevant policy and legislation to marine archaeology up to MHWS include the following:

- The World Heritage Convention (1972);
- United Nations Convention on the Law of the Sea (1982);
- Protection of Wrecks Act (1973);
- Ancient Monuments and Archaeological Areas Act (1979);
- Planning (Listed Buildings and Conservation Areas) Act (1990);
- Protection of Military Remains Act (1986);
- Merchant Shipping Act (1995);
- International Council of Monuments and Sites Charter on the Protection and Management of Underwater Cultural Heritage (1996) (the Sofia Charter);
- United Nations Educational, Scientific and Cultural Organization (UNESCO) Convention on the Protection of the Underwater Cultural Heritage (2001);
- Historic Environment (Wales) Act 2016;

- National Heritage Act (2002); and
- Marine and Coastal Access Act (2009).

11.4.3 Guidance

This chapter of the ES has been developed in accordance with the following guidelines:

- Planning Policy Wales Technical Advice Note 24: The Historic Environment;
- Managing the Marine Historic Environment of Wales (Cadw/Welsh Government, 2020);
- Historic England's (HE's) Conservation Principles, Policies and Guidance for the Sustainable Management of the Historic Environment (English Heritage (now Historic England), 2008);
- Conservation Principles for the Sustainable Management of the Historic Environment in Wales (Cadw, 2011);
- Code of Conduct (Chartered Institute for Archaeologists, 2014 (updated 2022));
- Standard and Guidance for Historic Environment Desk Based Assessment (Chartered Institute for Archaeologists, 2014 (updated 2020));
- COWRIE Historic Environment Guidance for the Offshore Renewable Energy Sector (Wessex Archaeology, 2007);
- Offshore Renewables Protocol for Archaeological Discoveries (PAD) (The Crown Estate, 2014);
- Offshore Geotechnical Investigations and Historic Environment Analysis: Guidance for the Renewable Energy Sector (Gribble and Leather, 2010);
- Archaeological Written Schemes of Investigation for Offshore Wind Farm Projects (The Crown Estate, 2021);
- Marine Geophysics Data Acquisition, Processing and Interpretation, Guidance Notes (English Heritage, 2013, currently under review by MSDS Marine for Historic England);
- Identifying and Protecting Palaeolithic Remains (English Heritage, 1998);
- Military Aircraft Crash Sites (English Heritage, 2002);
- Aircraft Crash Sites at Sea (Wessex Archaeology, 2008); and
- Code of Practice for Seabed Development (Joint Nautical Archaeology Policy Committee, 2006).

11.5 Consultation

A summary of the key issues raised during consultation activities undertaken to date specific to Marine Archaeology is presented in Table 11.3 below.

Table 11.3: Summary of Key Consultation Issues Raised During Consultation Activities Undertaken for The Proposed Development Relevant To Marine Archaeology

Date	Consultee and type of response	Issues raised	Response to issue raised and/or were considered in this chapter
January 2023	The Scoping Opinion contained no responses from consultees relevant to	N/A	

Date	Consultee and type of response	Issues raised	Response to issue raised and/or were considered in this chapter
	Marine Archaeology		
June 2023	Historic England (HE) – email to invite consultation	HE have been approached as part of the project consultation. Correspondence via email has confirmed that HE are not a statutory consultee on Offshore Petroleum Regulator for Environment and Decommissioning (OPRED) applications, however, the Eni is continuing to seek consultation opportunities with HE.	Consultation awaited.
June 2023	Royal Commission on the Ancient and Historic Monuments of Wales (RCAHMW) – consultation meeting	Introduction to the offshore elements of the Proposed Development; discussion of geophysical data coverage, noting the data is not full coverage; discussion of the location of *Resurgam* (Protected Wreck) and re-routing of the cables around the protected area; discussion on Archaeological Exclusion Zones (AEZs) and current routing of some cables through AEZs. Agreed a way forward which has been reflected in the documents produced as part of this application.	Key issues to be addressed are the lack of full coverage data and the routing of some cables through AEZs. Lack of full coverage data: This issue is dealt with through a commitment to collect and assess full coverage data prior to seabed impacts. This data will be reviewed by a competent and experienced marine archaeological geophysicist. Routing of cables through AEZs: This assessment makes a commitment to either investigate the AEZs and to amend them if appropriate, or to re-route around them and assess the wider area. There will be no impacts to AEZs by construction activities. The WSI will clearly set out how this investigation and mitigation is to be achieved.

11.6 Data sources

11.6.1 Desktop study

Information on Marine Archaeology within the Marine Archaeology Study Area was collected through a detailed desktop review of existing studies and datasets. The key sources and datasets are summarised in Table 11.4 below, and additional sources are referred to throughout the report.

The principal archaeological archives relating to the MASA area are the National Record of the Historic Environment (NRHE) as held by HE and the National Monuments Record Wales (NMRW) as held by RCAHMW. Designated datasets from HE and Cadw were also reviewed, as was the dataset of remains designated under the Protection of Military Remains Act. Data from the United Kingdom Hydrographic Office (UKHO) is a further resource, of which MSDS Marine holds in house and is utilised to corroborate positional information of known wrecks and obstructions on the seabed. In addition, Historic Environment Record (HER) data was obtained from Clwyd-Powys Archaeological Trust (CPAT), who also provided National Museum of Wales (NMW) data. Merseyside HER data was also obtained. Additionally Historic Seascape Characterisation data was used (note the coverage of this dataset includes English waters only). Finally British Geological Survey (BGS) data was also obtained, and other published and unpublished sources were reviewed and incorporated.

Table 11.4: Summary Of Key Desktop Sources

Title	Source	Year	Author
Historic England (HE) designated data	Historic England	2023 (extract)	Multiple (national dataset)
Cadw designated data	Cadw	2023 (extract)	Multiple (national dataset)
List of wrecks designated under the Protection of Military Remains Act, 1986	https://explore-marine-plans.marineservices.org.uk/	2023 (viewed)	Multiple (national dataset)
Wrecks and Obstructions dataset	UKHO	2023 (extract)	Multiple (national dataset)
National Record of the Historic Environment (NRHE) data	Historic England	2023 (extract)	Multiple (national dataset)
Royal Commission on the Ancient and Historic Monuments of Wales (RCAHMW) data	RCAHMW	2023 (extract)	Multiple (national dataset)
Clwyd-Powys Archaeological Trust (CPAT) Historic Environment Record (HER) data including National Museum of Wales (NMW) data	CPAT	2023 (extract)	Multiple (regional dataset)
Merseyside HER data	Merseyside HER	2023 (extract)	Multiple (regional dataset)
Historic Seascape Characterisation	Maritime Archaeology and SeaZone	2011	Maritime Archaeology and SeaZone
Platform and Well Ground Model Consultancy Report | Liverpool Bay Offshore United Kingdom. Fugro, Boskalis, Eni	Fugro 2023, Phase 2b Platform and Well Ground Model Consultancy Report | Liverpool Bay Offshore United Kingdom. Fugro, Boskalis, EN	2023	Fugro
Geology of the seabed and shallow subsurface: The Irish Sea	British Geological Survey (BGS)	2015	Mellett *et al*.
United Kingdom Offshore Regional Report (ORR): The geology of the Irish Sea.	BGS	1995	Jackson *et al*.
Liverpool Bay Sheet 53°N- 04°”. 1: 250,000 Series: Seabed Sediments and Quaternary Geology	BGS	1984	BGS
Anglesey Sheet 53°N- 06°”. 1: 250,000 Series: Quaternary Geology	BGS	1990	BGS
The West Coast Palaeolandscape Survey (WCPS)	Aggregate Levy Sustainability Fund (ALSF) report.	2011	Fitch S, Gaffney V, Ramsey E, and Kitchen E
Archaeological Assessment of Geophysical and Hydrographic Data.	Hy-Net Carbon Dioxide Transportation and Storage Project. Archaeological Assessment of Geophysical and Hydrographic Data. Report 2023/MSDS23250/1	2023	MSDS Marine

11.6.2 Site-specific surveys

In addition to the desk-based sources, a comprehensive marine geophysical survey was carried out for the Proposed Development. The survey comprised multi-beam bathymetry; side-scan sonar, magnetometer and sub-bottom profiler surveys, to inform a detailed understanding of the seabed anomalies, topography and underlying geological formations of the seabed. An archaeological review of the geophysical data has been carried out and is presented in MSDS Marine (2023a) with a detailed summary in Marine Archaeology Technical Report (MSDS Marine, 2023b). A summary of the surveys undertaken to inform the Marine Archaeology ES is outlined in Table 11.5.

Table 11.5: Summary Of Site-Specific Survey Data

Title	Extent of survey	Overview of survey	Survey contractor	Date	Reference to further information
Sidescan sonar	Within the Area of Project Physical Work and Hoyle Bank	Sidescan Sonar survey to characterise seabed and existing assets	James Fisher Subtech (JFS), reviewed archaeologically by MSDS Marine	2022	James Fisher Subtech, 2022. LBA and CCS Acoustic Survey 2022. Ref: 12377-OPS-REP-002; MSDS Marine 2023 Hy-Net Carbon Dioxide Transportation and Storage Project. Archaeological Assessment of Geophysical and Hydrographic Data. Report 2023/MSDS23250/1
Multibeam	Within the Area of Project Physical Work and Hoyle Bank	Survey to characterise seabed and existing assets	James Fisher Subtech (JFS) reviewed archaeologically by MSDS Marine	2022	James Fisher Subtech, 2022. LBA and CCS Acoustic Survey 2022. Ref: 12377-OPS-REP-002; MSDS Marine 2023 Hy-Net Carbon Dioxide Transportation and Storage Project. Archaeological Assessment of Geophysical and Hydrographic Data. Report 2023/MSDS23250/1
Magnetometer	Within the Area of Project Physical Work and Hoyle Bank	Survey to characterise seabed and existing assets	James Fisher Subtech (JFS) reviewed archaeologically by MSDS Marine	2022	James Fisher Subtech, 2022. LBA and CCS Acoustic Survey 2022. Ref: 12377-OPS-REP-002; MSDS Marine 2023 Hy-Net Carbon Dioxide Transportation and Storage Project. Archaeological Assessment of Geophysical and Hydrographic Data. Report 2023/MSDS23250/1
Sub-bottom Profiler	Within the Area of Project Physical Work and Hoyle Bank		XOcean reviewed archaeologically by MSDS Marine	2022	XOcean 2022, 00469-SHW-ENG-BATH Project Results and Interpretation Report. 00469-SHW-ENG-BATH; MSDS Marine 2023 Hy-Net Carbon Dioxide Transportation and Storage Project. Archaeological Assessment of Geophysical and Hydrographic Data. Report 2023/MSDS23250/1

Further details on data collection, positioning, quality and limitations are included within the Marine Archaeology Technical Report (MSDS Marine, 2023b), as are details relating to the methods used for the desk-based assessment and archaeological assessment of geophysical and hydrographic data. These methods and sources have been used to undertake the baseline assessment, which is summarised in the following section 11.7.

11.7 Existing baseline description

The marine archaeology baseline includes consideration of:

- submerged prehistory and palaeolandscapes;
- maritime and coastal remains;
- aviation crash sites; and
- historic Seascape Character.

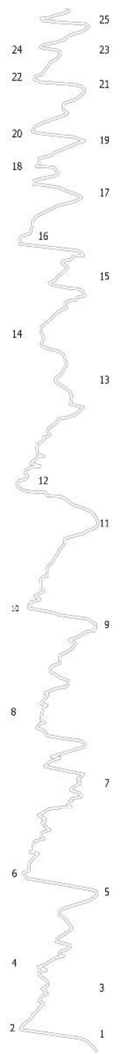
The main archaeological periods discussed in this report are listed in Table 11.6.

Table 11.6: Archaeological Periods And Dates Referred To In This ES

Broad Period	Sub-Period	Date
Palaeolithic	Lower	c.970,000 – 150,000 BP
	Middle	150,000 – 40,000 BP
	Upper	40,000 – 10,000 BP
Mesolithic	Early	8,000 BC – 7,000 BC
	Late	7,000 – 4,000 BC
Neolithic	Early	4,000 – 3,300 BC
	Middle	3,300 – 2,900 BC
	Late	2,900 – 2,200 BC
Bronze Age		2,600 – 700 BC
Iron Age		800 BC – 43 AD
Roman		43 – 410 AD
Early Medieval		410 – 1,066 AD
Medieval		1,066 – 1,540 AD
Post Medieval		1,540 – 1,901 AD
Modern		1,901 AD – Present

For the assessment of submerged prehistory, additional periods relating to Quaternary chronology are referred to. These are summarised in Table 11.7.

Table 11.7: Quaternary Chronology (Based On Historic England, N.D., With Dates From Lisiecki And Raymo, 2005)

Stage: Main	Stage: Sub.		Age: Start	Age: End	Climate	Marine Isotope Stage: Stages	Marine Isotope Stage: Record	Epochs and Periods
Beestonian			970,000	936,000	Interglacial	25		Pleistocene; Early Pleisto.; Lower Palaeolithic
			936,000	917,000		24		
			917,000	900,000	Interglacial	23		
			900,000	866,000	Stadial	22		
			866,000	814,000	Sequence poorly understood but evidence for a series of small expansions of the British Ice Sheet marking at least 4 interstadials and 5 warm episodes.	21		
			814,000	790,000		20		
Bruhnes-Matuyama reversal (c. 780kBP) Cromerian Complex			790,000	761,000		19		Middle Pleistocene
			761,000	712,000		18		
			712,000	676,000		17		
			676,000	621,000		16		
			621,000	563,000		15		
			563,000	524,000		14		
			524,000	478,000		13		
Anglian			478,000	424,000	Stadial	12		
Hoxnian			424,000	374,000	Interglacial	11		
Wolstonian/ Saalian complex	Unnamed		374,000	337,000	Stadial?	10		
	Purfleet		337,000	300,000	Interglacial	9		Middle Palaeolithic
	Early		300,000	243,000	Stadial?	8		
	Aveley		243,000	191,000	Interglacial	7		
	Late		191,000	123,000	Stadial	6		
Ipswichian			123,000	109,000	Interglacial	5e		Late Pleistocene
Devensian	Early		109,000	96,000	Stadial	5d		
		Chelford	96,000	87,000	Interstadial	5c		
			87,000	82,000	Stadial	5b		
		Brimpton	82,000	71,000	Interstadial	5a		
			71,000	57,000	Stadial	4		
	Mid	Upton Warren	57,000	29,000	Interstadial	3		Upper Pal
	Late	Dimlington	29,000	14,700	Stadial	2		
		Windemere	14,700	12,900	Interstadial			
		Loch Lomond	12,900	11,700	Stadial			
Holocene			11,700	Present	Interglacial	1		Holocene; Meso.

11.7.1 Summary of designated heritage assets

One designated heritage asset lies within the Area of Project Physical Work. This is:

- The Protected Wreck of the *Resurgam* (Marine Archaeology Technical Report (MSDS Marine, 2023b)). The *Resurgam* was an experimental submarine built in 1870. It is designated under the Protection of Wrecks Act 1973, and has an associated designated area with a 300 m radius. The wreck itself lies within the MASA but the designated circle extends to within the Area of Project Physical Work and Eni Development Area.

Two other designated heritage assets lie within the Study Area, but beyond the Area of Project Physical Work and the Eni Development Area. These are:

- The Scheduled wreck of the *Lelia*, a paddle steamer built in 1864 and associated with the British involvement in the American Civil War (Marine Archaeology Technical Report (MSDS Marine, 2023b)). It is designated under the Ancient Monuments and Archaeological Areas Act 1979 and lies within the MASA, c. 10 m beyond the Eni Development Area boundary, on its eastern side.
- The Grade II Listed Point of Ayr Lighthouse, thought to have been built in c. 1776 (Marine Archaeology Technical Report (MSDS Marine, 2023b)). It is designated under the Planning (Listed Buildings and Conservation Areas) Act 1990, and lies c. 1 km to the east of the proposed Landfall site and Eni Development Area.

11.7.2 Summary of non-designated heritage assets

A series of non-designated heritage assets lie within the Area of Project Physical Work, Eni Development Area, and MASA. These are summarised below and are based on all available desk-based and geophysical data, tying in information from pre-existing datasets (Table 11.8) and the archaeological assessment of geophysical survey data undertaken as part of this project (MSDS Marine, 2023a). Full details can be found within Marine Archaeology Technical Report (MSDS Marine, 2023b). Magnetic anomalies are listed separately in Marine Archaeology Technical Report (MSDS Marine, 2023b).

There are a total of 134 records within the MASA, 176 within the Eni Development Area, and 110 within the Area of Project Physical Work, giving a total of 420 records (including the three designated assets detailed above). The majority relate to heritage assets however, a number of geophysical anomalies have been interpreted as of being geological in nature. These are included in Table 11.8 below and gazetteer for completeness but are not considered further.

The remainder of the records include a range of wreck and potential wreck sites, other maritime remains (ranging from the remains of oil platforms to navigation beacons, unidentified obstructions, and other potential debris), palaeolandscape features, terrestrial features and records deriving from documentary evidence, including Named Locations (NLOs) of vessels lost in the area where there are currently no known seabed remains.

Table 11.8: Summary Of Non-Designated Heritage Assets

Broad Category	Type	Area of Project Physical Work	Eni Development Area	Study Area
Wreck remains	Wreck	2	30	20
	Wreck (possible)			1
	Wreck (probable)		1	
	Wreck or Ballast mound		1	
	Wreck or beacon		2	
	Wreck or debris		2	1
	Wreck or Wreckage (possible)		1	
	Wreck/Geology			1
	Wreckage		13	
	Possible wreck	3		6
	Possible wreck or cargo			2
	Possible wreckage		1	
Other maritime remains	Anchor, chain and cable		2	
	Beacon		3	
	Chain, Cable, or Rope	4		1
	Collapsed platform		1	

Broad Category	Type	Area of Project Physical Work	Eni Development Area	Study Area
	Debris	5	3	3
	Debris - likely infrastructure	20		1
	Disused wartime tower			1
	Fisherman's fastener		1	3
	Fishing gear	3		
	Tower		2	
	Foul		2	
	Geophysical anomaly - debris		1	2
	Geophysical anomaly - origin unknown		3	
	Geophysical anomaly - possible debris		2	
	Geophysical anomaly - potential anchor cable			1
	Mound	1		2
	Obstruction		3	2
	Obstruction: Non-submarine contact		3	2
	Pipe			1
	Platform		1	
	Possible oil rig leg		1	
	Potential debris	32	1	5
	Unidentified object			1
	Unidentified obstruction	9	75	3
	Unknown	1		
	Seabed disturbance	1		
	Linear feature	3		4
	Masonry			1
	Mattresses	2		
	Spoil ground		1	
Geological features	Geology	5	10	1
	Likely geological	14	1	2
Palaeolandscape Features	Glacial tunnel valley			1
	Footprints			1
Terrestrial and Coastal Features	Terrestrial - Anti-glider poles			1
	Terrestrial - boundary stone			2
	Terrestrial - Lifeboat house			1
	Terrestrial - Lighthouse			1
	Terrestrial - lifeboat station			1
	Terrestrial - lighthouse cottages			1
	Terrestrial - Pillbox			6
	Terrestrial - Summer camp			1
	Terrestrial asset - holiday park			1
	Terrestrial asset - lighthouse cottages			1

Broad Category	Type	Area of Project Physical Work	Eni Development Area	Study Area
	Terrestrial asset - Swimming baths			1
	Terrestrial- slipway			1
	Terrestrial - Event			3
	Terrestrial - Findspot			1
	Terrestrial - position in error	2	1	
	Test record.		4	
Documentary Records	NLO			1
	Aircraft (NLO)		2	7
	Wreck (NLO)	2	1	27
	Wreck (not found)	1	1	
	Navigational aid shown on historic maps			6
	Seascape			2
	Grand Total	**110**	**176**	**134**

11.7.3 Submerged prehistoric archaeology

The prehistoric archaeological record of the UK covers the period from the earliest hominin occupation, potentially as far back as 970,000 BP, to the end of the Iron Age and the Roman invasion of Britain by Claudius in AD 43. The coastline of the UK changed drastically during this period and large tracts of what is now the seabed were once subaerially exposed. The UK has been affected by several glacial events over the last 1 million years; including the Anglian (480 ka BP to 430 ka BP), the Wolstonian (350 ka BP to 132 ka BP), and the Devensian (122 ka BP to 10 ka BP), and intervening marine transgressions all of which have influenced archaeological potential.

Prehistoric archaeological potential is gauged with reference to evidence for human activity in the UK during each period, and the contemporary environment within the Site. Depositional environment and post-depositional factors are also key to understanding potential, and as such geological deposits present within the Site form an important consideration in understanding archaeological, palaeoenvironmental and palaeolandscape potential. Deposits with potential for prehistoric archaeological remains, or palaeoenvironmental information are generally those laid during periods of aerial exposure or by fluvial process, rather than sub-glacial or marine deposits. However, there is also potential for archaeological material to be redeposited or reworked within secondary contexts as a result of fluvial erosion or glacial processes (Hosfield and Chambers, 2004), this has been taken into account within the assessment.

Assessment of geophysical, geotechnical and desk-based sources has led to the identification of three main Quaternary units within the Site, overlying bedrock. The Quaternary units represent the environmental shift from glacially and proglacially dominated conditions of the Devensian (represented by Unit III and II), to later potentially pre-transgressional environments (possibly represented by Units II and I), followed by the modern active marine environment which characterises the Site today (Unit I). Full details are presented within Marine Archaeology Technical Report (MSDS Marine, 2023b).

11.7.3.1 Middle and upper palaeolithic

Unit III and Unit II derive from these periods. Unit III is associated with the Cardigan Bay Formation, thought to have been laid down as a sub glacial deposit in the Wolstonian or Devensian glaciation. Unit III therefore holds very limited archaeological potential. However, material may survive on the surface of the unit where later subaerial exposure may have occurred.

Unit II represents the late Devensian Western Irish Sea A Formation. This unit is thought to reflect glacial, glaciomarine or deltaic/prodeltaic conditions during the Devensian, and evidence of channelling to the west of the Site may reflect outwash deposits or other glacial features which may extend to within the Site. The inhospitable conditions represented by the bulk of the unit indicate limited archaeological potential, though the surface of the unit (if subaerially exposed following glacial retreat) may hold archaeological potential where not eroded by later forces. Palaeoenvironmental remains may also survive within this unit.

The chronology of landscape changes in the area during the Upper Palaeolithic to Mesolithic indicate the likelihood that the western half of the Site was submerged by 10k BP (by the end of the Upper Palaeolithic), with eastern areas and the cable route being submerged from 8k to 6k BP.

11.7.3.2 Mesolithic

Unit I is interpreted as the Surface Sands Formation. This formation includes two members. The lower (earlier) SL2 member, represents intertidal to marine environments. A borehole taken to the south-west of the Site produced evidence of reed beds dating to 9,200 BP within this member, indicating a potential pre-inundation land surface dating to the early Mesolithic. Landscape modelling by Fitch *et al.* (2011) also indicate potential for fluvial features within this Unit, which (when coupled with current sea level curve data) indicate potential within the eastern half of the Site from 10k BP. The southern part of the cable route also holds particular potential for Mesolithic remains, given the proximity of Mesolithic remains on the north west coastline (e.g. at Rhyl and early Neolithic middens within 1 km of the Landfall site). There is potential for both palaeoenvironmental and archaeological remains to be present within this unit, however, subsequent marine transgression has eroded the upper parts of this deposit, potentially affecting preservation. The Unit may also hold evidence of the modern marine sediments represented by the SL1 member of the Surface Sands Formation. There is potential for redeposited archaeological remains in this member.

11.7.4 Maritime and coastal remains

This section considers the potential for remains relating to coastal and maritime cultural landscapes defined as evidence of 'human utilisation of maritime space by boat, settlement, fishing, hunting, shipping and its attendant subcultures, such as pilotage, lighthouse and seamark maintenance' (Westerdahl, 1992). Remains considered therefore range from shipwrecks or other durable evidence such as cargos and ballast, to features including navigational aids, sailing marks, ports, harbours and jetties. Other coastal remains which do not necessarily relate to boat use are also considered, including fish traps and other evidence of human interaction with the sea or coast, such as coastal wartime features.

11.7.4.1 Prehistoric to Romano-British

While trade networks and maritime travel are evidenced throughout prehistory by the movement of ideas, goods and people, faunal assemblages indicate that maritime activities such as fishing were focused in coastal areas during the prehistoric and Roman periods, with limited evidence for marine exploitation from the Neolithic and throughout much of prehistory. Direct physical evidence of maritime craft dating to the prehistoric or Romano-British periods is very rare, though examples of watercraft exist from the Mesolithic period onward. There have been no finds of maritime remains dating to the prehistoric or Romano-British periods within the Area of Project Physical Work, Eni Development Area, or wider MASA. Mesolithic and later footprints and a findspot of a Roman brooch are recorded from the wider MASA, the former in the intertidal zone at Formby, and the latter at the mouth of the River Dee, indicating general activity in these periods (further supported by the presence of major Roman centres such as at Chester, c. 30 km south-east of the MASA, and other scattered settlement on the Wirral and North Wales coast (Allen *et al.,* 2016), though given the rarity of maritime remains the potential for such remains to occur within the Site is extremely limited.

11.7.4.2 Early medieval to medieval

Maritime technology and activity continued to develop in the early medieval and medieval periods. Invaders, and then settlers from Scandinavia and other areas brought new boat building technologies and opportunities for trade which led to the growth of a number of major ports around the coast of the UK (Hutchinson, 1997; Friel, 2003). In the north-west of England and North Wales activity in this period is attested to by place name evidence and historical records. A possible Norse ship has also been identified at Meols, c. 10 km east of the MASA. The results of radiocarbon dating, and dendrochronology are awaited to confirm the date and origin of the vessel, however, its potential presence and the wider evidence of Scandinavian activity in the area demonstrates the potential for maritime activity in the area during this period.

During the medieval period major centres were active at Parkgate, Chester and Burton on the River Dee, and during the 13th century Liverpool, which had previously been a fishing village, developed trade routes across the Irish Sea, gradually increasing its dominance through trade, first with Ireland and later with other British colonies. More locally, the remains of the 12th century Prestatyn Castle have been excavated c. 650 m south of the MASA, indicating medieval activity in the area.

The early medieval and medieval periods were therefore characterised by increasing maritime activity within the area of the Site. However, while activity increased maritime finds from these periods are still rare. Additionally, no remains dating to these periods are known from within the Site or MASA, and the potential for any remains of maritime craft or coastal activity dating to these periods is considered to be limited.

11.7.4.3 Post-medieval to modern

Maritime activity increased during the post-medieval period, led by local trading ports such as Liverpool, which by the 17th century had seen vast expansion and was trading with British colonies around the world. Numerous historic trading routes, active in the post-medieval period, are thought to have crossed the Eni Development Area and Area of Project Physical Work (Alvarez-Palau and Dunn, 2019), mirrored by aids to navigation including the Point of Ayr Lighthouse (Grade II Listed), which lies within the MASA, 1 km west of the landfall site, and other navigational aids such as buoys are mapped on charts.

Potential for maritime remains therefore increases from the post-medieval period onward with the development of ports along adjacent coastlines, such as Liverpool, and increases in the number of shipping routes crossing the area. The modern period, with its increase in trade, transport and two World Wars also marks a period in which potential is increased, and the role of Liverpool in the convoy system in addition to other wartime activity increases potential in the area. In addition to these changes, developments in shipbuilding technology also occurred: vessels were increasingly constructed of iron (from the 18th century), and then steel, leaving more durable traces on the seabed which can be detected using modern survey techniques. Documentation of losses also increased, and a total of 30 records of lost vessels are recorded within the Area of Project Physical Work, Eni Development Area and MASA, with the majority (21 records) dating from the 19th century, and others dating from the 18th century (one record) and 20th century (seven records).

The potential for remains of these periods to occur within the Area of Project Physical Work, Eni Development Area and MASA is therefore relatively high, and is borne out by some of the recorded maritime sites, discussed below.

11.7.4.4 Known and recorded maritime and coastal archaeology

Assessment of geophysical data and desk-based sources has demonstrated the presence of maritime remains within the Area of Project Physical Work, Eni Development Area and MASA. The assessment has found evidence of wrecks and possible wreck sites, other maritime remains (ranging from debris, mounds potentially indicating wreck sites, remains of tower bases which are thought to represent the remains of anti-aircraft forts dumped after World War II (WWII), to modern infrastructure and unidentified obstructions), terrestrial and coastal features with evidence of wartime activity, navigational aids, documentary records demonstrating the loss of vessels within the area, and geological features. Of particular note, are the presence of:

- five sites indicating wreck remains within Area of Project Physical Work;
- fifty-one sites indicating wreck remains within the Eni Development Area;

- two sites representing possible tower bases which are thought to represent the remains of anti-aircraft forts dumped after WWII within the Eni Development Area;
- thirty one sites indicating wreck remains within the wider Study Area. The latter includes the position of a Protected Wreck (the *Resurgam*), the designated circle for which extends to within the Area of Project Physical Work and Eni Development Area;
- other remains including mounds (which could indicate wreck sites), debris, fouls of unknown origin, and other unidentified obstructions are also present within the Area of Physical Project Work and Eni Development Area; and
- magnetic anomalies of potential archaeological significance, including anomalies of high and medium potential (Marine Archaeology Technical Report (MSDS Marine, 2023b)). The origin of the anomalies is unknown, but they have potential to be of archaeological significance.

The majority of the wrecks are undated, but where dates are they demonstrate a focus on 19th and 20th century craft, which is also borne out by the documented losses within the area. All maritime and coastal remains are summarised within Table 11.8 and Marine Archaeology Technical Report (MSDS Marine, 2023b).

The assessment has also found potential for other remains, including wartime coastal features and navigational aids. Pillboxes are present within the MASA around the Landfall site, though beyond both the Eni Development Area and Area of Physical Project Work. There are no known remains within the Eni Development Area and Area of Physical Project Work at the landfall site. The closest are low potential geophysical anomalies identified just offshore of the landfall location, seaward of the point where the Eni Development Area and Area of Physical Project Work widen.

The key known maritime remains are therefore those which occur below the low water mark, and include the wrecks and potential wreck sites enumerated above.

11.7.5 Aviation remains

There are no known aircraft crash sites within the Area of Project Physical Work, Eni Development Area or MASA. However, the assessment has identified potential for aircraft crash sites to occur, in particular associated with the use of Talacre Warren (which lies 1.5 km to the east of the landfall site) as a WWII Spitfire training camp. This potential is further demonstrated by records of nine documented losses of aircraft within the MASA and Eni Development Area, of which around half are Spitfires. While aircraft crashes tend to result in disarticulated remains, there is potential for remains of aircraft within the Area of Project Physical Work, Eni Development Area or MASA.

11.7.6 Historic seascape character

The assessment identified a variety of characteristics within the Eni Development Area and Area of Project Physical Work. These can be summarised as:

- modern installations and activities such as hydrocarbon wells, pipelines, submarine cables, aggregate extraction, spoil and waste dumping;
- a range of fishing methods used in the modern period;
- navigation routes, both modern and post medieval;
- wrecks and maritime debris (in some cases undated); and
- seabed types and characteristics including shoals and flats and fine sediment plains.

11.7.7 Data limitations

The key limitation to the assessment is the lack of full coverage geophysical data for the area, including within the Area of Project Physical Work and Eni Development Area. The current data coverage is discussed in detail in Marine Archaeology Technical Report (MSDS, 2023b), and the supporting archaeological assessment of geophysical survey data (MSDS Marine, 2023a). This limitation has been recognised in this assessment and fed into the recommendations for further work or mitigation.

11.8 Key parameters for assessment

11.8.1 Maximum design scenario

11.8.1.1 Overview

Volume 1, chapter 3 contains a full description of the Proposed Development Description. In summary, the Proposed Development will include the following construction activities:

- installation of a new Douglas Carbon Capture and Storage (CCS) platform using up to eight pile driven legs;
- installation of new topsides on the Hamilton Main, Hamilton North, and Lennox wellhead platforms and associated use of jack-up barges and vessel anchoring;
- repurposing of the existing subsea natural gas pipelines;
- development of the Hamilton Main, Hamilton North and Lennox reservoirs for CO_2 storage through the drilling and re-completion of injection wells by side-tracking existing production wells. This will involve re-drilling the wells (within the existing footprints of former wells) and installing CO_2-resistant tubulars and cement;
- drilling of two new monitoring wells, one at Hamilton North (well ten at Hamilton North, 110/13/HN_M2_1) and one at Hamilton Main (Well nine at Hamilton North, 110/13/HM_M2_1);
- other monitoring and sentinel wells will be created through use of existing wells, with need for fibre optics to be confirmed;
- installation of new pipelines connecting the new Douglas CCS and the existing subsea natural gas pipelines. This will require insertion of a small section of pipeline, laid on the seabed, to tie the new Douglas CCS platform to the existing pipelines;
- installation of new submarine power cables connecting the Douglas Platform with the onshore terminal, and connecting the Douglas Platform with the Hamilton Main, Hamilton North and Lennox Platforms. In general these cables will follow existing pipelines at an offset of 100 m, though micrositing around heritage assets and Unexploded Ordnance (UXO) where required;
- installation of concrete mattresses and cable protection at crossings and in areas where cable burial is not possible; and
- potential wet storage of cables close to platforms.

In addition to the installation of new infrastructure, or the repurposing of existing infrastructure, impacts will arise from the anchoring or positioning of vessels or jack-ups. Additionally, an offshore accommodation flotel will be stationed adjacent to the New Douglas CCS platform during construction, commissioning, and start-up activities (in the operation and maintenance phase) with associated anchoring impacts.

Sand wave clearance will also be necessary in some areas, for pipeline installation potentially in the areas south of the Douglas Platform, and West Hoyle Bank. This will be undertaken with a mass flow excavator, or a jet sled. Sand waves are approximately 2 m and 3 m in height, and a corridor approximately 10 m in width would be created through them. If the West Hoyle Bank route is not chosen the alternative route passes further east through a tidal channel. If this option is chosen some pre-lay dredging would be required to allow for a self-beaching Cable Lay Vessel (CLV) to ground itself at low tide on a 'flat' area of sandbank. The area to be dredged in this scenario would be approximately 180 m length, 60 m wide and between 1 and 2 m below LAT.

The landfall connection will be made using Horizontal Directional Drilling (HDD). HDD will be used to pass under the Talacre dunes and exit seaward of the MHWS point, within the beach area.

The maximum design scenarios identified in Table 11.9 have been selected as those having the potential to result in the greatest effect on an identified receptor or receptor group. These scenarios have been selected from the Project Design Envelope (PDE) provided in volume 1, chapter 3. Effects of a greater adverse significance are not predicted to arise should any other design scenario, based on details within the PDE (e.g. different infrastructure layout), to that assessed here be taken forward in the final design scheme.

Operation and maintenance activities will take place for the 25 anticipated years of the project. The activities will include monitoring, for example for any unexpected leaks, additionally cable repair, pipeline maintenance, and associated surveys will also take place using supply and standby vessels. Well interventions will be undertaken from a jack-up barge.

Decommissioning will include removal of all installations and injection facilities, as well as other equipment, infrastructure and materials.

11.8.1.2 Areas of work

Two primary areas have been defined for the purposes of this application. These include:

- the Area of Project Physical Work; and
- the Eni Development Area.

A third area, termed the wider MASA, will undergo no direct impacts associated with the development. The Area of Project Physical Work will be the focus for all construction activities. The installation of new wells, cables and the Douglas Platform will all be within this area, as will associated seabed preparation activities including sand wave clearance and dredging, as well as boulder clearance. Existing platforms to be repurposed also fall within this area. While the installation of new infrastructure and the conversion of existing platform infrastructure will fall within this zone, associated impacts including from jack up barges and anchoring of vessels may occur within the wider Eni Development Area. As such, taking a precautionary approach, mitigation will be applied across both of these areas, ensuring appropriate and proportionate protection for the marine historic environment.

Table 11.9: Maximum Design Scenario

Potential impact	Maximum Design Scenario	Justification
Sediment disturbance and deposition leading to indirect impacts on marine archaeology receptors (the exposure or burial of receptors).	The potential changes to sedimentation have been Modelled in Physical Processes Assessment Technical Report (RPS Group, 2023), which identified seabed preparation, the drilling of monitoring wells, and the laying of cables to be the principal construction elements which have a bearing on sediment transport and sedimentation. *Construction Phase:* **Site preparation** • Sand wave clearance in two potential locations, south of the existing Douglas Platform and West Hoyle Bank area, with average heights of c.3 m and lengths of c.100 m and c.15 m respectively. Excavation of a 10 m wide corridor will be necessary. • Tidal channel preparation: If the West Hoyle Bank route is not chosen the alternative route passes further east through a tidal channel. If this option is chosen some pre-lay dredging would be required to allow for a self-beaching Cable Lay Vessel (CLV) to ground itself at low tide on a 'flat' area of sandbank. The area to be dredged in this scenario would be approximately 180 m length, 60 m wide and between 1 m and 2 m below Lowest Astronomical Tide (LAT). • Boulder clearance. **Platform installation** • Installation of new platform at Douglas using up to eight pile driven legs. Each pile will be approximately 1.5 m in diameter and 40.25 m in total length, with a penetration depth of around 22 m. • Installation of new topsides on the Hamilton Main, Hamilton North, and Lennox wellhead platforms (there will be no additional seabed impacts for this work, beyond use of jack up barges) **Well drilling and modifications** • Drilling of two new monitoring wells at Hamilton North (Well ten) and Hamilton Main (Well nine). The wells with both extend through the entire Quaternary sequence and into the bedrock. Jack ups to be used during drilling. • Existing well holes will be reused for carbon injection or used as sentinel wells. The wells will be prepared for CO_2 storage through the drilling and re-completion of injection wells by side-tracking existing production wells, and with well casings removed and CO_2 -resistant tubulars concrete lining being inserted. Side-tracking will be within the bedrock	The following activities have the potential to cause sediment disturbance and deposition leading to indirect impacts on marine archaeology receptors, through burial or erosion. *Construction phase:* **Site preparation** Sand wave clearance south of the Douglas Oil Platform (OP) and in the West Hoyle Bank Area are set to be undertaken across two sections where sand waves are present. To enable the laying of cables, a c.10 m wide corridor will be excavated using a mass flow excavator/jet sled, which will suspend sediment at the seafloor. South of the Douglas OP, suspended sediment is expected to be concentrated within 200 m of the seabed release (peak value of c.1,400 mg/l), though with finer sediment distributed further afield (up to 12 km away with maximum concentrations of <100 mg/l) (Physical Processes Assessment Technical Report (RPS Group, 2023)). Sedimentation is anticipated to occur within 8 km of the work, though with maximum values of <50 mm within 10 m of the point of excavation. At West Hoyle Bank in order to allow the laying of the cable directly across the feature, a dredged channel will be necessary. During clearance activities material will be side cast along the c.1,000 m length of channel and backfilled after cable installation. The trench width is expected to be c.21 m in width and c.7 m in depth. Maximum plume extents are expected to be within 25 km, to the south east, though the majority of the material is expected to fall adjacent to the dredged channel. Maximum suspended sediment values are modelled at 3,000-10,000 mg/l, however in most areas fall below 30 mg/l, and concentrations are generally <10 mg/l in the Eni Development Area. Sedimentation will be at its maximum values of c.5 m adjacent to the dredged channel, though may occur at negligible levels c. 8 km into the Dee Estuary. Boulder clearance activities will result in minimal increases in suspended sediment concentrations and have therefore not been considered in the assessment. **Platform installation**

Potential impact	Maximum Design Scenario	Justification
	and all works within the Quaternary sediment and on the seabed would be within the area of existing impacts. **Cable installation and pipeline works** • Installation of new fibre optic cables from the Point of Ayr (PoA) to Douglas OP. Two cables will be laid c. 30 m apart, each cable laid in an installation zone of c. 15 m in width for each cable. Cables will be primarily installed using a plough (not exceeding 15 m in impact width). The maximum depth is set at 3 m. Any cable protection will fall within this zone of impacts. • Installation of new inter-oil platform cables (Douglas – Hamilton; Douglas – Hamilton North; Douglas – Lennox). Two cables will be laid c. 30 m apart, each cable laid in an installation zone of c. 15 m in width for each cable. Cables will be primarily installed using a plough (not exceeding 15 m in impact width). The maximum depth is set at 3 m. Any cable protection will fall within this zone of impacts. A dynamic-positioning vessel is the preferred option for installation thus there will be no additional anchoring impacts. • Installation of new pipeline from the Douglas CCS to the existing subsea natural gas pipelines. • Potential wet storage of cables. • Existing pipelines will be utilised for CO_2 transmission. • Installation of concrete mattresses and cable protection at crossings and in areas where cable burial is not possible. **Vessel use** • Use of jack ups and vessel anchoring during construction, in addition to other vessels including a flotel. *Operation and maintenance:* • Project lifespan of c. 25 years. • Maintenance of platforms and infrastructure including removal of marine growth, replacement of anodes and painting or modifications to J tubes and ancillary structures. Associated impacts from vessel anchoring and potential jack up use. • Survey and repair events for cables and pipeline maintenance, and cable reburial • Well interventions • Jack up use and vessel anchoring during Operation and Maintenance (O&M) activities	Piling for the new platform (Douglas) may cause some suspended sediment however the method chosen (driven piles) are not likely to result in significant suspended sediment. **Well drilling and modifications** Drilling of new wells may lead to the discharge of sediments. The new wells will require drilling of two sections the first of which is a 26” opening in which the 20” conductor will be encased, and the second a deeper cutting to penetrate bedrock (Mercia Mudstones Group). The first section will clear c.30.48 m of sand and silt and the drilling of c.84.43 m of coarser sediment, expected to be Quaternary sediment. Suspended sediment is expected, with plumes at Hamilton Main and Hamilton North extending potentially 8 km from the drill sites, though the greatest sedimentation is seen within 50 m of the drill sites. At Hamilton Main, maximum concentrations across the plume can rise to a peak of c.360 mg/l, however maximum concentrations are generally are limited to <20 mg/l, reducing rapidly away from discharge location. Sedimentation is expected within 50 m of the drill sites, where values of up to c. 70 mm are anticipated, though generally sedimentation under 0.03 mm is expected further afield, within the range of the tidal ellipse. At Hamilton North maximum suspended sediment concentrations are limited to 500 mg/l in the direct vicinity of the drill site and are generally less than 5 mg/l across the rest of the plume (reaching up to 8 m from the drill site). The maximum sedimentation values are expected to be c. 100 mm within c. 50 m of the drill site. **Cable installation** Point of Ayr (PoA) to Douglas: Installation of this cable may result in suspended sediment up to 15 km from the cable installation, expected to be at c. <1 mg/l. Maximum suspended sediment concentrations are expected along the cable route itself, generally at <10,000 mg/l, increasing over the shallow West Hoyle Bank to 300,000 mg/l, peaking at c.640,000 mg/l. However, maximum sedimentation occurs within c.30 m of the cable route, limited to <300 mm of deposited material. Douglas to Lennox: Maximum suspended sediment concentrations occur within c.50 m the trenching route, with high mean values of <1,000 mg/l. The plume may extend over 15 km from the trenching route, though with suspended sediment at near background values. Maximum sedimentation is anticipated within 50 m of the cable route, with deposition limited to <50 cm (peak of c.32 cm). **Vessel use**

<table>
<tr><th>Potential impact</th><th>Maximum Design Scenario</th><th>Justification</th></tr>
<tr><td></td><td>Decommissioning:
Post-closure phase is anticipated to be c. 20 years in duration
Potential removal of infrastructure may cause impacts though these are likely to be within the footprint of existing impacts.
Jack up use and vessel anchoring during decommissioning, including use of cargo barges, anchor handling vessels and other support vessels.</td><td>Vessel use is not expected to cause significant changes to sedimentation.
Operation and Maintenance
The primary impact on sedimentation is likely to be from cable replacement, following the modelled case set out above for cable installation. Alteration of sediment transport regimes leading to potential erosion or burial of archaeological sites are considered below.
Decommissioning
The changes to sedimentation associated with decommissioning have not been modelled. However, changes to sediment transport and deposition are likely when removing infrastructure where this infrastructure has a seabed interaction.</td></tr>
<tr><td>Direct damage to marine archaeology receptors (e.g. wrecks, debris, submerged prehistoric receptors (palaeolandscapes and associated archaeological receptors)</td><td>Construction Phase:
Site preparation
Sand wave clearance in two potential locations, south of the existing Douglas Platforms, with average heights of c.3 m and lengths of c.100 m and c.15 m respectively. Excavation of a 10 m wide corridor will be necessary.
Tidal channel preparation: If the West Hoyle Bank route is not chosen the alternative route passes further east through a tidal channel. If this option is chosen some pre-lay dredging would be required to allow for a self-beaching CLV to ground itself at low tide on a ‘flat’ area of sandbank. The area to be dredged in this scenario would be approximately 180 m length, 60 m wide and between 1 m and 2 m below LAT.
Boulder clearance.
Platform installation
Installation of new platform at Douglas using up to eight pile driven legs. Each pile will be approximately 1.5 m in diameter and 40.25 m in total length, with a penetration depth of around 22 m.
Well drilling and modifications
Installation of new monitoring wells at Hamilton North (Well ten) and Hamilton Main (Well nine). The wells with both extend through the entire Quaternary sequence and into the bedrock. Jack ups to be used during drilling.
Cable installation</td><td>Impacts including site preparation, platform installation, well drilling and modifications, cable laying and associated vessel use all have the potential to cause direct damage to archaeological remains on and within the seabed. These include known and potential maritime and coastal remains; potential submerged prehistoric landscapes and sites; and potential aviation remains.
Maximum design parameters for operation, maintenance and decommissioning are not known but will be lower than for installation. Cable repair, remediation and reburial, well interventions and all associated vessel and jack up activities may cause impacts. Removal of infrastructure may cause impacts though these are likely to be largely within the footprint of existing impacts.</td></tr>
</table>

Potential impact	Maximum Design Scenario	Justification
	Installation of new fibre optic cables from the PoA to Douglas OP. Two cables will be laid c. 30 m apart, each cable laid in an installation zone of c. 15 m in width for each cable. Cables will be primarily installed using a plough (not exceeding 15 m in impact width). Any cable protection will fall within this zone of impacts. Installation of new inter-oil platform cables (Douglas – Hamilton; Douglas – Hamilton North; Douglas – Lennox). Two cables will be laid c. 30 m apart, each cable laid in an installation zone of c. 15 m in width for each cable. Cables will be primarily installed using a plough (not exceeding 15 m in impact width). Any cable protection will fall within this zone of impacts. A dynamic-positioning vessel is the preferred option for installation thus there will be no additional anchoring impacts. Potential wet storage of cables. **Vessel use** • Use of jack ups and vessel anchoring during construction, in addition to other vessels including a flotel. *Operation and maintenance:* • Project lifespan of c. 25 years. • Maintenance of platforms and infrastructure including removal of marine growth, replacement of anodes and painting or modifications to J tubes and ancillary structures. Associated impacts from vessel anchoring and potential jack up use. • Survey and repair events for cables and pipeline maintenance, and cable reburial • Well interventions • Jack up use and vessel anchoring during O&M activities *Decommissioning:* • Post-closure phase is anticipated to be c. 20 years in duration • Potential removal of infrastructure may cause impacts though these are likely to be within the footprint of existing impacts. • Jack up use and vessel anchoring during decommissioning, including use of cargo barges, anchor handling vessels and other support vessels.	
Direct damage to coastal/intertidal archaeological remains through cable installation at the landfall site	*Construction* • Cable laying from the PoA to Douglas OP will involve cables making landfall around the Talacre dune system. The two cables will pass under the dunes (landward of MHWS) and will punch out within the intertidal zone. Horizontal Directional Drilling (HDD) will be used in construction,	Impacts to potential coastal and intertidal remains may be incurred during cable installation and associated activities in the intertidal zone.

Potential impact	Maximum Design Scenario	Justification
	with the exit pits located just seaward of the MHWS mark. Associated impacts from vessels or beach vehicles may also be incurred.	
Alteration of sediment transport regimes leading to potential erosion or burial of archaeological sites	• Use of jack up barges during construction, operation and decommissioning may cause localised scour. *Operation and maintenance phase* • Installation of new platform at Douglas using up to eight pile driven legs. Each pile will be approximately 1.5 m in diameter and 40.25 m in total length, with a penetration depth of around 22 m. • Cables and associated cable crossings: the PoA to Douglas cables would require up to 16 crossings (eight per cable), with a width of c. 5 m and total length of 1,600 m along each cable route; and up to 10 crossings on two of the inter OP cables, with a width of c. 5 m at each area of cable protection and total length of 1,600 m per cable.	Alteration of sediment transport regimes are likely to happen primarily following construction, during the operation and maintenance phase. The Douglas OP installation and areas of cable protection provide the largest obstruction to flow in the water column (other platforms are already constructed and will be reused). Additional changes may be felt through use of jack up barges during all phases of the development. The changes have the potential to lead to indirect impacts on marine archaeology receptors, through burial or erosion.
Change of use has the potential to affect the Historic Seascape Character	• Change of use from an oil and gas field to a carbon capture and storage development.	Change of use has the potential to affect the Historic Seascape Character

11.8.2 Impacts scoped out of the assessment

On the basis of the baseline environment and the description of development outlined in volume 1, chapter 3, no impacts are proposed to be scoped out of the assessment for marine archaeology.

11.9 Methodology for assessment of effects

The marine archaeology impact assessment has followed the methodology set out in volume 1, chapter 5.

11.9.1 Impact assessment criteria

The criteria for determining the significance of effects is a two-stage process that involves defining the magnitude of the impacts and the sensitivity of the receptors. This section describes the criteria applied in this chapter to assign values to the magnitude of potential impacts and the sensitivity of the receptors. The terms used to define magnitude and sensitivity are based on those which are described in further detail in volume 1, chapter 5.

Table 11.10: Definition of Terms Relating To The Magnitude Of An Impact

Magnitude of impact	Definition
High	Total loss of, or major alteration to, key elements/features of the baseline (pre-development) conditions such that post development character/composition/attributes will be fundamentally changed and may be lost from the site altogether.
Medium	Loss of, or alteration to, more key elements/features of the baseline conditions such that post development character/composition/attributes of baseline will be partially changed.
Low	Minor shift away from baseline conditions. Change arising from the loss/alteration will be discernible but underlying character/composition/attributes of baseline condition will be similar to pre-development circumstances/patterns.
Negligible	Very slight change from baseline condition. Change barely distinguishable, approximating to the ‘no change’ situation.
No change	No change from baseline conditions.

The capability of a receptor to accommodate change and its ability to recover if affected is a function of its sensitivity. Receptor sensitivity is typically assessed via the following factors:

- adaptability – the degree to which a receptor can avoid or adapt to an effect;
- tolerance – the ability of a receptor to accommodate temporary or permanent change without significant adverse impact;
- recoverability – the temporal scale over and extent to which a receptor will recover following an effect; and
- value – a measure of the receptor’s importance, rarity and worth.

Marine archaeology receptors cannot adapt, tolerate or recover from impacts resulting in damage or loss caused by development. As a result, the sensitivity of a receptor can only be determined through its value.

Based on HE’s Conservation Principles, Policies and Guidance for the Sustainable Management of the Historic Environment (English Heritage, 2008) and Conservation Principles for the Sustainable Management of the Historic Environment in Wales (Cadw, 2011) the significance of a historic asset ’embraces all the diverse cultural and natural heritage values that people associate with it, or which prompt them to respond to it’. Significance is determined by the following value criteria:

- evidential value – deriving from the potential of a place to yield evidence about past human activity;
- historical value – deriving from the ways in which past people, events and aspects of life can be connected through a place to the present. It tends to be illustrative or associative;
- aesthetic value – deriving from the ways in which people draw sensory and intellectual stimulation from a place; and
- communal value – deriving from the meanings of a place for the people who relate to it, or for whom it figures in their collective experience or memory. Communal values are closely bound up with historical (particularly associative) and aesthetic values but tend to have additional and specific aspects.

HE's Ships and Boats: Prehistory to Present – Selection Guide (Historic England, 2017) sets a criteria of value to shipwrecks specifically that is defined as:

- period;
- rarity;
- documentation;
- group value;
- survival/condition; and
- potential.

The criteria for defining value, and therefore sensitivity, in this chapter are outlined in Table 11.11, below.

Table 11.11: Definition of Terms Relating To The Value (And Therefore Sensitivity) Of The Receptor

Value	Definition
Very High	Singular or excellent example and/or significant or high potential to contribute to knowledge and understanding. Receptors with a demonstrable international or national dimension to their importance are likely to fall within this category. Wrecked ships and aircraft that are protected under the Protection of Wrecks Act 1973, Ancient Monuments and Archaeological Areas Act 1979 or Protection of Military Remains Act 1986 with an international dimension or their importance as well as as-yet undesignated sites that are demonstrably of very high archaeological value. Known submerged prehistoric sites and landscapes with a confirmed presence of largely *in situ* artefactual material or palaeogeographic features with demonstrable potential to include artefactual and/or palaeoenvironmental material, possibly as part of a prehistoric site or landscape.
High	Good example and/or high potential to contribute to knowledge and understanding. Includes shipwrecks and aircraft that are protected under the Protection of Wrecks Act 1973, Ancient Monuments and Archaeological Areas Act 1979 or Protection of Military Remains Act 1986 as well as as-yet undesignated sites that do not have statutory protection or equivalent significance, but have high potential based on an assessment of their importance following the Historic England Selection Guide (Historic England, 2017). Prehistoric deposits with high potential to contribute to an understanding of the palaeoenvironment.
Medium	Average example and/or moderate potential to contribute to knowledge and understanding and/or outreach. Includes wrecks of ships and aircraft that do not have statutory protection or equivalent significance, but have moderate potential based on an assessment of their importance following the Historic England Selection Guide (Historic England, 2017). Prehistoric deposits with moderate potential to contribute to an understanding of the palaeoenvironment.
Low	Below average example and/or low potential to contribute to knowledge and understanding and/or outreach.

Value	Definition
	Includes wrecks of ships and aircraft that do not have statutory protection or equivalent significance, but have low potential based on an assessment of their importance following the Historic England Selection Guide (Historic England, 2017). Prehistoric deposits with low potential to contribute to an understanding of the palaeoenvironment.
Negligible	Poor example and/or little or no potential to contribute to knowledge and understanding and/or outreach. Assets with little or no surviving archaeological interest.

The significance of the effect upon marine archaeology is determined by correlating the magnitude of the impact and the sensitivity of the receptor. The particular method employed for this assessment is presented in Table 11.12. Where a range of significance of effect is presented the final assessment for each effect is based upon expert judgement.

For the purposes of this assessment, any effects with a significance level of minor or less have been concluded to be not significant in terms of the 2020 EIA Regulations and 2017 EIA regulations.

Table 11.12: Matrix Used For The Assessment Of The Significance Of Effect

Sensitivity of Receptor	Magnitude of Impact				
		Negligible	Low	Medium	High
	Negligible	Negligible	Negligible or Minor	Negligible or Minor	Minor
	Low	Negligible or Minor	Negligible or Minor	Minor	Minor or Moderate
	Medium	Negligible or Minor	Minor	Moderate	Moderate or Major
	High	Minor	Minor or Moderate	Moderate or Major	Major or Substantial
	Very High	Minor	Moderate or Major	Major or Substantial	Substantial

11.10 Embedded mitigation

For the purposes of the EIA process, the term 'measures adopted as part of the project' is used to include the following measures (adapted from IEMA, 2016):

- Measures included as part of the project design. These include modifications to the location or design envelope of the Project which are integrated into the application for consent. These measures are secured through the consent itself through the description of the development and the parameters secured in the consent for development and/or marine licences (referred to as primary mitigation in IEMA, 2016).
- Measures required to meet legislative requirements, or actions that are standard practice used to manage commonly occurring environmental effects and are secured through the consent for development and/or the conditions of the marine licences (referred to as tertiary mitigation in IEMA, 2016).

A number of measures (primary and tertiary) have been adopted as part of the Project to reduce the potential for impacts on marine archaeology. These are outlined in Table 11.13 below. As there is a secured commitment to implementing these measures for the Project, they have been considered in the assessment presented in section 11.11 (i.e. the determination of magnitude and therefore significance assumes implementation of these measures). The measures adopted as part of the Project are captured in the Outline WSI and PAD submitted with the application.

Table 11.13: Measures Adopted As Part Of The Project

Measures adopted as part of the project	Justification	How the measure will be secured
Primary measures: Measures included as part of the project design		
The identification and implementation of AEZs around those sites identified as having high and medium archaeological potential (Table 11.14). Further details provided in the Outline WSI. Final cable routing, well drilling and platform construction to avoid any known archaeological constraints identified in pre-construction site investigation surveys through micro siting.	To avoid direct impacts on sites of identified archaeological significance.	Proposed to be secured through a condition in the marine licence(s).
The identification and implementation of Temporary Archaeological Exclusion Zones (TAEZs) based on all available information including the stated positional accuracy, the recorded size of the target and the potential archaeological significance around those records for wrecks, obstructions, debris and other sites of archaeological potential outside of the survey data coverage but within the Project boundary. TAEZs are recommended in Table 11.15. Further details provided in the Outline WSI.	To avoid impacts on sites of archaeological importance.	Proposed to be secured through a condition in the marine licence(s).
Archaeological input into specifications for, and archaeological analysis of, any further pre-construction geophysical and geotechnical surveys. Further details provided in the Outline WSI.	To identify any sites of archaeological importance that may require further investigation, avoidance or engagement with the archaeological curators. To offset the impacts of the Project on sediments of geoarchaeological/ palaeoenvironmental importance and enhance knowledge of the offshore marine archaeological resource.	Proposed to be secured through a condition in the marine licence(s).
Project archaeologists to be consulted in the preparation of any pre-construction Remotely Operated Vehicle (ROV)/diver surveys and, if appropriate, in monitoring/checking of data. Further details provided in the Outline WSI.	To identify any sites of archaeological importance that may require further investigation, avoidance or engagement with the archaeological curators.	Proposed to be secured through a condition in the marine licence(s).
Operational awareness of the location of those archaeological anomalies identified as having a low potential. Reporting through the agreed protocol (PAD) will be undertaken should material of potential archaeological	To identify any sites of archaeological importance that may require further investigation, avoidance or engagement with the archaeological curators.	Proposed to be secured through a condition in the marine licence(s).

Measures adopted as part of the project	Justification	How the measure will be secured
interest be encountered. Further details provided in the Outline WSI.		
Implementation of a protocol for recording finds of archaeological interest, following the guidance for the Protocol for Archaeological Discoveries (PAD).	To identify any currently unknown sites of archaeological importance that may require further investigation, avoidance or engagement with the archaeological curators.	Proposed to be secured through a condition in the marine licence(s).
Archaeologists to be consulted in the preparation of pre-construction cable route clearance or other pre-construction operations and, if appropriate, to carry out archaeological monitoring of such work. Further details provided in the Outline WSI.	To record archaeological remains that may be affected by pre-construction clearance operation.	Proposed to be secured through a condition in the marine licence(s).
Mitigation of unavoidable direct impacts on known sites of archaeological significance: Options include i) preservation by record; ii) stabilisation; iii) detailed analysis and safeguarding of otherwise comparable sites elsewhere. Further details provided in the Outline WSI.	To offset the effects of disturbance/destruction of irreplaceable archaeological remains.	Proposed to be secured through a condition in the marine licence(s).
Tertiary measures: Measures required to meet legislative requirements, or adopted standard industry practice		
Commitment to implementation of the Offshore WSI which is submitted with this application, prior to any post-consent works within the Eni Development Area and Area of Physical Project Works.	The Outline WSI is submitted alongside the application and contains a method statement for pre-construction surveys and details of monitoring requirements. The PAD will ensure the protection and, if necessary, recording of previously unknown sites/objects of archaeological significance affected by the development.	Proposed to be secured through a condition in the marine licence(s).

11.10.1 Archaeological exclusion zones

Best practice favours the preservation *in situ* of archaeological remains, therefore the ideal preferred mitigation for archaeological remains is avoidance (COWRIE, 2007). For the Project, AEZs have been proposed that prohibit development-related activities within their extents, which vary depending upon the nature of the site. The final development layout will take into account these preliminary zones, which may evolve or be removed (with the agreement of Cadw and HE) as the Project progresses, subject to layout designs and additional subsequent surveys that may be required.

All AEZs agreed with the archaeological curators, through the Offshore WSI, will be marked on the Design Plan. If impacts cannot be avoided, measures to reduce, remedy or offset disturbance will be agreed.

In view of their potential archaeological significance, AEZs (either in the form of individual AEZs or clusters) will be placed around the nine locations which include the Protected Wreck of the *Resurgam*, and Scheduled wreck of the *Lelia*, both of which have statutory designated areas, included here as AEZs. The others represent high and medium potential anomalies identified by the geophysical data assessment. These anomalies have been recommended AEZs based on the size of the anomaly, the extents of any debris, the potential significance of the anomaly, the potential impact of the development and the seabed dynamics within the area.

Dependant of the form of the anomaly, AEZs have either been recommended as a radius from the centre point of the anomaly or as a distance from the extents. Particularly in the case of shipwrecks, which tend to be longer in length than width, the use of a circle provides unequal protection around the extents. This not only impacts the protection afforded but does not present proportional mitigation.

The proposed AEZs are listed in Table 11.14 and shown in Figure 11.1 to Figure 11.3. Scope is allowed for their amendment in light of further evidence and with the involvement of consultees. Currently, planned cable routes bisect a number of Archaeological Exclusion Zones. There is therefore a commitment to either investigate AEZs and refine the extents of AEZs where appropriate; and/or to re-route around these AEZs and to collect and assess data from the wider area to do so (ensuring that impacts do not take place before archaeological assessment of full-coverage geophysical data has been conducted, including on any deviations to the cable routes necessary to avoid AEZs). This work will take place prior to any seabed impacts in the area, and there will be no impacts to finalised AEZs during construction, operation, maintenance and decommissioning activities. Further details of AEZs and archaeological monitoring are provided in the Outline WSI and PAD.

The designated wreck of the *Resurgam* and the statutory protected area (Statutory Instrument 1996 No. 1741), have been included within this section. Whilst the wreck lies outside of the Eni Development Area and the Area of Project Physical Work the statutory protected area extends into these areas. To note, the designated area is not centred on the location of the wreck as provided by UKHO (detailed in Table 11.14), the location of the designated area is presented in Figure 11.1. Likewise, the scheduled wreck of the *Lelia* has also been included. Both the wreck and the designated circle lie within the Study Area, but due to proximity to the Eni Development Area the site has been included here to ensure awareness.

Table 11.14: Archaeological Exclusion Zones

MSDS_ID	Geophysical ID	Description	Easting (ED50 UTM30N)	Northing (ED50 UTM30N)	AEZ (m)	Type
E_001		*Resurgam*. Protected Wreck. Submarine	463157.66	5916617.67	300	Radius (not centred)
E_002		*Lelia*. Scheduled. Paddle Steamer	474625.65	5926786.95	50	Radius
E_005	CCS23_052	Wreck	475696.8	5914362.7	75	Extents

MSDS_ID	Geophysical ID	Description	Easting (ED50 UTM30N)	Northing (ED50 UTM30N)	AEZ (m)	Type
E_006	CCS23_020	Potential wreck	461786.6	5933019.5	75	Extents
E_010	CCS23_054	Mound	472907.1	5915455.1	25	Extents
E_095	CCS23_092	Debris	461580.3	5928986.4	25	Extents
E_096	CCS23_094	Debris	476748.4	5914455.3	15	Radius
E_097	CCS23_095	Debris	476667.2	5914598.3	15	Radius
E_098	CCS23_104	Debris	476023.9	5937756.2	50	Extents

11.10.2 Temporary archaeological exclusion zones

Sixty-seven TAEZs have been recommended within the Eni Development Area and Area of Physical Project Work. TAEZs are recommended where an anomaly is not visible in the geophysical dataset but is known to exist based on information from other datasets (e.g. UKHO data), where the position cannot be determined with enough accuracy for refined exclusion zones, or where the extents are not fully known. They are often larger than AEZs but are identified as temporary as they are highly likely to be altered following higher resolution or full coverage data assessment, or investigation with an ROV, however, they will remain in place until alterations have been formally agreed.

TAEZs have been assigned where remains are thought to be of medium, high or uncertain archaeological potential. All wreck remains which lie within the Area of Physical Project Work and Eni Development Area, listed in Table 11.8, have been recommended either AEZs or TAEZs. Other maritime remains including wreck sites or potential wreck sites, wreckage, the two potential WWII anti-aircraft towers, and unidentified fouls, obstructions, debris and magnetic anomalies have been recommended for TAEZs where they are considered to be of potential high or medium archaeological significance or where the significance is as yet unknown. Those remains which have not been recommended for protection by a TAEZ have been excluded following assessment which has determined their low archaeological potential. This is the case for maritime remains including chain cable or rope, collapsed oil platforms, likely infrastructure, fishing gear, concrete mattresses and other similar remains. Other remains which have not been recommended for protection by a TAEZ have been excluded where assessment has determined an unlikelihood of remains being present at the given location (e.g. fisherman's fastenings and unidentified obstructions connected with records of fisherman's fastenings, unidentified non-submarine contacts, and spoil ground, the extents of which are unknown). All terrestrial assets (see summary in Table 11.8) lie beyond the Area of Physical Project Work and Eni Development Area, and are therefore not recommended AEZs. Likewise documentary records are not recommended for TAEZs due to the low likelihood of physical remains at the given locations. In summary, the assessment has determined the following groupings of remains, and has made the following recommendations:

Remains identified as of high archaeological potential, which have been recommended TAEZs:

- Wrecks, wreckage and wreck remains.

Remains identified as of medium archaeological potential within the geophysical assessment, which have been recommended TAEZs:

- debris;
- mounds; and
- two potential WWII anti-aircraft towers.

Unidentified remains with uncertain archaeological interest, which have been recommended TAEZs. These include:

- fouls;
- obstructions; and
- magnetic anomalies of high and medium archaeological potential.

Remains identified as of low archaeological potential within the geophysical assessment or by the desk-based assessment which have not been recommended AEZs/TAEZs:

- debris and potential debris;
- beacons (discarded navigation beacons);
- geophysical anomalies (debris and origin unknown);
- unknown anomalies;
- seabed disturbance; and
- linear features.

Modern elements with no archaeological interest which have not been recommended AEZs/TAEZs. These include:

- anchor, chain and cable and chain, cable or rope;
- collapsed platforms;
- platforms;
- possible oil rig leg;
- debris (likely infrastructure);
- fishing gear; and
- concrete mattresses.

Remains where the extents or positions are unknown or questionable which have not been recommended AEZs/TAEZs:

- unidentified obstructions and fisherman's fasteners;
- obstruction classed as a Non – Submarine Contact (NSC); and
- spoil ground.

The above bullet points account for all remains within the Eni Development Area and Eni Area of Physical Project work, detailed in Table 11.8.

The size of the TAEZs takes into consideration the proximity of available survey data, the potential to represent material of archaeological significance, the perceived accuracy of the position, and other anomalies that may be present within the surrounding area. Anomalies and their recommended exclusion zones are detailed in Table 11.15 and the distribution presented in Figure 11.1, with detailed distributions in Figure 11.4 to Figure 11.8.

Table 11.15: Temporary Archaeological Exclusion Zones

MSDS TR ID	Geophysical ID	Type	Easting (ED50 UTM30N)	Northing (ED50 UTM30N)	AEZ (m)	AEZ Type
E_013		Wreck	461936.409	5930419.47	150	Radius
E_016		Wreck	465945.894	5930704.11	150	Radius

MSDS TR ID	Geophysical ID	Type	Easting (ED50 UTM30N)	Northing (ED50 UTM30N)	AEZ (m)	AEZ Type
E_017		Wreck	464004.008	5930992.88	150	Radius
E_018		Wreck	462622.612	5930132.13	150	Radius
E_019		Wreck	464944.288	5931135.99	150	Radius
E_020		Wreck	465748.985	5928944.17	150	Radius
E_021		Wreck	463219.551	5931000.8	150	Radius
E_022		Wreck	463335.604	5930295.26	150	Radius
E_023		Wreck	464473.676	5930268	150	Radius
E_025		Wreck	479313.151	5938753.4	150	Radius
E_026		Wreck	475854.121	5942736.87	150	Radius
E_027		Wreck	471718.371	5941023.76	150	Radius
E_030		Wreck	466862.893	5930172.27	150	Radius
E_031		Wreck	464452.733	5934664.68	150	Radius
E_032		Wreck	474292.184	5942705.61	150	Radius
E_033		Wreck	473631.371	5942010.22	150	Radius
E_034		Wreck	473171.832	5942226.08	150	Radius
E_035		Wreck	473101.251	5941451.39	150	Radius
E_036		Wreck	473268.123	5942491.94	150	Radius
E_037		Wreck	467864.906	5939373.83	150	Radius
E_038		Wreck	468907.256	5938563.4	150	Radius
E_040		Wreck	470529.796	5939325.49	150	Radius
E_043		Wreck	487647.245	5944174.28	150	Radius
E_044		Wreck	491021.934	5939923.43	150	Radius
E_045		Wreck	465747.155	5931230.86	150	Radius
E_048		Wreck	474120.979	5942040.87	150	Radius
E_052		Wreck	490156.377	5937636.74	150	Radius
E_054		Wreck	465936.149	5926795.95	50	Radius
E_058		Wreck	473841.365	5933249.41	150	Radius
E_059		Wreck	473159.973	5945159.62	150	Radius
E_060		Wreck (probable)	464763.209	5930562.51	50	Radius
E_061		Wreck or ballast mound	480201.187	5946851.51	50	Radius
E_062		Wreck or debris	464336.382	5929649.71	50	Radius
E_063		Wreck or debris	473072.826	5941685.19	50	Radius
E_065		Wreck or beacon	473179.159	5940423.67	50	Radius
E_066		Wreck or beacon	473009.024	5941134.83	50	Radius
E_070		Possible wreck	475487.923	5914655.71	50	Radius
E_071		Possible wreck	476423.397	5914374.67	50	Radius
E_077		Wreck or wreckage (possible)	473394.939	5941332.89	50	Radius
E_078		Wreckage	473064.822	5942019.01	50	Radius
E_079		Wreckage	473389.805	5942176.62	50	Radius
E_080		Wreckage	473345.743	5942182.43	50	Radius
E_081		Wreckage	470165.918	5939914.9	50	Radius

MSDS TR ID	Geophysical ID	Type	Easting (ED50 UTM30N)	Northing (ED50 UTM30N)	AEZ (m)	AEZ Type
E_082		Wreckage	473371.504	5941477.66	50	Radius
E_083		Wreckage	473320.944	5942089.94	50	Radius
E_084		Wreckage	474352.147	5942547.71	50	Radius
E_085		Wreckage	473458.147	5941397.43	50	Radius
E_086		Wreckage	473598.255	5939846.47	50	Radius
E_087		Wreckage	474751.24	5938506.9	50	Radius
E_088		Wreckage	474431.873	5942248.7	50	Radius
E_089		Wreckage	473195.497	5941352.57	50	Radius
E_090		Wreckage	473230.141	5941433.96	50	Radius
E_091		Possible wreckage	473391.011	5941223.52	50	Radius
E_093		Debris	473446.026	5941399.36	50	Radius
E_094		Debris	474424.38	5942693.77	50	Radius
E_179		Tower	468297.634	5940854.15	50	Radius
E_180		Tower	473671.771	5938796.54	50	Radius
E_188		Obstruction	480525.477	5938531.93	25	Radius
E_194		Foul	473550.442	5939581.58	25	Radius
E_195		Foul	473170.608	5939698.7	25	Radius
E_421	CCS23_M206	Magnetic anomaly	475824.1	5914015.1	25	Radius
E_422	CCS23_M220	Magnetic anomaly	473906.2	5915305.7	25	Radius
E_423	CCS23_M221	Magnetic anomaly	468331.6	5916557.8	25	Radius
E_424	CCS23_M235/237	Magnetic anomaly	473810.2	5915328.8	50	Radius
E_425	CCS23_M268	Magnetic anomaly	461729.3	5928916.4	25	Radius
E_426	CCS23_M199	Magnetic anomaly	476341.72	5914668.39	25	Radius
E_427	CCS23_M215	Magnetic anomaly	476634.56	5914622.8	50	Radius

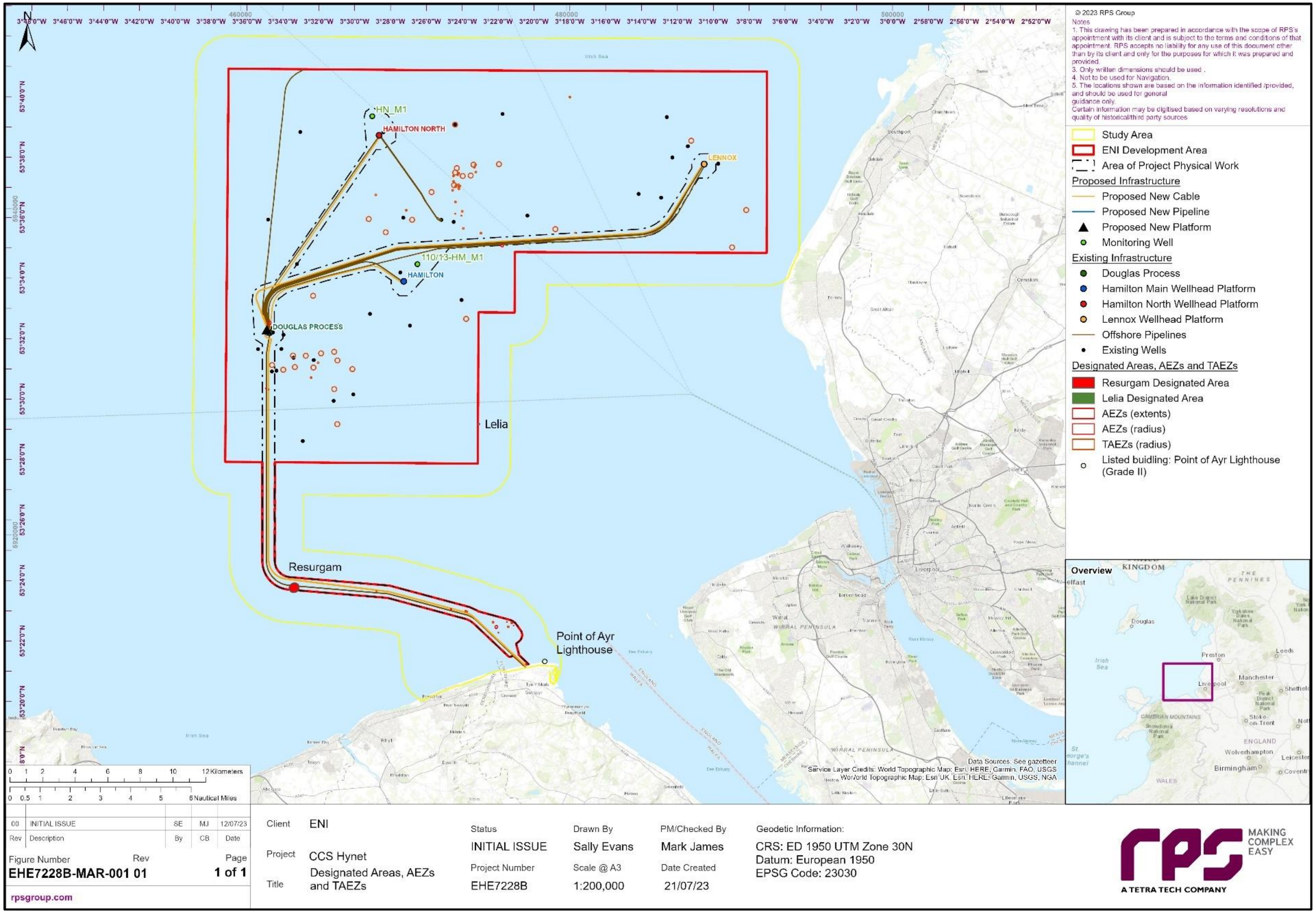


Figure 11.1: Distribution Of All Designated Areas, AEZs And TAEZs

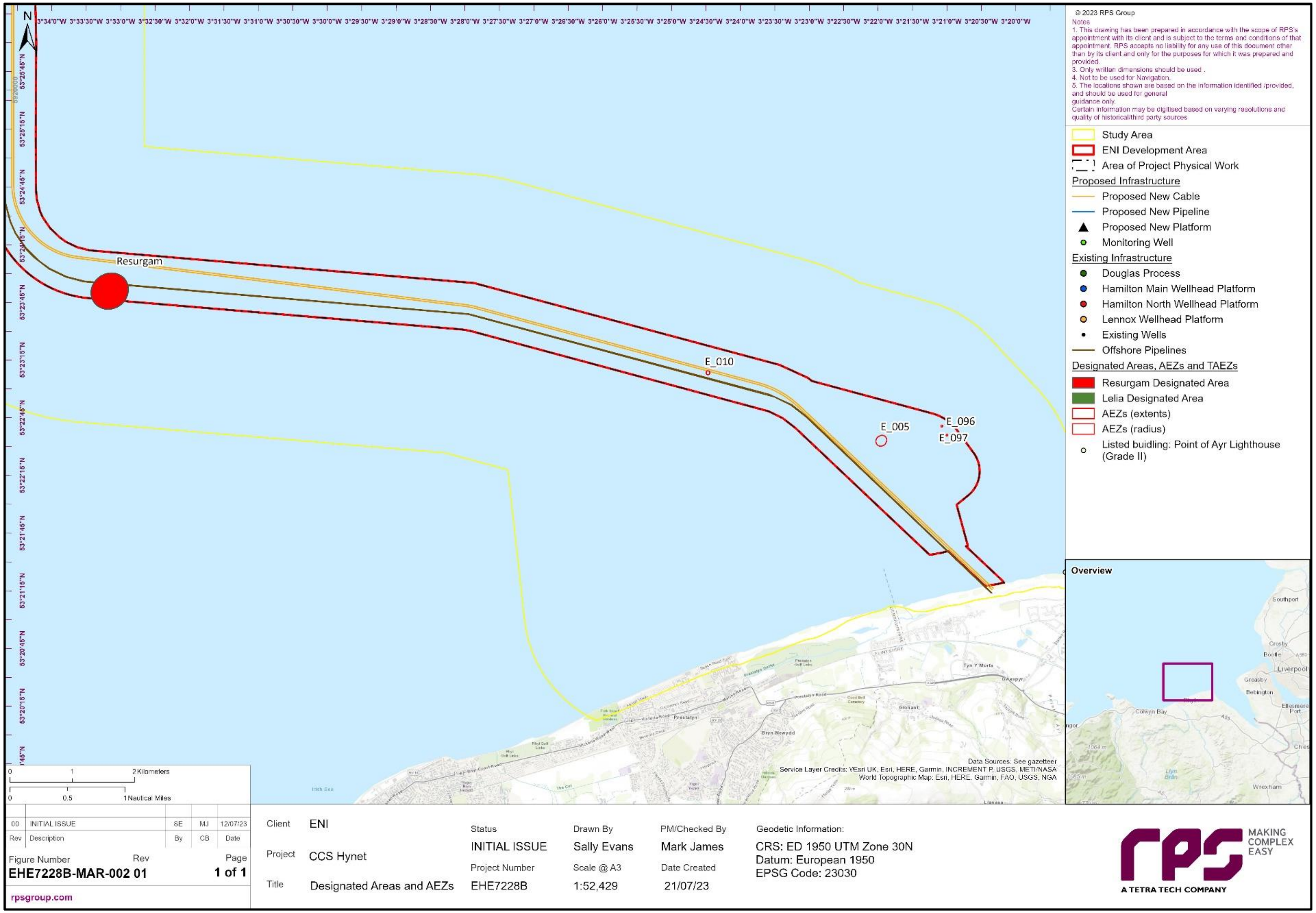


Figure 11.2: Distribution Of All Designated Areas And AEZs (south)

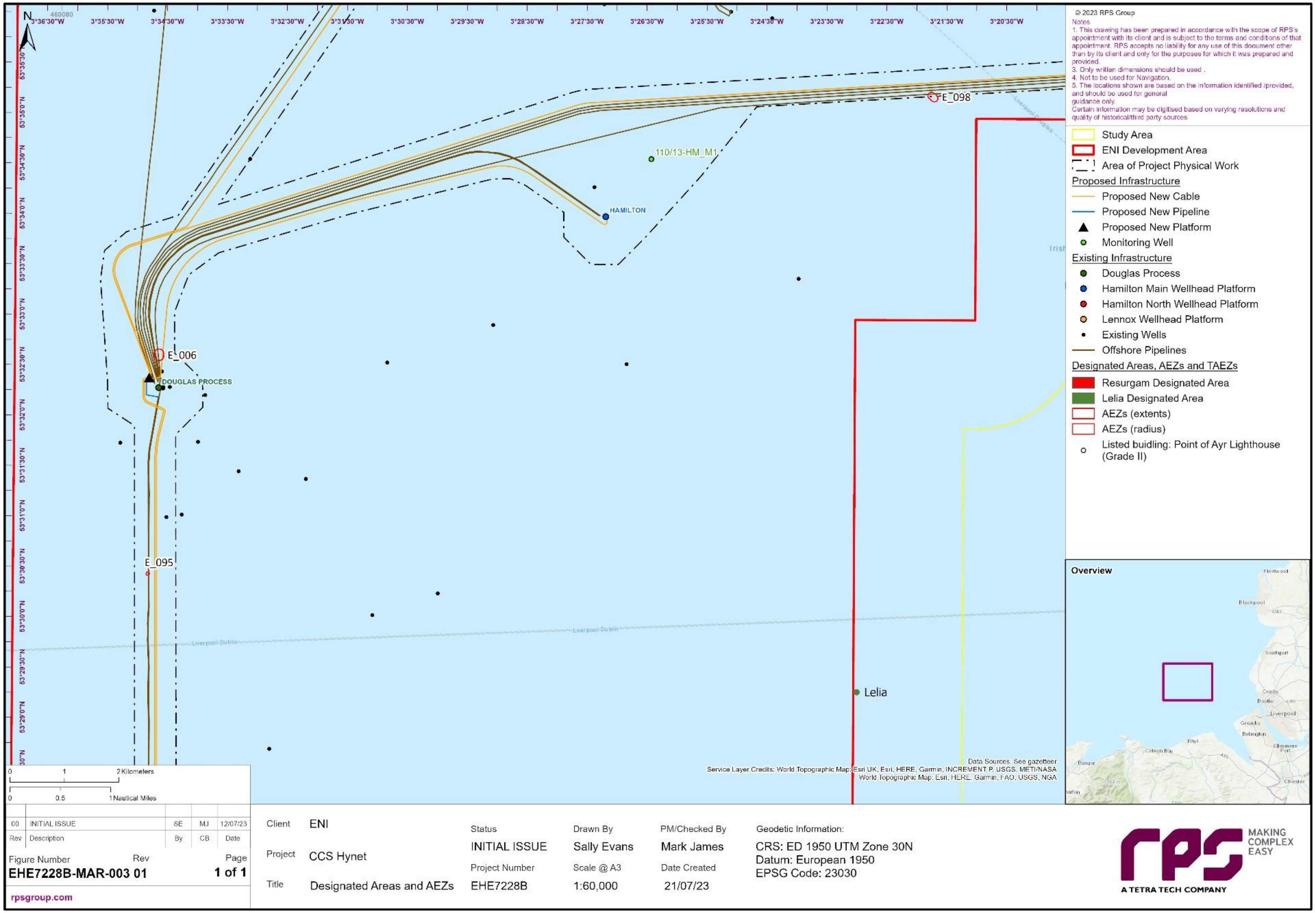


Figure 11.3: Distribution Of All Designated Areas And AEZs (north)

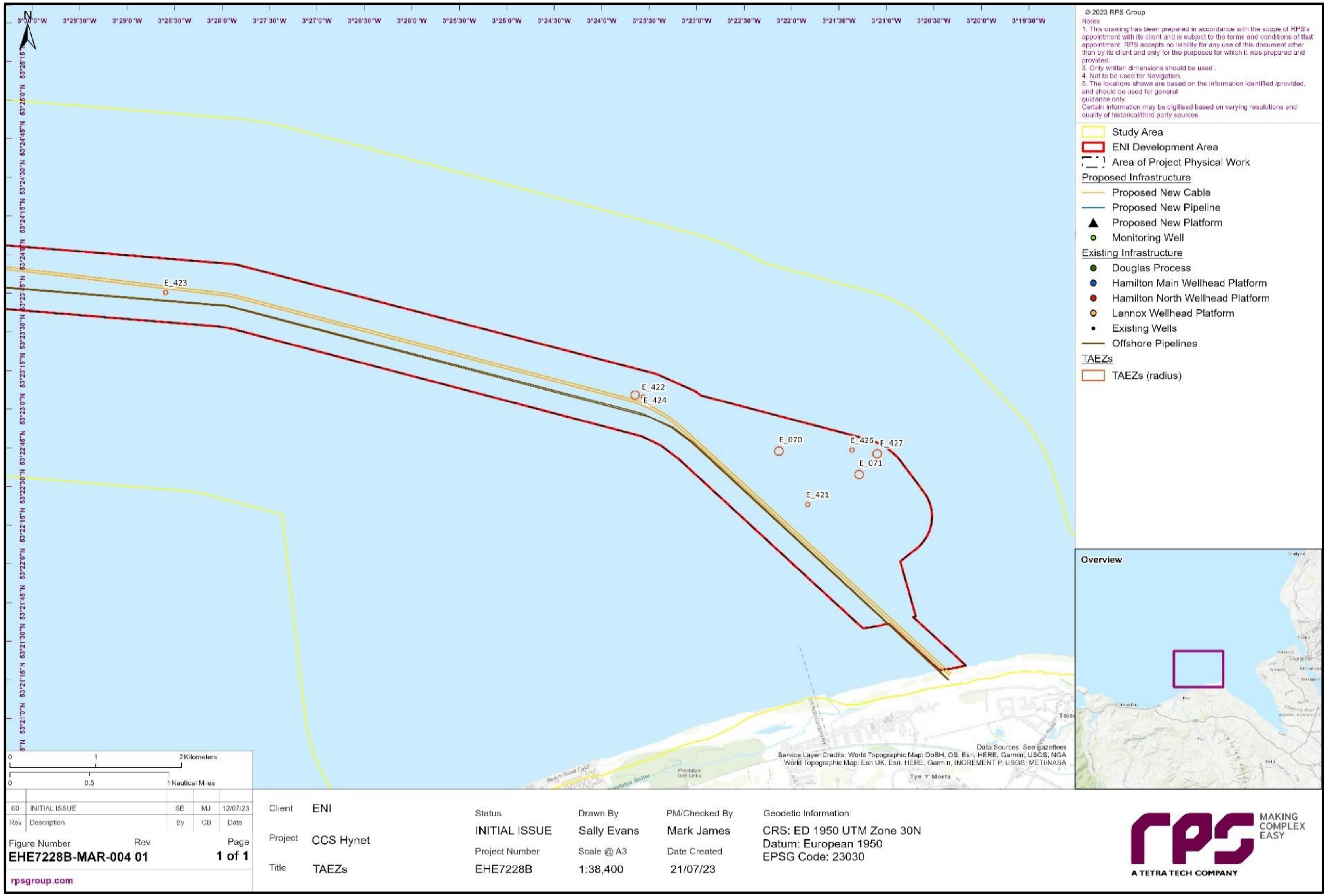


Figure 11.4: Distribution Of TAEZs (Southern Cable Route And Landfall)

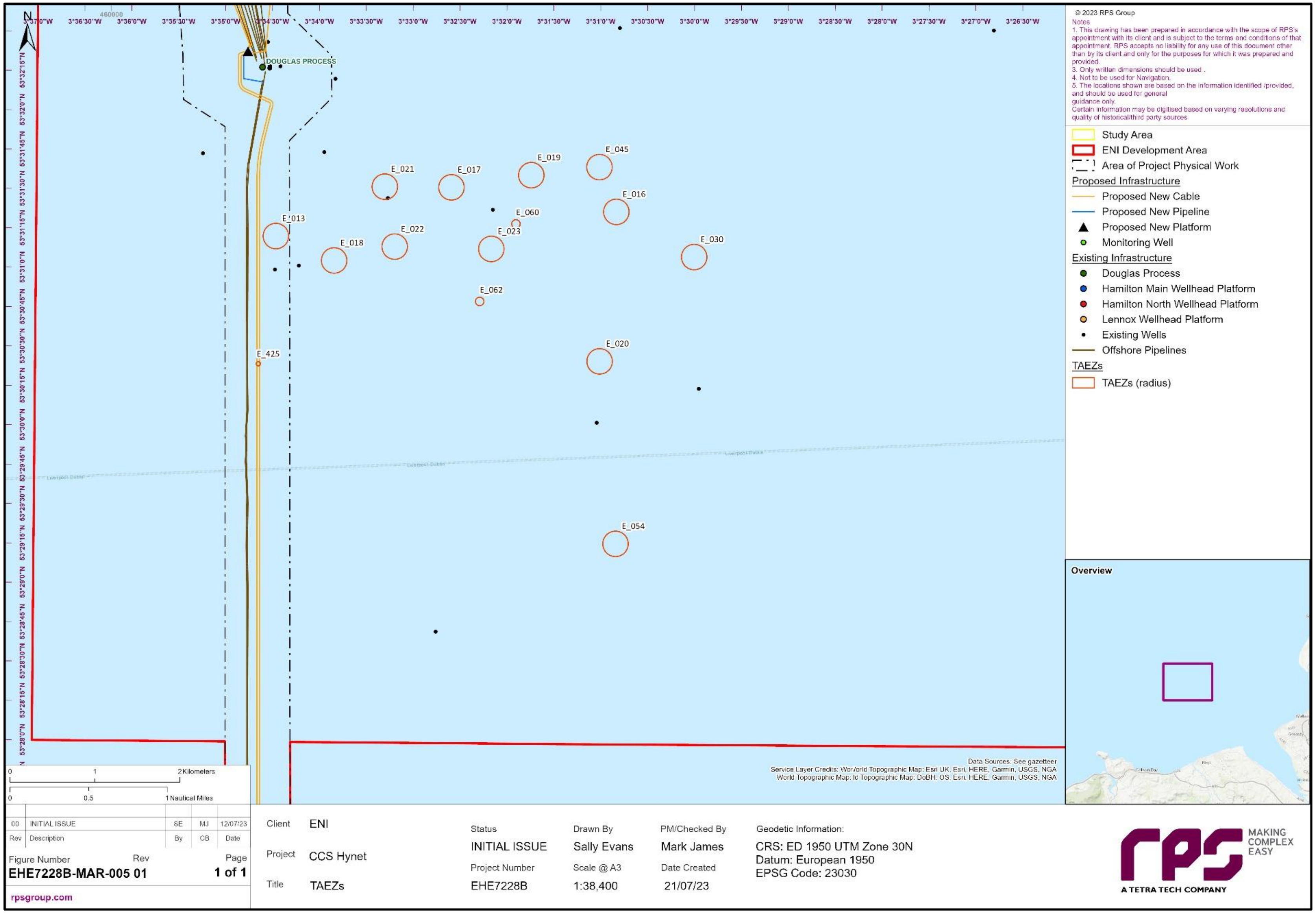


Figure 11.5: Distribution Of TAEZs (South Of Douglas Platform)

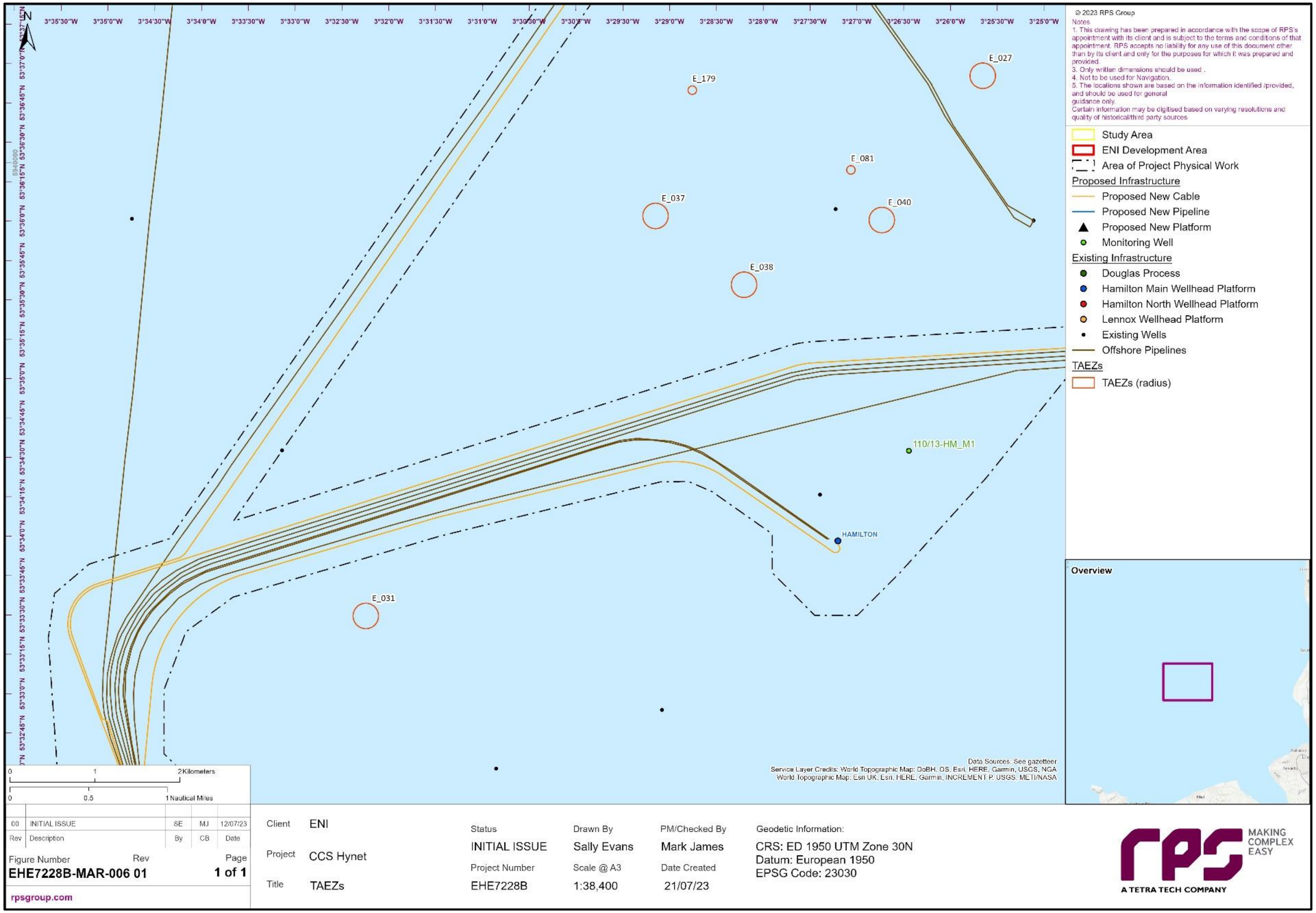


Figure 11.6: Distribution Of TAEZs (North Of Douglas Platform)

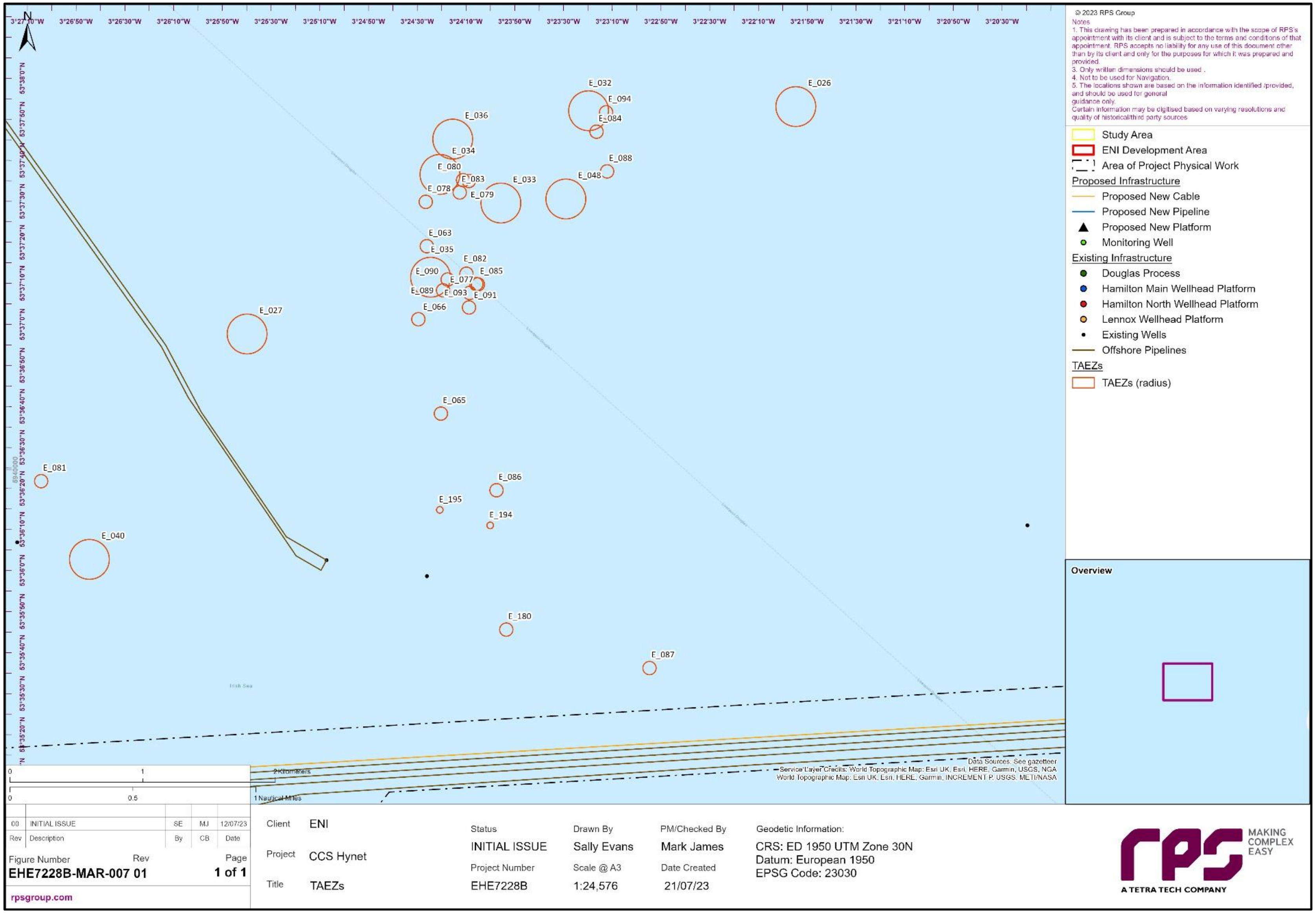


Figure 11.7: Distribution Of TAEZs (Between Hamilton Platforms)

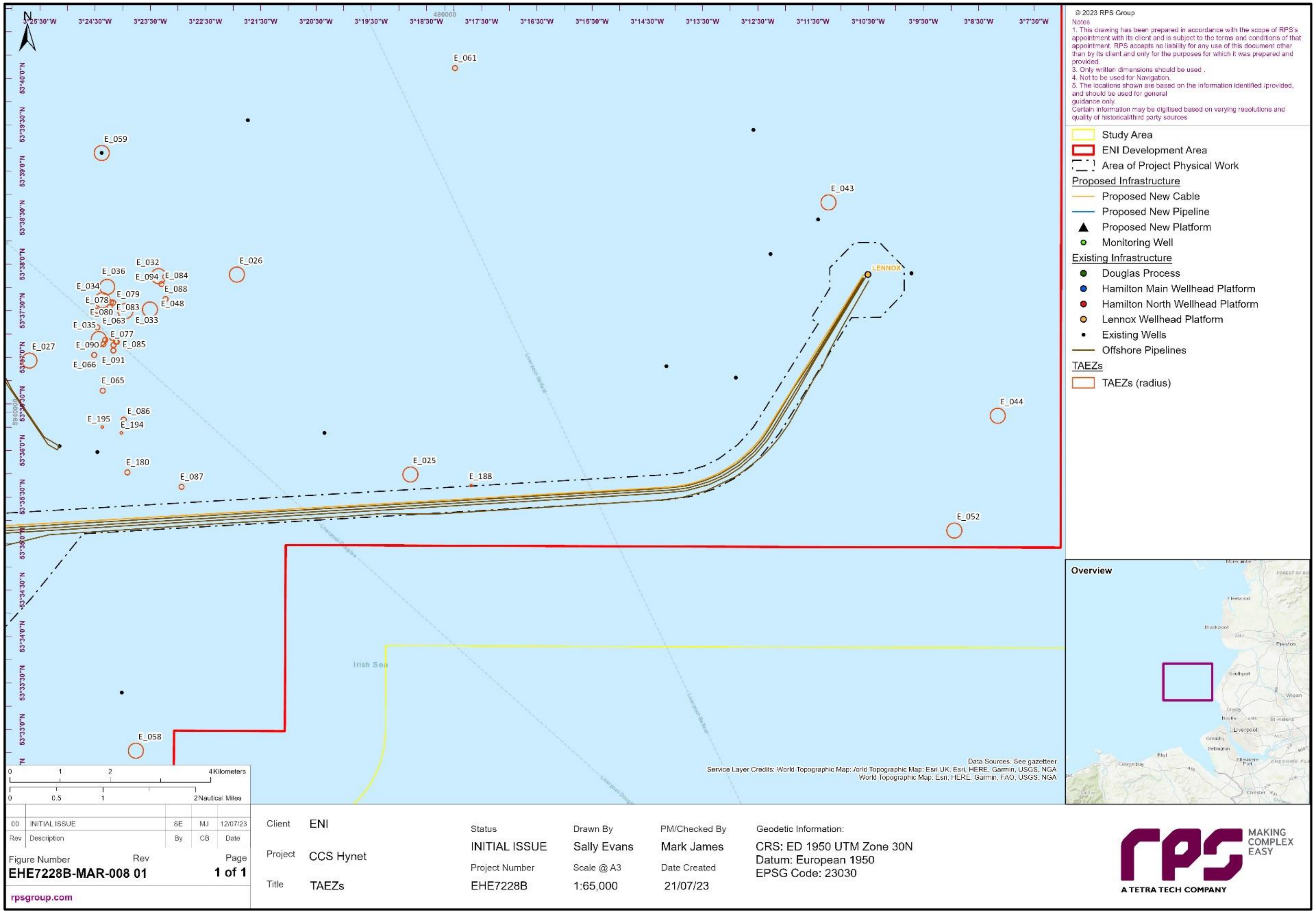


Figure 11.8: Distribution Of TAEZs (Eastern Area To Lennox Platform)

11.10.3 Preservation by record

Where preservation *in situ* is not practicable, disturbance of archaeological sites or material will be offset by appropriate and satisfactory measures, also known as 'preservation by record'. In these circumstances, the effects of the Project will be offset by carrying out excavation and recording prior to the impact occurring (COWRIE, 2007).

It is likely that previously unknown wrecks, archaeological sites or material may only be encountered during the course of the construction, maintenance and/or decommissioning of the Project. Procedures will therefore be put in place to allow for such eventualities.

A protocol for reporting finds of archaeological interest will be followed, in line with The Offshore Renewables PAD (The Crown Estate, 2014). This will involve the reporting of archaeological discoveries made during the lifetime of the Project. This protocol covers the reporting and investigating of unexpected archaeological discoveries encountered during construction, operations and maintenance and decommissioning activities, informed by the guidance of a marine archaeologist specialised in working with PADs for offshore wind farm projects. This protocol further makes provision for the implementation of TAEZs around areas of possible archaeological interest, for prompt archaeological advice and, if necessary, for archaeological inspection of important features prior to further construction, maintenance or decommissioning activities in the vicinity. It complies with the Merchant Shipping Act 1995, including notification to the Receiver of Wrecks, in accordance with the Code of Practice for Seabed Developers (Joint Nautical Archaeology Policy Committee (JNAPC), 2006). The PAD will be submitted as part of the Outline WSI at application.

11.11 Assessment of significance

The impacts of the construction, operations and maintenance, and decommissioning phases of the Project have been assessed on marine archaeology. The potential impacts arising from the construction, operations and maintenance and decommissioning phases of the Project are listed in Table 11.9 along with the maximum design scenario against which each impact has been assessed.

A description of the potential effect on marine archaeology receptors caused by each identified impact is given below.

11.11.1 Sediment disturbance and deposition leading to indirect impacts on known archaeological receptors

The construction, operations and maintenance and decommissioning of the Project may lead to sediment disturbance and deposition leading to indirect impacts on marine archaeology receptors. The maximum design scenario is represented by sand wave clearance and dredging, platform installation, well drilling and modifications and cable installation and is summarised in Table 11.9.

The disturbance of sediment/seabed deposits can result in the exposure of known marine archaeology receptors (i.e. wreck sites) and the exposure of as yet unknown wreck sites and associated materials. Such activities can also result in the burial of known receptors.

11.11.1.1 Construction, operation, maintenance and decommissioning phase

Magnitude of impact

The potential changes to sedimentation have been modelled in Physical Processes Assessment Technical Report (RPS Group, 2023), which identified seabed preparation, the drilling of monitoring wells, and the laying of cables to be the principal construction elements which have a bearing on sediment transport and sedimentation. Full details of the construction activities which will result in sediment disturbance and deposition are provided in Table 11.9.

These construction activities will disturb the seabed, resulting in sediment being released into the water column and subsequently redeposited. Impacts of sediment disturbance and deposition have the potential to expose previously unrecorded marine archaeology receptors, and also to bury or partially bury known marine archaeology receptors, resulting in the potential for direct impacts on marine archaeology assets located on or within the seabed.

The changes to sediment transport and deposition are set out in detail within Physical Processes Assessment Technical Report (RPS Group, 2023) and are summarised in Table 11.9, and below. The physical processes studies found that during site preparation activities ahead of cable installation, including sand wave clearance in two potential locations, south of Douglas OP, and at West Hoyle Bank, sediment transport and sedimentation would be altered from the baseline. Modelling demonstrated that suspended sediment for the former would be at its maximum levels within 200 m of the seabed release with a peak value of c.1,400 mg/l at the point of mobilisation. Finer sediments would be carried further within the tidal ellipse, with maximum concentrations of <100 mg/l. These plumes may extent c. 12 km west to east. All sedimentation would occur within 8 km of the work, with maximum deposition limited to <50 mm within 10 m of the point of excavation.

At West Hoyle Bank, dredging through a channel to allow cable installation was modelled. This showed that suspended sediment would have a maximum plume of 25 km, reaching southeast to the mouth of the River Dee. Maximum suspended sediment values were modelled at 3,000-10,000 mg/l however in most areas fall below 30 mg/l, and concentrations are generally <10 mg/l in the Eni Development Area. Sedimentation may occur at maximum values of c.5 m adjacent to the dredged channel with average sedimentation values outside of the dredge path generally limited to <50 mm, and <10 mm. Sedimentation may occur at negligible levels c. 8 km into the Dee Estuary.

If the West Hoyle Bank route is not chosen the alternative route passes further east through a tidal channel. If this option is chosen some pre-lay dredging would still be required to allow for a self-beaching CLV to ground itself at low tide on a ‘flat’ area of sandbank. The area to be dredged in this scenario would be approximately 180 m length, 60 m wide and between 1 m and 2 m below LAT. This is likely to cause suspended sediment and sedimentation, though the values have not been modelled.

Drilling operations for the insertion of two new monitoring wells at Hamilton Main and Hamilton North will also result in suspended sediment and sedimentation. The new wells will require drilling of two sections the first of which is a 26” opening in which the 20” conductor will be encased, and the second a deeper cutting to penetrate bedrock (Mercia Mudstones Group). The first section will clear c.30.48 m of sand and silt and the drilling of c.84.43 m of coarser sediment, expected to be Quaternary sediment. Suspended sediment is expected, with plumes at Hamilton Main and Hamilton North extending potentially 8 km from the drill sites. At Hamilton Main, maximum concentrations across the plume can rise in excess of 300 mg/l to a peak of c.360 mg/l, however maximum concentrations are generally are limited to <20 mg/l, reducing rapidly away from the drill site discharge location. Sedimentation is expected within 50 m of the drill sites, where values of up to c. 70 mm are anticipated, though generally sedimentation under 0.03 mm is expected further afield, within the range of the tidal ellipse. At Hamilton North maximum suspended sediment concentrations are limited to 500 mg/l in the direct vicinity of the drill site and are generally less than 5 mg/l across the rest of the plume (reaching up to 8 m from the drill site). The maximum sedimentation values are expected to be c. 100 mm within c. 50 m of the drill site, with much lower values settling within the plume area as at Hamilton Main.

Cable laying activities would also lead to suspended sediment and sedimentation. The effects of these installations on sediment transport and sedimentation have been modelled, assuming cables are trenched (the maximum design scenario). Modelling was undertaken for two representative routes: The PoA to Douglas route, and the Douglas OP to Lennox route. Other cable route installations are anticipated to have a similar effect. The PoA to Douglas cable is expected to result in sediment up to 15 km from the cable installation, however, sment transport within the wider area (15 km from the cable route) is expected to be at c. <1 mg/l. Maximum suspended sediment concentrations are expected along the cable route itself, generally at <10,000 mg/l, increasing over the shallow West Hoyle Bank to 300,000 mg/l, peaking at c.640,000 mg/l. Maximum sedimentation occurs within c.30 m of the cable route, and is limited to <300 mm of deposited material, with the deepest sedimentation close to the cable route. Physical processes for the Douglas OP to Lennox cable have also been modelled, finding that maximum suspended sediment concentrations occur within c.50 m the trenching route, with high mean values of <1,000 mg/l. The plume may extend over 15 km from the trenching route, though with suspended sediment at near background values. Maximum sedimentation is anticipated within 50 m of the cable route, with deposition limited to <50 cm (peak of c.32 cm).

The primary impact on sedimentation during the operation and maintenance phase is likely to be from cable replacement, following the modelled case set out above for cable installation. Alteration of sediment transport regimes leading to potential erosion or burial of archaeological sites are considered below.

The changes to sedimentation associated with decommissioning have not been modelled. However, changes to sediment transport and deposition are likely when removing infrastructure where this infrastructure has a seabed interaction.

Additional changes to sedimentation may come from other activities including vessel anchoring and use of jack up barges, in addition to other works summarised in Table 11.9. While these other works may mobilise small amounts of sediment, the primary elements which are considered to have a bearing on sediment transport and deposition have been detailed above (seabed preparation, the drilling of monitoring wells, and the laying of cables).

Following the works suspended sediments would return to baseline levels, within a couple of days. Thus the changes would be temporary.

Sediment disturbance and deposition has the potential to impact archaeological sites. While changes in sediment transport and sedimentation have been noted, modelling indicates an increase in sediment suggesting coverage rather than exposure of archaeological sites, which may afford protection to sites in many cases. Thus, while this increase in sedimentation may affect known archaeological receptors, including those within AEZs and TAEZs, the increases may afford protection to the sites. Embedded mitigation measures also set out procedures in the case of exposure of sites. The principal mitigation measure is implementation of a protocol for reporting finds of archaeological interest, ensuring the recording, assessment and investigation or protection of new sites where warranted.

The indirect impacts on marine archaeology receptors during the construction, operations and maintenance and decommissioning of the Project is predicted to be of local spatial extent, short term duration (though impacts from sediment deposition may be longer term), intermittent and medium reversibility. It is predicted that the impact will affect marine archaeology indirectly and may result in a benefit to sites, through additional burial, though this is likely to be limited in extent. Exposure of sites is mitigated through use of the protocol for reporting finds of archaeological interest. Overall, and with embedded mitigation in place, the magnitude is considered to be **low.**

Sensitivity of the receptor

Palaeolandscape and submerged prehistoric remains

Assessment has led to the identification of three main Quaternary units within the Site, representing the environmental shift from glacially and proglacially dominated conditions of the Devensian (represented by Unit III and II), to later potentially pre-transgressional environments (possibly represented by Units II and I), followed by the modern active marine environment which characterises the Site today (Unit I). Units III and II hold low archaeological potential in general, though material may survive on the surface of the unit where later subaerial exposure may have occurred and where later erosion has not removed such evidence. Unit I may hold both palaeoenvironmental and archaeological potential, however, subsequent marine transgression has eroded the upper parts of this deposit, potentially affecting preservation of any prehistoric sites. Potential for redeposited remains has also been identified.

Palaeolandscape and palaeoenvironmental remains do not tend to warrant designation in most cases and are not considered highly significant in general They may, however, be capable of contributing to our understanding of palaeolandscapes following the Last Glacial Maximum. Such deposits could hold evidential value within their palaeoenvironmental remains, sea level data and dating evidence, which is considered a priority by research frameworks including People and the Sea (Ransley *et al*., 2013). The deposits may therefore be capable of addressing priorities within these agendas, and therefore may be considered to hold a moderate level of value. In contrast, submerged prehistoric sites are rare and, depending on the level of survival and nature of the remains, may be of up to high value. However, no such sites or palaeoenvironmental remains are known within the Eni Development Area or Area of Project Physical Work.

New sites may be exposed through erosion. Burial may also affect any sites which are currently already buried. Any such items would be unable to adapt to, tolerate, or recover from the impact where erosion to take place. The sensitivity of the receptors are therefore considered to be high.

Maritime and coastal remains

Potential for remains of wreck sites and other maritime and coastal remains has been defined as increasing during the post-medieval and modern periods, in association with increased trade, transport, wartime activity and changes in vessel construction. The assessment has also found evidence of other maritime remains ranging from debris, mounds potentially indicating wreck sites, remains of tower bases which are thought to represent the remains of anti-aircraft forts dumped after WWII, to other unidentified geophysical anomalies. The assessment has also found potential for other remains, including wartime coastal features and navigational aids (see Table 11.8 for a summary).

Wrecks

The value of a wreck, site or find, is case specific, dependent upon age, historical importance and rarity, and under the right conditions, wrecks can be of high value. These items are unable to adapt to, tolerate, or recover from the impact, except in the case of burial. The sensitivity of the receptors are therefore considered to be high.

Other maritime remains

Other maritime remains are discussed above. The majority are of low archaeological potential (see summary in Section 11.7), however, debris and mounds which may represent wreck-related remains have also been identified, and could be of up to medium archaeological value. Likewise, two potential WWII anti-aircraft towers have also been identified. These may hold evidential and historical value, though limited as they are not thought to be *in situ* (the records indicate dumped remains), and therefore a medium value is considered appropriate. Other remains including fouls and obstructions have an unknown value, and a range of magnetic anomalies with high and medium values are recorded.

Given the recorded maritime history of the area there is potential for other remains which may also be of up to high value. These items are unable to adapt to, tolerate, or recover from the impact, except in the case of burial. The sensitivity of the receptors are therefore considered to be medium to high.

Aviation remains

The assessment also found potential for remains of aviation crash sites, in particular for Spitfires and other wartime crash sites, though none are currently recorded within the Eni Development Area of Area of Project Physical Work. Such sites can be of high value, with certain aircraft automatically designated under the Protection of Military Remains Act. As with wrecks these remains are unable to adapt to, tolerate, or recover from the impact, except in the case of burial. The sensitivity of the receptors are therefore considered to be high.

Significance of the effect

The measures adopted as part of the Project outlined in Table 11.13 include measures to ensure that any newly exposed archaeological assets are recorded. These measures include implementation of a protocol for reporting finds of archaeological interest, ensuring identification, recording and mitigation for new sites where appropriate.

Overall, the magnitude of the impact is deemed to be low and the sensitivity of the receptors is considered to be medium to high. Based on professional judgement, the effect will, therefore, be of **minor** significance, which is not significant in EIA terms. Additionally, the effects may benefit the receptors through additional burial.

11.11.2 Direct damage to known archaeological receptors

The seabed activities to facilitate the construction, operations and maintenance and decommissioning of the Project have the potential to impact both maritime archaeology receptors and submerged prehistoric receptors within the Eni Development Area and Area of Physical Project Work.

11.11.2.1 Construction, operation, maintenance and decommissioning phase

Magnitude of impact

Direct impacts to the seabed during construction will include sand wave clearance at two potential locations (south of Douglas OP and at West Hoyle Bank), leading to clearance of sand waves with average heights of c.3 m and lengths of c.100 m and c.15 m respectively at the two locations. Excavation of a 10 m wide corridor will be necessary at each location, in preparation for cable installation. Additionally, if the West Hoyle Bank route is not chosen the alternative route passes further east through a tidal channel. If this option is chosen some pre-lay dredging would be required to allow for a self-beaching CLV to ground itself at low tide on a ‘flat’ area of sandbank. The area to be dredged in this scenario would be approximately 180 m length, 60 m wide and between 1 and 2 m below LAT. Construction will also involve installation of a new platform at Douglas using up to eight pile driven legs. Each pile will be approximately 1.5 m in diameter and 40.25 m in total length, with a penetration depth of around 22 m. Additionally, two new wells will be drilled, to maximum depths of 3,000 and 3,200 m respectively, and new cables will be inserted. The cables from the PoA to Douglas OP will include two cables laid c. 30 m apart, each cable laid in an installation zone of c. 15 m in width. Cables running between oil platforms will also be inserted, again with two cables laid c. 30 m apart, each cable laid in an installation zone of c. 15 m in width. All cables will be primarily installed using a plough (not exceeding 15 m in impact width). In addition to the construction of new infrastructure, direct seabed impacts will occur through use of jack up vessels and anchoring of other vessels. These activities are likely to be focused around the new infrastructure, all within the Area of Project Physical Work, but may also extend into the Eni Development Area. Anchoring and jack up impacts may also be felt in areas where existing infrastructure is to be modified for use under the Project, including the existing oil platforms and wells. Other impacts may arise from the wet storage of cables and boulder clearance.

The maximum design parameters for operation, maintenance and decommissioning are not known but will be lower than for installation. Cable repair, remediation and reburial may cause impacts, as may well interventions and all associated vessel and jack up activities. Removal of infrastructure during decommissioning may also cause impacts though these are likely to be largely within the footprint of existing impacts.

These activities have the potential to directly and permanently impact upon marine archaeology receptors on the seabed, including maritime remains, and those that lie concealed below the covering sands including potential submerged prehistoric landscapes. These activities also have the potential to expose previously unrecorded marine archaeology receptors. However, embedded mitigation has already been applied to avoid and mitigate impacts. The relevant embedded mitigation includes:

- Establishment of AEZs and TAEZs around wrecks, and archaeological remains of potential high and medium significance, including potential wrecks, wreckage, debris, mounds, potential remains of WWII aircraft towers, obstructions and fouls. Full details of the AEZs and TAEZs is included in section 11.10.1.. No installation activities or other activities which would impact the seabed (including vessel anchoring etc) will take place within these zones, unless permitted by Cadw and HE. Modifications to AEZs based on new or additional data will also be agreed with Cadw and HE prior to any impacts on the seabed. Currently, planned cable routes bisect a number of AEZs. There is therefore a commitment to either investigate AEZs and refine the extents of AEZs where appropriate; and/or to re-route around these AEZs and to collect and assess data from the wider area to do so (ensuring that impacts do not take place before archaeological assessment of full-coverage geophysical data has been conducted, including on any deviations to the cable routes necessary to avoid AEZs). This work will take place prior to any seabed impacts in the area, and there will be no impacts to finalised AEZs during construction, operation, maintenance and decommissioning activities.

- Archaeological input into specifications for, and archaeological analysis of, any further pre-construction geophysical and geotechnical surveys:
  - From the geotechnical perspective, geoarchaeological assessment will accompany planned geotechnical works. This will follow a staged process, and accepted guidance. Further details will be set out within the Outline WSI. Survey specific method statements will be appended to the WSI and approved by HE prior to the commencment of any site investigation.This will be the mechanism for ensuring impacts to the submerged prehistoric landscape are understood and mitigated.
  - From the geophysical perspective, there will be input into and review of geophysical survey data by an experienced marine archaeological geophysicist. New data will be collected ensuring full coverage of the Area of Project Physical Work prior to any seabed impacts. This includes collection and review of any data where micrositing of cables leads to re-routing through areas in which there is no data coverage. Additionally, due to re-routing around the designated area associated with the Protected Wreck *Resurgam*, the planned cable routes currently pass through an area in which full coverage data has not yet been assessed. This data is in collection and will be assessed prior to any seabed impacts.
- Implementation of a protocol for recording finds of archaeological interest, following the guidance for the PAD. This will ensure identification and appropriate protection or investigation of sites of archaeological importance which are currently unknown.

With the embedded mitigation in place, the magnitude of impact, which will be of local spatial extent, long term (permanent) duration and with no reversibility, is considered to be low.

Sensitivity of receptors

The value of the receptors including known wrecks and other maritime remains, potential palaeolandscape remains and submerged prehistoric sites, and potential aviation crash sites, has been discussed in detail above (see section 11.11.1). The marine archaeology receptors are deemed to be of high vulnerability to direct damage, low recoverability and of varying value, up to high value. The sensitivity of the receptors is therefore considered to be up to high.

Significance of effect

Overall, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be high. Based on professional judgement and following implementation of embedded mitigation, it is considered that the effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

11.11.3 Direct damage to coastal/intertidal archaeological remains through cable installation at the landfall site

Magnitude of impact

Cable laying from the PoA to Douglas OP will involve cables making landfall around the Talacre dune system. The two cables will pass under the dunes (landward of MHWS) and will punch out within the intertidal zone. HDD will be used in construction, with the exit pits located just seaward of the MHWS mark. These activities, and associated cable laying across the intertidal zone, have the potential to impact remains which lie between the low and high water marks. Associated impacts from vessels or beach vehicles may also be incurred.

Neither of the new cables will cross or impact upon any known archaeological sites within this zone. However, evidence of wartime activity in the form of pillboxes has been identified along this section of the coast, with the nearest recorded pillbox located c. 150 m from the proposed cable routes, within the MASA (see Marine Archaeology Technical Report (MSDS Marine, 2023b)). Potential for associated wartime remains is present within the intertidal zone.

Additionally, potential for crashed aircraft has also been identified. This is particularly due to the use of Talacre Warren as a Spitfire training camp, with a number of Spitfires and other wartime military aircraft lost within the area. While no aircraft crash sites are currently recorded within the Eni Development Area or Area of Project Physical Works there is potential for such remains to be encountered.

The intertidal zone has currently not been surveyed using geophysical equipment. In line with the commitment to provide and review full coverage data prior to impacts occurring this should also take place within the intertidal zone. Archaeological assessment of this data will allow for a closer characterisation of potential and known sites within the intertidal zone, and mitigation should be recommended following these surveys and assessments, where required. This should seek to protect, or investigate, any newly identified sites, as appropriate according to the significance of the sites. Additionally, the embedded mitigation measure which indicates that archaeologists will be consulted in the preparation of pre-construction cable route clearance or other pre-construction operations and, if appropriate, to carry out archaeological monitoring of such work will also come into play, should sufficient potential be identified following the pre-construction surveys. This mitigation is presented within the Outline WSI.

The potential for unrecorded remains will also be mitigated through implementation of a protocol for reporting finds of archaeological interest. This PAD should be in place across the entire scheme, including during any intertidal works. Should any material be encountered the opportunity to protect or investigate the material will be afforded, in line with the protocol. Further details are set out within the Outline WSI.

Overall, the impact from intertidal cable laying is predicted to be localised in its spatial extent, though with any impacts permanent and irreversible. Following embedded mitigation, the magnitude of the impact is considered to be low.

Sensitivity of receptors

The value of coastal archaeological features including pillboxes and other wartime remains can be up to high: Scheduled and Listed examples exist within the UK, though designation does not occur in all cases and is specific to the historical, evidential, communal, and aesthetic value of each heritage asset. Nevertheless, heritage assets of this type can be up to high value. The value of aircraft has been discussed above, and potential for high value has been determined.

Neither type of asset has the ability to recover from direct physical impacts, and they are considered to be of high vulnerability to the impacts. Sensitivity is therefore considered to be high (though no such receptors are currently recorded within the Eni Development Area or Area of Project Physical Work).

Significance of effect

Overall, the magnitude of the impact is deemed to be low and the sensitivity of the potential receptors is considered to be high. Based on professional judgement and following implementation of embedded mitigation, it is considered that the effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

11.11.4 Alteration of sediment transport regimes

The presence of infrastructure on the seabed can obstruct flow in the water column and lead to localised changes in the sediment transport regimes. This has the potential to impact on marine archaeology within the Study Area and the immediate vicinity.

11.11.4.1 Construction, operation, maintenance and decommissioning phase

Magnitude of impact

The primary impacts associated with the alteration of sediment transport regimes will occur during the operation and maintenance phases. They include impacts which follow on from the construction of the new platform at Douglas using up to eight pile driven legs, and from the installation of cables and associated cable crossings. The PoA to Douglas cables would require up to 16 crossings (eight per cable), with a width of c. 5 m and total length of 1,600 m along each cable route; and up to ten crossings on two of the inter OP cables, with a width of c. 5 m at each area of cable protection and total length of 1,600 m per cable. The Douglas OP installation and areas of cable protection provide the largest obstruction to flow in the water column (other platforms are already constructed and will be reused). Additional changes may occur through use of jack up barges during all phases of the development. The changes to sediment transport regimes have the potential to bury known archaeological sites and to expose others and previously unknown sites.

The extent of the effects of the alteration to sediment transport regimes have not been modelled, but are not anticipated to be extensive. They are anticipated to be localised and focused around the infrastructure described above.

The impacts may lead to the exposure of new sites. The embedded mitigation includes implementation of a protocol for reporting finds of archaeological interest for the identification, recording and mitigation for new sites where appropriate.

The impact is predicted to be of local spatial extent, long term duration, continuous though with some reversibility (if sites are buried rather than eroded). It is predicted that the impact will affect the receptor indirectly. Following embedded mitigation, the magnitude is therefore considered to be negligible.

Sensitivity of the receptors

The primary potential impacts from this alteration would be to maritime archaeological remains, which are vulnerable to exposure or burial. The sensitivity of maritime and coastal remains has been discussed above. They have been found to be of varying value (up to high). These items are unable to adapt to, tolerate, or recover from the impact, except in the case of burial, and receptor sensitivity is therefore considered to be up to high.

Significance of effect

Overall, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be medium. Based on professional judgement it is considered that the effect will, therefore, be of **minor** significance, which is not significant in EIA terms. Additionally, while impacts from erosion would be adverse, burial may lead to a positive effect.

11.11.5 Change of use: effects on historic seascape character

The proposed development would involve the insertion of new infrastructure. The effects on the Historic Seascape Character (HSC) are therefore assessed.

11.11.5.1 Construction, operation, maintenance and decommissioning phase

Magnitude of impact

The development will primarily reuse existing infrastructure, and will add a new platform at Douglas OP, and new cables. These developments are in line with the character and location of the existing infrastructure, with the cables and platform situated within a few hundred meters of existing infrastructure. Likewise, operations and maintenance activities are likely to be in line with those which have characterised the area in its previous use as an oil and gas field. Decommissioning may lead to removal of some infrastructure, though again this is likely to be in line with previous conditions.

The assessment identified a variety of characteristics within the Eni Development Area and Area of Project Physical Work. These can be summarised as:

- modern installations and activities such as hydrocarbon wells, pipelines, submarine cables, aggregate extraction, spoil and waste dumping;
- a range of fishing methods used in the modern period;
- navigation routes, both modern and post medieval;
- wrecks and maritime debris (in some cases undated); and
- seabed types and characteristics including shoals and flats and fine sediment plains.

Overall, the proposed development would be in line with the modern installations already present within the area, though would form a new type of development (CCS). While the development type would be new it would not pose a significant change to the character of the area. Other activities including fishing, navigation and seabed character would remain substantially unchanged in terms of the character of the area. Potential impacts to wrecks have been mitigated through implementation of AEZs and thus no change to the character of these assets is anticipated. Therefore overall, it is considered that there would be no change to the HSC of the area. Further assessment is therefore not required.

11.12 Cumulative impact assessment

11.12.1 Methodology

The Cumulative Effects Assessment (CEA) takes into account the impact associated with the Project together with other projects and plans. The projects and plans selected as relevant to the CEA presented within this chapter are based upon the results of a screening exercise. Each project has been considered on a case-by-case basis for screening in or out of this chapter's assessment based upon data confidence, effect-receptor pathways and the spatial/temporal scales involved.

The marine archaeology CEA methodology has followed the methodology set out in volume 1, chapter 5. As part of the assessment, all projects and plans considered alongside the Proposed Development have been allocated into 'tiers' reflecting their current stage within the planning and development process, these are listed below.

Tier 1:

- Hilbre Swash Area 393;
- Burbo Bank Extension Offshore Wind Farm (OWF): Dredge disposal site and cable repair and remediation;
- Gwynt y Mor OWF, removal of met mast;
- Awel y Môr OWF;
- Prestatyn Coastal Defence; and
- MaresConnect Interconnector.

This tiered approach is adopted to provide a clear assessment of the Project alongside other projects, plans and activities. The specific projects, plans and activities scoped into the CEA, are outline in Table 11.16. They include projects with a temporal and geographic overlap with the Eni Development Area, Area of Physical Project Work or Study Area.

11.12.1.1 Maximum design scenario

The maximum design scenarios identified in Table 11.9 have been selected as those having the potential to result in the greatest effect on an identified receptor or receptor group. The cumulative effects presented and assessed in this section have been selected from the PDE provided in volume 2, chapter 14 as well as the information available on other projects and plans, in order to inform a 'maximum design scenario'. Effects of greater adverse significance are not predicted to arise should any other development scenario, based on details within the PDE, to that assessed here, be taken forward in the final design scheme.

Table 11.16: List Of Other Projects, Plans And Activities Considered Within The CEA

Project/ Plan	Status	Distance from Eni Development Area (km)	Description of project/plan	Licence start date	Licence end date	Overlap with Eni Project
Burbo Bank Extension OWF: Dredge disposal site	Open	0.5	Burbo Bank Extension Offshore Wind Farm (OWF): Dredge disposal site	Unknown	Unknown	Temporal (overlap with Eni HyNet construction and operation)
Burbo Bank Extension OWF: cable repair and remediation	Consented/Licensed	0.0	Burbo Bank Extension OWF: cable repair and remediation	20/07/2017	01/09/2027	Temporal (overlap with Eni HyNet construction)
Hilbre Swash Area 393	Unknown	0.0	Hilbre Swash Area 393	01/01/2014	01/01/2030	Temporal (overlap with Eni HyNet construction and operation)
Gwynt y Mor OWF, removal of met mast	Unknown	0.0	Gwynt y Mor OWF, removal of met mast	21/11/2022	30/11/2027	Temporal (overlap with Eni HyNet construction)
Awel y Môr OWF	Submitted	1.1	Awel y Môr OWF	01/01/2030	01/01/2055	Temporal (overlap with Eni HyNet construction and operation)
Prestatyn Coastal Defence	Consented/Licensed	2.0	Prestatyn Coastal Defence	31/07/2021	31/05/2025	Temporal (overlap with Eni HyNet construction)
MaresConnect Interconnector	Permitted	0.0	MaresConnect Interconnector	Unknown	Unknown	Temporal (overlap with Eni HyNet construction and operation)

Table 11.17: Maximum Design Scenario Considered For The Assessment Of Potential Cumulative Effects On Marine Archaeology

Potential cumulative effect	Phase C	Phase O	Phase D	Maximum Design Scenario	Justification
Direct damage to marine archaeology receptors (e.g. wrecks, debris, submerged prehistoric receptors (palaeolandscapes and associated archaeological receptors)	Y	Y	Y	Maximum design scenario as described for the Project (Table 11.9) assessed cumulatively with the following other projects/plans: • Burbo Bank Extension OWF: Dredge disposal site and cable repair and remediation; • Hilbre Swash Area 393; • Gwynt y Mor OWF removal of met mast; • Awel y Môr OWF; • Prestatyn Coastal Defence; and • MaresConnect Interconnector.	Maximum potential for culminative effects of direct damage to marine archaeology receptors.
Direct damage to coastal/ intertidal archaeological remains through cable installation at the landfall site	Y			There is no overlap between the landfall site and other developments and therefore no cumulative impacts are anticipated.	There is no overlap between the landfall site and other developments and therefore no cumulative impacts are anticipated. This element has therefore been scoped out of the CEA.
Sediment disturbance and deposition leading to indirect impacts on marine archaeology receptors (the exposure or burial of receptors).	Y	Y	Y	Maximum design scenario as described for the Project (Table 11.9) assessed cumulatively with the following other projects/plans: • Burbo Bank Extension OWF: Dredge disposal site and cable repair and remediation; • Hilbre Swash Area 393; • Gwynt y Mor OWF, removal of met mast; • Awel y Môr OWF; and • MaresConnect Interconnector.	Maximum potential for culminative effects of sediment disturbance and deposition leading to indirect effects on marine archaeology receptors.
Alteration of sediment transport regimes leading to potential erosion or burial of archaeological sites	Y	Y	Y	Maximum design scenario as described for the Project (Table 11.9) assessed cumulatively with the following other projects/plans: • Burbo Bank Extension OWF: Dredge disposal site and cable repair and remediation; • Hilbre Swash Area 393; • Gwynt y Mor OWF removal of met mast; • Awel y Môr OWF; • Prestatyn Coastal Defence; and • MaresConnect Interconnector.	Maximum potential for culminative effects of alteration of transport regimes to have indirect impacts on marine archaeology receptors.

11.12.2 Cumulative effects assessment

A description of the significance of cumulative effects upon marine archaeology receptors arising from each identified impact is given below.

11.12.2.1 Direct damage to maritime archaeology receptors (e.g. wrecks, debris, submerged prehistoric receptors (palaeolandscapes and associated archaeological receptors)

The Project, together with the projects and plans identified in Table 11.16, may result in direct damage to marine archaeology receptors. Other projects and plans screened into the assessment include:

- Aggregate extraction:
  - Hilbre Swash Area 393;
- Offshore Wind Farms:
  - Burbo Bank Extension OWF: Dredge disposal site and cable repair and remediation
  - Gwynt y Mor OWF, removal of met mast;
  - Awel y Môr OWF.
- Coastal Defences:
  - Prestatyn Coastal Defence.
- Interconnectors:
  - MaresConnect Interconnector.

Construction, operation, maintenance and decommissioning phases

Magnitude of impact

Where known, the status of the projects identified for inclusion of the CEA have been detailed in Table 11.16. The details indicate the following:

- Submitted:
  - The application for Awel y Môr OWF has been submitted, and it is possible therefore that construction, operation, maintenance and decommissioning phases will overlap with those of the HyNet Carbon Dioxide Transportation and Storage Project. In addition to temporal overlaps, the OWF also shares spatial overlaps with the Project. Impacts associated with this OWF are likely to include site preparation activities, construction of turbines using piled foundations, cable installation and installation of associated infrastructure. Operation and maintenance activities for OWFs typically includes scope for cable repair, replacement and remediation, in addition to cleaning and maintaining turbines and bases. Decommissioning may result in the removal of infrastructure.
- Permitted:
  - The MaresConnect Interconnector project has been permitted, and it is possible therefore that construction, operation, maintenance and decommissioning phases will overlap with those of the HyNet Carbon Dioxide Transportation and Storage Project. Impacts including site preparation works and cable installation has the potential to lead to a cumulative impact on marine archaeology receptors;
  - The cable repair and remediation for the Burbo Extension OWF Project has been permitted. It is possible therefore that these activities (considered under the operation and maintenance phase of the project) will overlap with those of the HyNet Carbon Dioxide Transportation and Storage

Project. Additionally, the Burbo Extension OWF export cable route also crosses the proposed Project cable route, indicating the potential for overlapping activities. The cable repair and remediation activities have the potential to lead to a cumulative impact on marine archaeology receptors; and

- The Prestatyn Coastal Defence project has been permitted, and it is possible therefore that construction, operation and maintenance phases of this project will overlap with those of the HyNet Carbon Dioxide Transportation and Storage Project. The preferred option for this development involves insertion of an earth embankment to protect the area of Prestatyn (around the golf course boundaries). This may result in works in the intertidal zone including site preparation activities and construction of the embankment, which have the potential to lead to a cumulative impact on marine archaeology receptors.

- Unknown: The status of the following projects is unknown, however, all have the potential to overlap with the Project, both temporally and spatially.
  - Burbo Bank Extension OWF Disposal Site;
  - Hilbre Swash Area 393; and
  - Gwynt y Mor OWF: Removal of met mast.

These activities have the potential to cumulatively, directly and permanently impact upon marine archaeology receptors on the seabed, including maritime remains, and those that lie concealed below the covering sands including potential submerged prehistoric landscapes. Direct impacts to receptors are most likely where there are overlapping spatial components of the projects (see Table 11.16). These activities also have the potential to expose previously unrecorded marine archaeology receptors. However, embedded mitigation has already been applied to avoid and mitigate impacts:

- As described in sections 11.10.1 AEZs and TAEZs will be established for any identified maritime archaeological receptors of high and medium significance, including all wrecks and potential wrecks, in addition to other remains. Additionally, where known, the AEZs implemented for other projects which are currently active have been applied to this Project. This is the case for example for MSDS_ E_054, which is an unnamed wreck falling within the boundaries of the Eni Development Area and Aggregate Area 393 (see Marine Archaeology Technical Report (MSDS Marine, 2023b)). The probability for direct damage to occur in association with the Project is therefore low.
- There will also be input into specifications for, and archaeological analysis of, any further pre-construction geophysical and geotechnical surveys. From the geotechnical perspective, geoarchaeological assessment will accompany planned geotechnical works. This will follow a staged process and accepted guidance. This is the mechanism for ensuring impacts to the submerged prehistoric landscape are understood and mitigated. From the geophysical perspective, there will be input into and review of geophysical survey data by an experienced marine archaeological geophysicist. New data will be collected ensuring full coverage of the Area of Project Physical Work prior to any seabed impacts. This includes collection and review of any data where micrositing of cables leads to re-routing through areas in which there is no data coverage. Additionally, due to re-routing around the designated area associated with the Protected Wreck *Resurgam*, the planned cable routes currently pass through an area in which full coverage data has not yet been assessed. This data is in collection and will be assessed prior to any seabed impacts. Further details will be set out within the Outline WSI.
- Unknown archaeological sites may also be impacted, however, following additional review of full coverage geophysical data and any additional mitigation following that review (e.g. implementation of new AEZs), and implementation of a protocol for reporting finds of archaeological interest (set out within the Outline WSI), the probability of impacting unknown sites is low.

The cumulative effect is predicted to be of local spatial extent, long term duration, and be irreversible. It is predicted that the impact will affect the receptor directly. However, followng the mitigation implemented for the Project, the magnitude is considered to be low.

Sensitivity of receptor

The sensitivity of the receptors including known wrecks and other maritime remains, potential palaeolandscape remains and submerged prehistoric sites, has been discussed in detail above (see section 11.11.1). The marine archaeology receptors are deemed to be of high vulnerability, low recoverability and of varying value, up to high value. The sensitivity of the receptors is therefore considered to be up to high.

Significance of effect

The measures adopted as part of the Project outlined in section 11.10 include measures to ensure avoidance of an archaeological receptors; mitigate impacts to the palaeolandscape through geoarchaeological analysis, and set out workflows that ensure any newly exposed archaeological assets are identified, recorded and protected or investigated as necessary.

Overall, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **minor** significance, which is not significant in EIA terms.

11.12.2.2 Sediment disturbance and deposition leading to indirect impacts on known archaeological receptors

Potential indirect effects upon marine archaeology receptors from sediment disturbance have been outlined in relation to the Project. Other projects and plans screened into the assessment include:

- Aggregate extraction:
  - Hilbre Swash Area 393;
- Offshore Wind Farms:
  - Burbo Bank Extension OWF: Dredge disposal site and cable repair and remediation;
  - Awel y Môr OWF.
- Interconnectors:
  - MaresConnect Interconnector.

Construction, operation, maintenance and decommissioning phases

Magnitude of impact

Where known, the status of the projects identified for inclusion of the CEA have been detailed in Table 11.16, along with project details. The effects on sediment disturbance vary between development types, and stages.

Offshore wind farms in construction may cause sediment disturbance through site preparations and cable installation. Those which have already been constructed and are in operations and maintenance phases may cause sediment disturbance through cable repair and replacement. Likewise, interconnectors (the MaresConnect Interconnector) have the potential to cause similar impacts, through site preparation and cable installation. Vessel anchoring and jack up use associated with the developments also has the potential to increase sediment disturbance. Decommissioning may also cause disturbance through the removal of infrastructure such as cables or turbines. Aggregate extraction is associated with dredging activities which cause sediment plumes and redeposition of sediment. These developments therefore have the potential to increase sediment disturbance and deposition leading to a culminative indirect impact on marine archaeology receptors.

As described for the Project, sediment disturbance and deposition has the potential to impact archaeological sites. As described in section 11.10, an Outline WSI and PAD accompanies this application, to inform the construction, operation, maintenance and decommissioning works and to facilitate the recording and reporting of any archaeological material discovered as a result of increased sediment disturbance which may lead to the exposure of new sites.

The cumulative effect is predicted to be of local spatial extent, short term duration (though impacts from sediment deposition may be longer term), intermittent and medium reversibility. It is predicted that the impact will affect the receptor indirectly. The magnitude is therefore, considered to be low.

Sensitivity of receptor

The sensitivity of the receptors including known wrecks and other maritime remains, potential palaeolandscape remains and submerged prehistoric sites, has been discussed in detail above (see section 11.11.1). The marine archaeology receptors are vulnerable sites that can be exposed further by disturbance activities. They have low recoverability and are of varying value, up to high value. The sensitivity of the receptors is therefore considered to be up to high.

Significance of effect

The measures adopted as part of the Project outlined in section 11.10 include measures to ensure that any newly exposed archaeological assets are recorded.

Overall, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

11.12.2.3 Alteration of sediment transport regimes

The Project, together with the projects and plans identified in Table 11.16 may result in alteration of transport regimes. During the operations and maintenance phase the presence of infrastructure may alter the sediment transport and sediment transport pathways leading to changes in the Project area. Other projects and plans screened into the assessment include:

- Aggregate extraction:
  - Hilbre Swash Area 393;
- Offshore Wind Farms:
  - Burbo Bank Extension OWF: Dredge disposal site and cable repair and remediation;
  - Awel y Môr OWF.
- Interconnectors:
  - MaresConnect Interconnector.

Operation and maintenance phases

Magnitude of impact

The operations and maintenance phase of the Project may coincide with the operations and maintenance phases of OWFs in the area, and those due for construction. Impacts from alterations to sediment transport regimes may arise from changes around the turbines, offshore export cables and protection, and cable repair or reburial activities (also likely for the MaresConnect Interconnector), any associated vessel anchor deployments or jack up use. Dredging operations may also take place, altering sediment transport regimes through the mobilisation of sediment into the water column while dredging activities take place.

The assessment set out in section 11.11.4 found that the impacts from the project would result in a negligible magnitude of impact, following embedded mitigation which includes implementation for reporting finds of archaeological interest for the identification, recording and mitigation for new sites where appropriate (should new sites be exposed by erosion). Impacts from the other developments assessed in this CEA are likely to be of a similar scale: with local spatial extent, long term duration, continuous though with some reversibility (if sites are buried rather than eroded). The impacts to receptors would be direct. Overall, the magnitude is considered to be low.

Sensitivity of receptor

The sensitivity of the receptors including known wrecks and other maritime remains, potential palaeolandscape remains and submerged prehistoric sites, has been discussed in detail above (see section 11.11.1). The marine archaeology receptors are vulnerable sites that can be exposed further by disturbance activities. They have low recoverability and are of varying value, up to high value. The sensitivity of the receptors is therefore considered to be up to high.

Significance of effect

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

11.12.3 Transboundary effects

A screening of transboundary impacts has been carried out and has identified that there was no potential for significant transboundary effects with regard to marine archaeology from the Project upon the interests of other states.

11.13 Conclusion

Information on marine archaeology within the Area of Project Physical Work, Eni Development Area and Study Area was collected through desktop review, site surveys and consultation.

Overall, it is concluded that there will be no significant effects arising from the Project during the construction, operations and maintenance or decommissioning phases. Table 11.18 presents a summary of the potential impacts, measures adopted as part of the project and residual effects in respect to marine archaeology. The impacts assessed include: sediment disturbance and deposition leading to indirect impacts on marine archaeology receptors; direct damage to marine archaeology receptors (e.g. wrecks, debris, submerged prehistoric receptors (palaeolandscapes and associated archaeological receptors); direct damage to coastal/intertidal archaeological remains through cable installation at the landfall site; alteration of sediment transport regimes; and change of use: effects on HSC.

The assessment also found that there will be no significant cumulative effects from the Project alongside other projects/plans. Table 11.19 presents a summary of the potential cumulative impacts, mitigation measures and residual effects. The cumulative impacts assessed include: sediment disturbance and deposition leading to indirect impacts on marine archaeology receptors; direct damage to marine archaeology receptors (e.g. wrecks, debris, submerged prehistoric receptors (palaeolandscapes and associated archaeological receptors); and alteration of sediment transport regimes.

No potential transboundary impacts have been identified in regard to effects of the Project.

Table 11.18: Summary Of Potential Environmental Effects, Mitigation And Monitoring

Potential effect	Phase			Measures adopted as part of the project	Magnitude of impact	Sensitivity of receptor	Significance of effect	Further mitigation	Residual effect	Proposed monitoring
Direct damage to marine archaeology receptors (e.g. wrecks, debris, submerged prehistoric receptors (palaeolandscapes and associated archaeological receptors)	Y	Y	Y	Establishment of AEZs and TAEZs; Additional data reviews and revised recommendations for AEZs; Re-routing and micrositing; Archaeological input into and assessment of geophysical and geotechnical investigations; Implementation of a protocol for reporting finds of archaeological interest for the identification, recording and mitigation for new sites where appropriate.	C: Low O: Low D: Low	C: High O: High D: High	C: Minor Adverse O: Minor Adverse D: Minor Adverse	N/A	C: Minor Adverse O: Minor Adverse D: Minor Adverse	N/A
Direct damage to coastal/intertidal archaeological remains through cable installation at the landfall site	Y			Additional data reviews to ensure archaeological assessment of full coverage geophysical data and revised recommendations for AEZs; Archaeologists will be consulted in the preparation of pre-construction cable route clearance or other pre-construction clearance operation and, if appropriate, to carry out archaeological monitoring of such work; Implementation of a protocol for reporting finds of archaeological interest for the identification, recording and mitigation for new sites where appropriate.	C: Low O: Low D: Low	C: High O: High D: High	C: Minor Adverse O: Minor Adverse D: Minor Adverse	N/A	C: Minor Adverse O: Minor Adverse D: Minor Adverse	N/A
Sediment disturbance and deposition leading to indirect impacts on marine archaeology	Y	Y	Y	Implementation of a protocol for reporting finds of archaeological interest for the identification, recording and mitigation for new sites where appropriate. Known sites of significance are protected by AEZs and TAEZs.	C: Low O: Low D: Low	C: High O: High D: High	C: Minor Adverse O: Minor Adverse D: Minor Adverse	N/A	C: Minor Adverse O: Minor Adverse D: Minor Adverse	N/A

Potential effect	Phase			Measures adopted as part of the project	Magnitude of impact	Sensitivity of receptor	Significance of effect	Further mitigation	Residual effect	Proposed monitoring
receptors (the exposure or burial of receptors).										
Alteration of sediment transport regimes leading to potential erosion or burial of archaeological sites		Y		Implementation of a protocol for reporting finds of archaeological interest for the identification, recording and mitigation for new sites where appropriate.	O: Negligible	O: High	O: Minor Adverse	N/A	O: Minor Adverse	N/A
Change of use: effects on Historic Seascape Character				No change identified.	No change.	-	-		-	

*C= Construction, O= Operation and Maintenance, D= Decommissioning

Table 11.19: Summary Of Potential Cumulative Environmental Effects, Mitigation And Monitoring

Potential cumulative effect	Phase			Measures adopted as part of the project	Magnitude of impact	Sensitivity of receptor	Significance of effect	Further mitigation	Residual effect	Proposed monitoring
Direct damage to marine archaeology receptors (e.g. wrecks, debris, submerged prehistoric receptors (palaeolandscapes and associated archaeological receptors)	Y	Y	Y	Establishment of AEZs and TAESz; Additional data reviews and revised recommendations for AEZs; Re-routing and micrositing; Archaeological input into and assessment of geophysical and geotechnical investigations; Implementation of a protocol for reporting finds of archaeological interest for the identification, recording and mitigation for new sites where appropriate.	C: Low O: Low D: Low	C: High O: High D: High	C: Minor Adverse O: Minor Adverse D: Minor Adverse	N/A	C: Minor Adverse O: Minor Adverse D: Minor Adverse	N/A
Direct damage to coastal/intertidal archaeological remains through cable installation at the landfall site	Y			Additional data reviews to ensure archaeological assessment of full coverage geophysical data and revised recommendations for AEZs; Archaeologists will be consulted in the preparation of pre-construction cable route clearance or other pre-construction clearance operation and, if appropriate, to carry out archaeological monitoring of such work; Implementation of a protocol for reporting finds of archaeological interest for the identification, recording and mitigation for new sites where appropriate.	C: Low O: Low D: Low	C: High O: High D: High	C: Minor Adverse O: Minor Adverse D: Minor Adverse	N/A	C: Minor Adverse O: Minor Adverse D: Minor Adverse	N/A
Sediment disturbance and deposition leading to indirect impacts on marine	Y	Y	Y	Implementation of a protocol for reporting finds of archaeological interest for the identification, recording and mitigation for new sites where appropriate.	C: Low O: Low D: Low	C: High O: High D: High	C: Minor Adverse O: Minor Adverse D: Minor Adverse	N/A	C: Minor Adverse O: Minor Adverse D: Minor Adverse	N/A

Potential cumulative effect	Phase			Measures adopted as part of the project	Magnitude of impact	Sensitivity of receptor	Significance of effect	Further mitigation	Residual effect	Proposed monitoring
archaeology receptors (the exposure or burial of receptors).										
Alteration of sediment transport regimes leading to potential erosion or burial of archaeological sites		Y		Implementation of a protocol for reporting finds of archaeological interest for the identification, recording and mitigation for new sites where appropriate.	O: Negligible	O: High	O: Minor Adverse	N/A	O: Minor Adverse	N/A

11.14 References

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Liverpool Bay CCS Ltd
HYNET CARBON DIOXIDE TRANSPORTATION AND STORAGE PROJECT - OFFSHORE

Environmental Statement
Volume 2, chapter 12: Infrastructure and Other Sea Users

EHE7228B
Liverpool Bay CCS Limited
Final
February 2024
Offshore ES
Infrastructure and Other Sea Users

Glossary

Term	Meaning
Environmental Impact Assessment	A statutory process by which certain planned projects must be assessed before a formal decision to proceed can be made. It involves the collection and consideration of environmental information, which fulfils the assessment requirements of the EIA Directive and EIA Regulations, including the publication of an Environmental Impact Assessment (EIA) Report.
Magnitude	Size, extent and duration of an impact.
Maximum Design Scenario	The maximum design parameters of each Proposed Development asset (both on and offshore) considered to be a worst case for any given assessment but within the range of the Project Description Envelope.
Mitigation Measure	Measure which would avoid, reduce, or remediate an impact
Project	The HyNet Carbon Dioxide Transportation and Storage Project.
Project Design Envelope (PDE)	Also known as the Rochdale Envelope, the PDE concept is routinely utilised in both onshore and offshore planning applications to allow for some flexibility in design options, particularly offshore, and more particularly for foundations and turbine type, where the full details of the project are not known at application submission but where sufficient detail is available to enable all environmental impacts to be appropriately considered during the EIA.
Proposed Development	The offshore components of the Project which are subject of this Environmental Statement, as described in volume 1, chapter 3.
The Applicant	This is Liverpool Bay CCS Ltd.

Acronyms and Initialisations

Acronym/Initialisation	Description
AIS	Automatic Identification System
CCS	Carbon Capture and Storage
CEA	Cumulative Effects Assessment
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CSIP	Cable Specification and Installation Plan
CTV	Crew Transfer Vessel
EIA	Environmental Impact Assessment
ES	Environmental Statement
ESCA	European Subsea Cables UK Association
EMODnet	European Marine Observation and Data Network
HDD	Horizontal Directional Drilling
HRA	Habitats Regulations Appraisal
ICPC	International Cable Protection Committee
KIS-ORCA	Kingfisher Information Service – Offshore Renewables and Cable Awareness
MDS	Maximum Design Scenario
MHWS	Mean High Water Springs
NRA	Navigational Risk Assessment
NSTA	North Sea Transition Authority
OP	Offshore Platform
PDE	Project Design Envelope
PEXA	Military Practice and Exercise Areas
RIAA	Report to Inform Appropriate Assessment

Acronym/Initialisation	Description
RYA	Royal Yachting Association
SSC	Suspended Sediment Concentration
TCE	The Crown Estate
UKHO	United Kingdom Hydrographic Office

Units

Unit	Description
%	Percent
km	Kilometres
km^2	Kilometres squared
m	Metres (distance)
m^2	Metres squared (area)
m^3	Metres cubed (volume)
MW	Megawatt

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12 INFRASTRUCTURE AND OTHER SEA USERS

12.1 Introduction

This chapter of the Offshore Environmental Statement (ES) presents the assessment of the likely significant effects (as per the 'EIA Regulations') on the environment of the Proposed Development on infrastructure and other sea users. Specifically, this chapter considers the potential impacts from the construction, operation and maintenance, and decommissioning of the offshore and intertidal components (seaward of the Mean High Water Springs (MHWS) mark) of the development area, which includes the pipelines and cables leading to MHWS.

Likely significant effect is a term used in both the 'EIA Regulations' and the Habitat Regulations. Reference to likely significant effect in this Offshore ES refers to 'likely significant effect' as used by the 'EIA Regulations'. This Offshore ES is accompanied by a Report to Inform Appropriate Assessment (RIAA) which uses the term as defined by the Habitats Regulations Appraisal (HRA) Regulations.

12.2 Purpose of this chapter

The primary purpose of the Offshore ES is outlined in volume 1, chapter 1. It is intended that the Offshore ES will provide the statutory and non-statutory stakeholders, with sufficient information to determine the likely significant effects of the Proposed Development on the receiving environment. In particular, this Infrastructure and Other Sea Users ES chapter:

- presents the existing environmental baseline established from desk studies and consultation;
- identifies any assumptions and limitations encountered in compiling the environmental information;
- presents the potential environmental effects on infrastructure and other sea users arising from the Proposed Development, based on the information gathered and the analysis and assessments undertaken; and
- highlights any necessary monitoring and/or mitigation measures which could prevent, minimise, reduce, or offset the possible environmental effects of the Proposed Development on infrastructure and other sea users.

12.3 Study area

The infrastructure and other sea users study area varies in scale depending on the receptor. Two study areas have been defined for the assessment of two different groupings of receptors. These are the infrastructure and other sea users regional study area (1,579.2 km^2), and the infrastructure and other sea users local study area (205.0 km^2), as shown in Figure 12.1.

The infrastructure and other sea users local study area is defined as a 1 km buffer around the Proposed Development infrastructure. A 1 km buffer has been included because while undergoing maintenance, oil and gas infrastructure, cables and pipelines, and offshore wind farm structures will require a 500 m safety zone, or advisory clearance distance. This area includes the extent of potential direct physical overlap between activities associated with the Proposed Development and the following receptors:

- recreational activities including, sailing and motor cruising, and recreational fishing;
- offshore energy projects (including offshore wind farms, oil and gas activities and carbon capture and storage);
- cable and pipeline operators; and
- offshore microwave fixed communication links.

The infrastructure and other sea users regional study area represents one tidal excursion from any Proposed Development infrastructure, as this will be the furthest extent any sediment disturbed by activities associated with the Proposed Development will be carried to. This study area is relevant to those receptors which are susceptible to increases in Suspended Sediment Concentrations (SSCs):

- aggregate extraction and disposal sites; and
- recreational activities such as scuba diving and bathing.

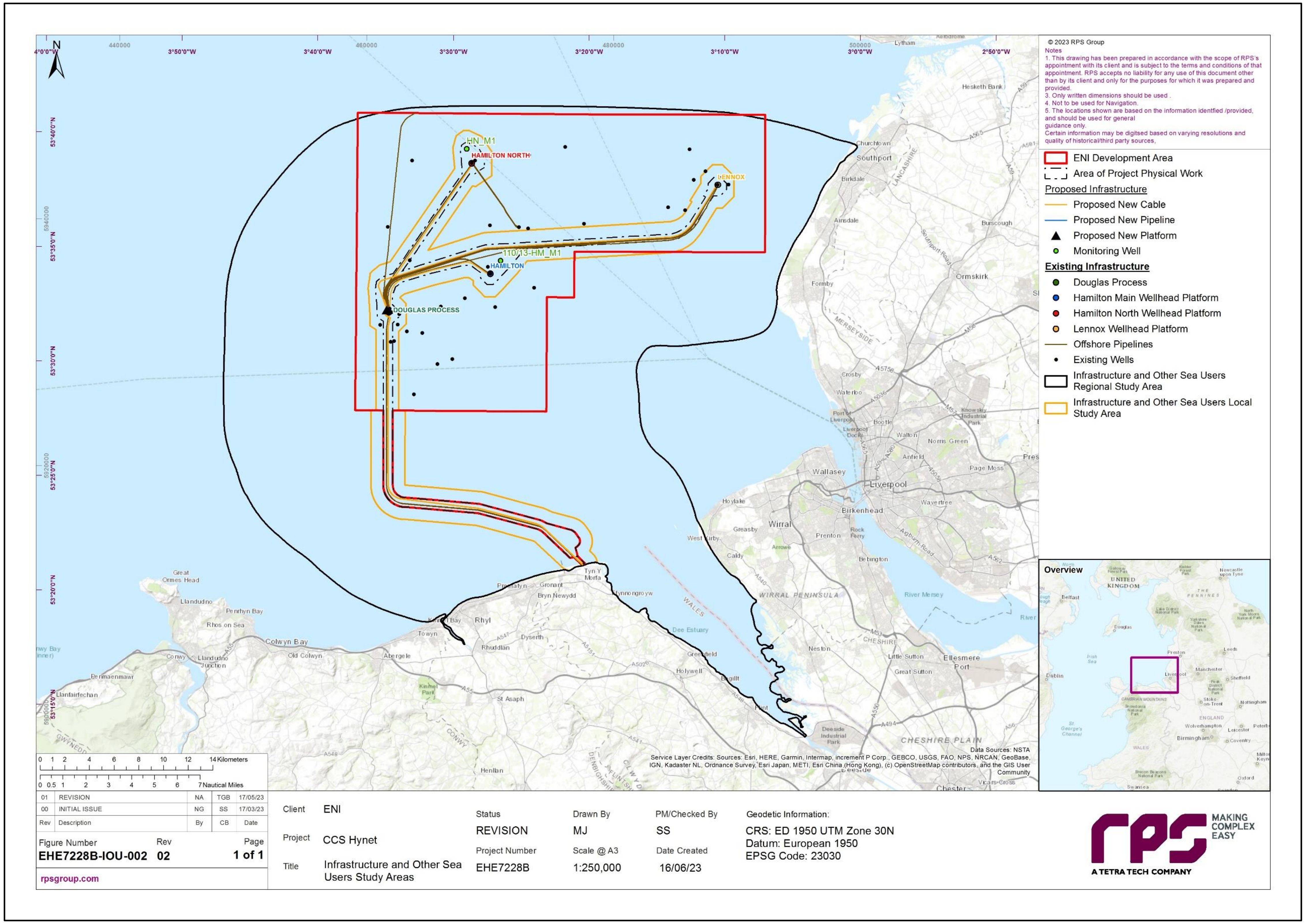

Figure 12.1: The Infrastructure And Other Sea Users Study Areas

12.4 Policy and legislative context

The policy context for the Proposed Development is set out in volume 1, chapter 2. Specific policy relevant to infrastructure and other sea users is laid out below.

12.4.1 Marine plans

The assessment of potential changes to other sea users has also been made with consideration to the specific policies set out in the North West Inshore and North West Offshore Coast Marine Plans (MMO, 2021) and Welsh National Marine Plan (WNMP) (Welsh Government, 2019). Key provisions are set out in Table 12.1 along with details as to how these have been addressed within the assessment.

Table 12.1: Summary Of Inshore And Offshore Marine Plan Policies Of Relevance To Infrastructure And Other Sea Users

Policy	Key provisions	How and where considered
North West Inshore and North West Offshore Coast Marine Plan		
NW-AGG-1	Proposals in areas where a licence for extraction of aggregates has been granted or formally applied for should not be authorised, unless it is demonstrated that the proposal is compatible with aggregate extraction.	Figure 12.2 shows potential overlap between the Proposed Development and marine aggregate extraction sites. Measures adopted as part of the Proposed Development (with relevance to infrastructure and other sea users) are contained in section 12.10, and an assessment of impacts is contained in section 12.11.
NW-CO-1	Proposals that may have significant adverse impacts on, or displace, existing activities must demonstrate that they will, in order of preference: Avoid Minimise Mitigate adverse impacts so they are no longer significant. If it is not possible to mitigate significant adverse impacts, proposals must state the case for proceeding.	Measures adopted as part of the Proposed Development (with relevance to other sea users) are contained in section 12.10, and an assessment of impacts is contained in section 12.11.
NW-CAB-1	Preference should be given to proposals for cable installation where the method of protection is burial. Where burial is not achievable, decisions should take account of protection measures for the cable that may be proposed by the applicant. Where burial or protection measures are not appropriate, proposals should state the case for proceeding without those measures.	Cable burial is one of the measures adopted as part of the Proposed Development listed in section 12.10.
NW-CAB-3	Where seeking to locate close to existing subsea cables, proposals should demonstrate compatibility with ongoing function, maintenance and decommissioning activities relating to the cable.	Cable crossing and proximity agreements are measures adopted as part of the Proposed Development listed in section 12.10.
NW-OG-1	Proposals in areas where a licence for oil and gas has been granted or formally applied for should not be authorised unless it is demonstrated that the other development or activity is compatible with the oil and gas activity.	Impacts upon oil and gas licence blocks are considered within section 12.11.6.

Policy	Key provisions	How and where considered
Welsh National Marine Plan		
SAF_01	Proposals likely to have significant adverse impacts upon an established activity covered by a formal application or authorisation must demonstrate how they will address compatibility issues with that activity. Proposals unable to demonstrate adequate compatibility must present a clear and convincing case for the proposal to progress under exceptional circumstances. Proposals likely to have significant adverse impacts upon an established activity not subject to a formal authorisation must demonstrate how they will address compatibility issues with that activity. Proposals unable to demonstrate adequate compatibility must present a clear and convincing case for proceeding.	This chapter covers established activities such as aggregate extraction and disposal, infrastructure, and recreational activities. Impacts on these activities are assessed in section 12.11. Measures adopted as part of the Proposed Development to reduce and/or avoid adverse impacts are presented in section 12.10.

12.5 Consultation

A summary of the key issues raised during consultation activities undertaken to date specific to infrastructure and other sea users is presented in Table 12.2 below, together with how these issues have been considered in the production of this chapter.

Table 12.2: Summary Of Key Consultation Issues Raised During Consultation Activities Undertaken For The Proposed Development Relevant To Infrastructure And Other Sea Users

Date	Consultee and type of response	Issues raised	Response to issue raised and/or were considered in this chapter
January 2023	OPRED - Scoping opinion	It is advised that nearshore works are undertaken outside of the Bathing Season (15th May to 30th September) to avoid risks to bathers associated with contaminant releases.	Noted and programme will take this into consideration where operationally practicable.

12.6 Methodology to inform the baseline

12.6.1 Desktop study

Information on infrastructure and other sea users within the infrastructure and other sea users study areas was collected through a detailed desktop review of existing studies and datasets. These are summarised in Table 12.3 below.

Table 12.3: Summary Of Key Desktop Reports

Title	Source	Year	Author
Cable routes	Kingfisher Information Service – Offshore Renewables and Cable Awareness (KIS-ORCA)	2021	KIS-ORCA
Disposal sites	European Marine Observation and Data Network (EMODnet)	2015	EMODnet
Offshore wind farms	The Crown Estate (TCE)	2022	TCE
Aggregate extraction areas	TCE	2022	TCE
Pipelines	North Sea Transition Authority (NSTA)	2022	NSTA
Wells	NSTA	2022	NSTA
Hydrocarbon platforms	NSTA	2022	NSTA
Subsurface structures	NSTA	2022	NSTA
Hydrocarbon fields	NSTA	2022	NSTA
Oil and gas licence blocks	NSTA	2022	NSTA
United Kingdom Continental Shelf (UKCS) block	NSTA	2022	NSTA
Marinas	UK Coastal Atlas of Recreational Boating	2018	Royal Yachting Association (RYA)
Recreational activities	UK Coastal Atlas of Recreational Boating	2018	RYA
RYA clubs	UK Coastal Atlas of Recreational Boating	2018	RYA
RYA training centres	UK Coastal Atlas of Recreational Boating	2018	RYA
General boating areas	UK Coastal Atlas of Recreational Boating	2018	RYA
Data from marine vessel traffic surveys	MarineTraffic	2019	MarineTraffic
Wrecks (diving sites)	UK Diving	2010	UK Diving
Communication links	Ofcom	2019	Ofcom
Recreational fishing	Centre for Environment, Fisheries and Aquaculture Science (Cefas) British Sea Fishing	2021 2020	Cefas British Sea Fishing

No site-specific surveys have been undertaken to provide information for infrastructure and other sea users. This is because a sufficient amount of information is already available (Table 12.3). The majority of the data used to inform this chapter has been taken from these desktop studies. Survey data from 2019 MarineTraffic surveys has been incorporated in the form of Automatic Identification System (AIS) tracks for recreational vessels (Figure 12.3).

12.7 Baseline environment by study area

12.7.1 Infrastructure and other sea users regional study area

Other sea users receptors within the infrastructure and other sea users regional study area include:

- Marine aggregate extraction sites.
- Marine disposal sites.
- Marine recreational dive sites.

The baseline environment for these receptors is described below.

12.7.1.1 Marine aggregate extraction sites

As per Figure 12.2, there are two open licensed marine aggregate extraction sites within the infrastructure and other sea users regional study area:

- Liverpool Bay Area 457, operated by Westminster Gravels Ltd, located north of the Douglas Process Platform (also within the infrastructure and other sea users local study area).
- Hilbre Swash 393, owned by Mersey Sand Suppliers, located southwest of the Douglas Process Platform.

Dredger routes are considered within volume 2, chapter 10.

12.7.1.2 Marine aggregate disposal sites

As per Figure 12.2, there are six closed, one disused and two open licensed marine aggregate disposal areas within the infrastructure and other sea users regional study area. The two open sites are:

- Site Y (IS150), which is also within the infrastructure and other sea users local study area.
- Site Z (IS140).

Only marine sediment dredged from dock sites and navigation channels and small amounts of fish waste are permitted to be disposed of at sea, with industrial waste banned since 1992 and sewage sludge since 1998 (Cefas, 2009).

12.7.1.3 Recreational dive sites

There are six wreck diving sites within the infrastructure and other sea users regional study area (Figure 12.3).

12.7.1.4 Recreational bathing sites

There are eight recreational bathing sites within the infrastructure and other sea users regional study area (Figure 12.3).

12.7.1.5 Military Practice and Exercise Areas

Military Practice and Exercise Areas (PEXAs) are areas available for training use primarily by the UK armed forces but also those of overseas nations. There are no PEXAs located within other sea users regional study area and consequently there will be no direct obstruction created to activities conducted in PEXAs.

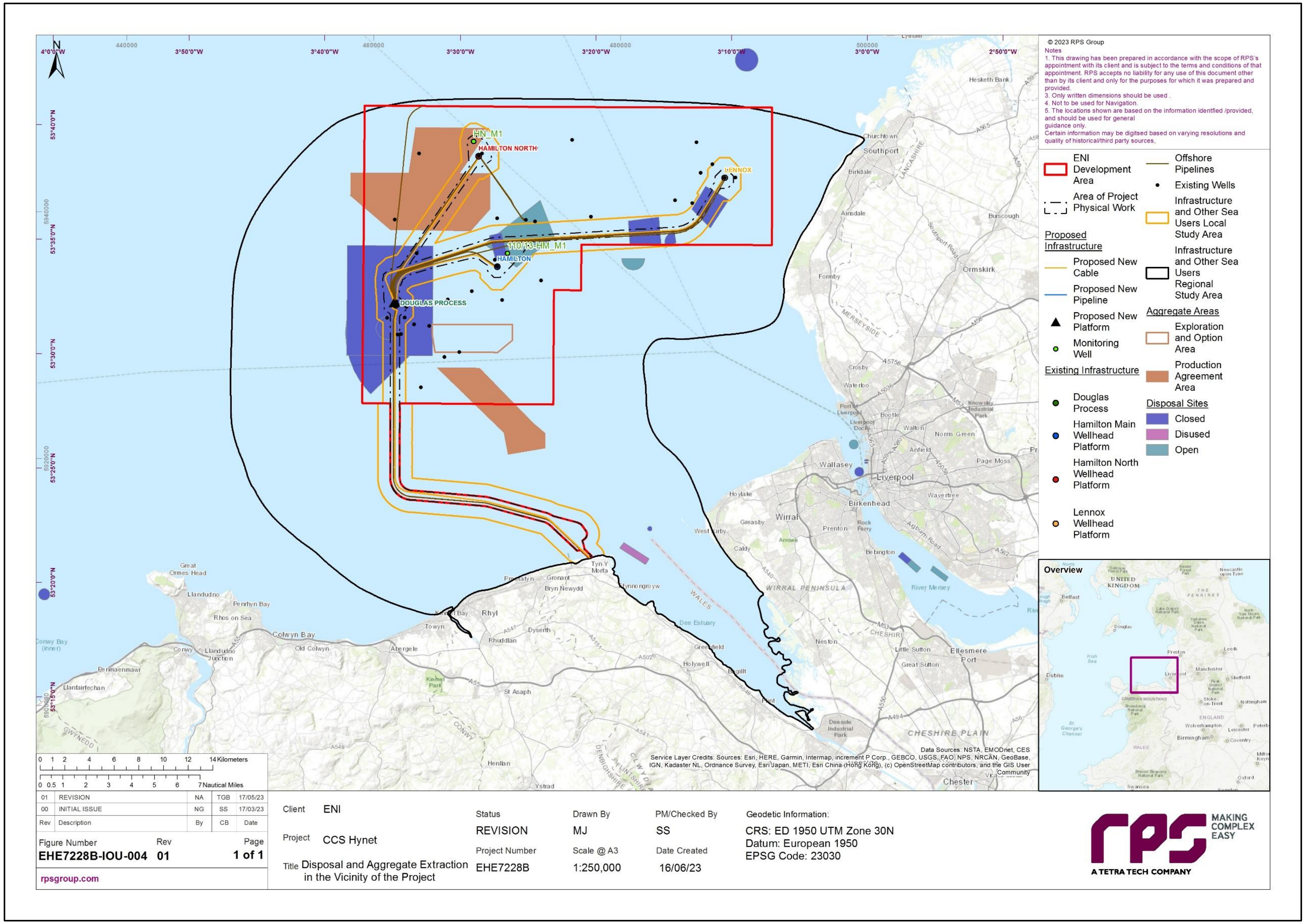

Figure 12.2: Marine Aggregate Extraction And Disposal Sites In The Vicinity Of The Proposed Development

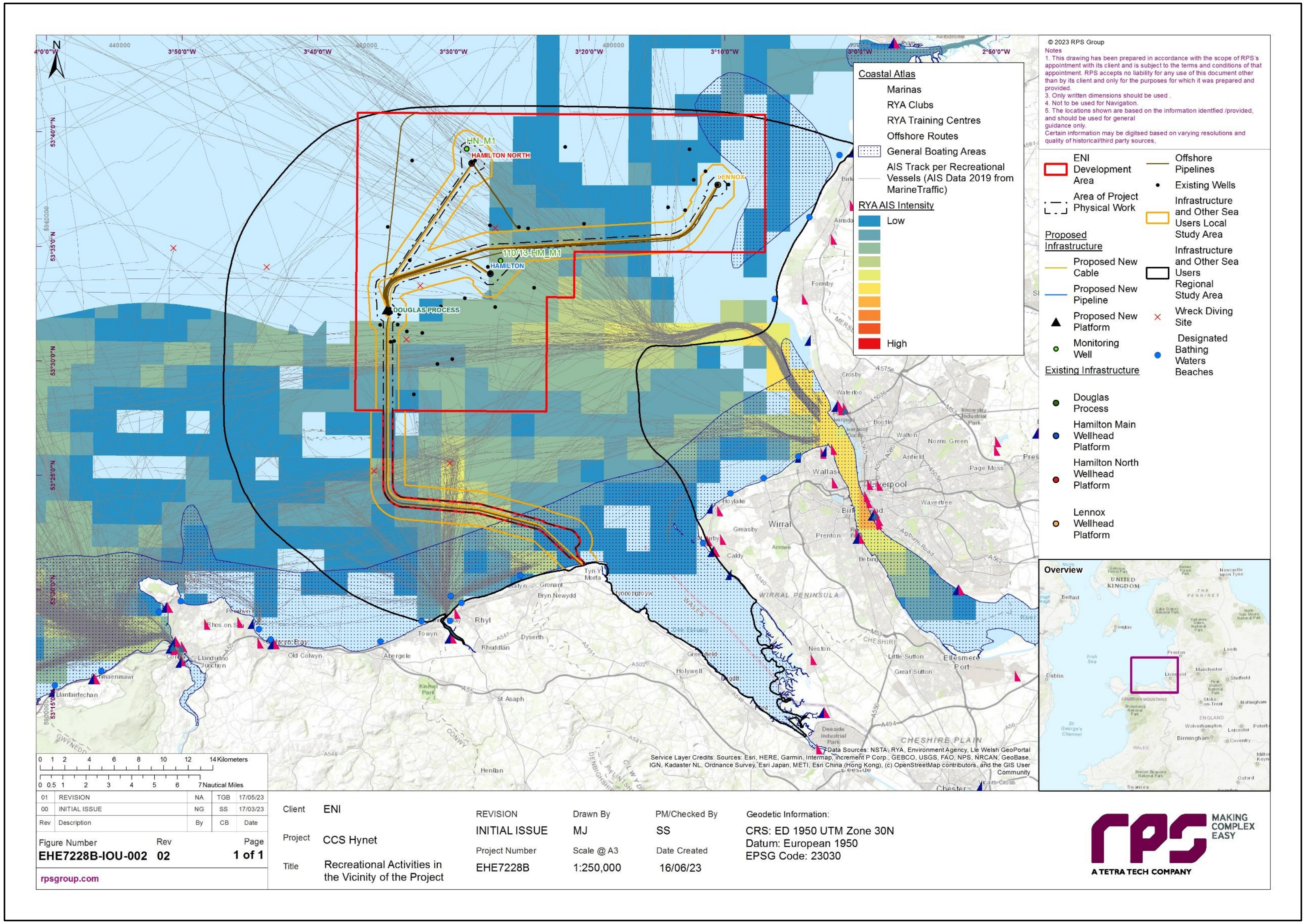

Figure 12.3: Recreational Activities In The Vicinity Of The Proposed Development

12.7.2 Infrastructure and other sea users local study area

Other sea users receptors within the infrastructure and other sea users local study area include:

- Offshore energy projects (including offshore wind farms, oil and gas activities and carbon capture and storage).
- Cable and pipeline operators.
- Offshore microwave fixed communication links.
- Recreational activities such as sailing and motor cruising, and recreational fishing.

The baseline environment for these receptors is described below.

12.7.2.1 Recreational sailing and motor cruising

Recreational sailing is generally divided into two categories: offshore and inshore. Offshore sailing is usually undertaken by yachts in the form of either cruising or organised offshore racing. Cruising may include day trips between local ports and often includes a return journey to the home port on the same day.

Navigational safety and risk to recreational vessels is considered in Navigational Risk Assessment (the NRA) (Anatec Limited and RPS Group, 2023). The other sea users chapter will only consider receptors undertaking recreational sailing and motor cruising as an activity.

The RYA data is limited to inshore waters, but AIS data tracks show that recreational vessels transit through offshore waters within the infrastructure and other sea users local study area. There is medium to low recreational activity over the majority of the infrastructure and other sea users local study area.

12.7.2.2 Recreational fishing

Sea fishing trips run from Conwy, North Wales and specialise in wreck fishing, deep sea fishing and reef fishing from Anglesey to Liverpool Bay (Sea Fishing Trips in North Wales, 2022). Sea fishing trips also operate from the Isle of Man (Manx Sea Fishing, 2022) and Fleetwood, Lancashire (Blue Mink Boat Charters, 2022) amongst other ports along the coasts of the east Irish Sea.

12.7.3 Infrastructure

12.7.3.1 Offshore wind farms

There are a number of proposed and operational offshore wind farms in the east Irish Sea, the closest of which are shown in Figure 12.4. There is spatial overlap between a number of proposed or operational wind farms and the infrastructure and other sea users local study area as shown in Table 12.4 .

Four bidding areas for leasing under TCE Offshore Wind Leasing Round 4 were released in September 2019, three of which are located in the Irish Sea; The Morgan Offshore Wind Project (being developed by bp/EnBW), the Mona Offshore Wind Project (being developed by bp/EnBW) and the Morecambe Offshore Windfarm (being developed by Offshore Wind Ltd, a joint venture between Cobra Instalaciones y Servicios, S.A. and Flotation Energy).

Within Isle of Man territorial waters, Ørsted has signed an Agreement for Lease allowing them to investigate an area for a proposed offshore wind farm.

More information on the other offshore wind farms in the east Irish Sea is contained in Table 12.4.

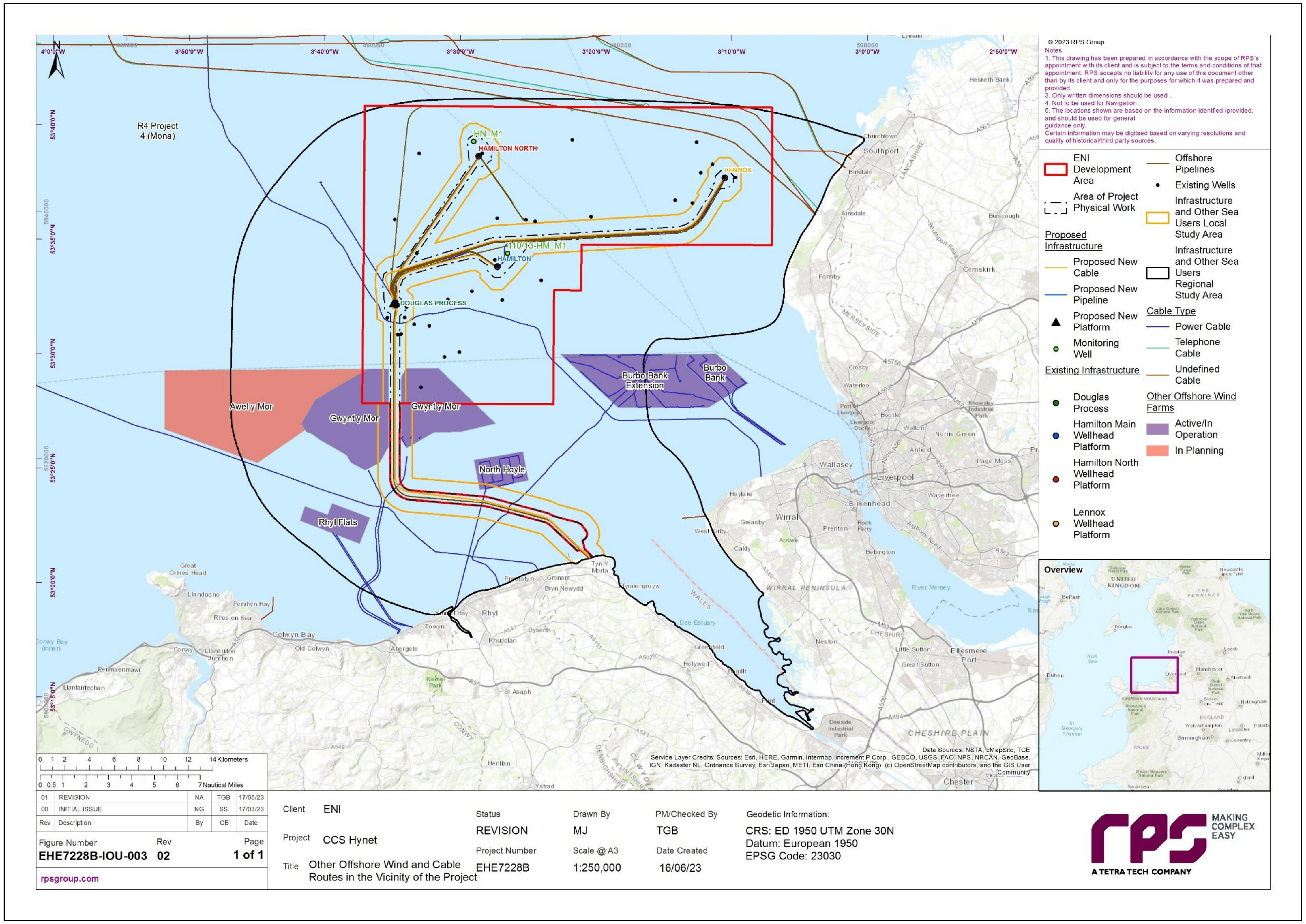

Figure 12.4: Offshore Wind Farms And Cables In The Vicinity Of The Proposed Development

Table 12.4: Offshore Wind Farms In The East Irish Sea

Name	Capacity (MW)	Operator	Distance to other sea users local study area (km)
Operational			
Gwynt y Môr	576	Innogy	0.00
Burbo Bank Extension	259	Ørsted	0.50
North Hoyle	60	RWE npower renewables	3.90
Rhyl Flats	90	RWE Renewables	8.50
Burbo Bank	90	Ørsted	10.20
West of Duddon Sands	389	Ørsted	29.00
Barrow	90	Barrow Offshore Wind Ltd.	34.00
Walney Extension (3 and 4)	659	Ørsted	35.40
Walney 1	184	Walney (UK) Offshore Windfarms Ltd.	37.20
Walney 2	184	Walney (UK) Offshore Windfarms Ltd.	39.80
Ormonde	150	Ormonde Energy Ltd.	44.70
Round 4 projects			
Mona Offshore Wind Project	1,500	bp/EnBW	5.50
Morecambe Offshore Windfarm	480	Offshore Wind Ltd.	7.60
Morgan Offshore Wind Project	1,500	bp/EnBW	34.10
Proposed			
Awel y Môr	1,100	Innogy	0.00
Isle of Man Wind Farm	TBC	Ørsted	56.90

12.7.3.2 Cables

There are four power cables (not owned by the Applicant) which intersect the infrastructure and other sea users local study area (shown in Figure 12.4);

- Western HVDC link, operated by National Grid and Scottish Power.
- Gwynt y Môr offshore wind farm export cable, operated by Innogy.
- North Hoyle offshore wind farm export cable, operated by RWE npower renewables.
- Burbo Bank Extension offshore wind farm export cable, operated by Ørsted.

There are no pipelines not operated by the Applicant intersecting the infrastructure and other sea users local study area.

12.7.3.3 Oil and gas licence blocks

Licences for the exploration and extraction of oil and gas on the United Kingdom Continental Shelf (UKCS) have been offered since 1964 and are granted by the North Sea Transition Authority (NSTA). These licences are granted for identified geographical United Kingdom Hydrographic Office (UKHO) areas (blocks and sub-blocks) in consecutive rounds. As shown in Figure 12.5, five currently licensed blocks overlap with the infrastructure and other sea users local study area. These are blocks 110/13b, 11013a, 110/15a (all operated by the Applicant) and blocks 110/14a and 110/14c (both operated by Chrysaor Resources (Irish Sea) Limited (part of Harbour Energy)).

It should be noted that on 07 October 2022 the NSTA launched the 33rd Oil and Gas Licensing Round, inviting applications for licences to explore and potentially develop 898 blocks and part-blocks, which may lead to over 100 licences being awarded. At the time of writing awards from this licensing round have not been announced as such are not considered further in this chapter.

12.7.3.4 Oil and gas platforms and pipelines

Figure 12.6 shows offshore oil and gas installations and pipelines in the vicinity of the Proposed Development. There are four platforms within the infrastructure and other sea users local study area:

- Douglas Process Platform, operated by the Applicant.
- Hamilton North Wellhead Platform, operated by the Applicant.
- Hamilton Main Wellhead Platform, operated by the Applicant.
- Lennox Wellhead Platform, operated by the Applicant.

The wellhead platforms are connected by existing pipelines that tie back to the Douglas Process Platform and then via the HyNet Offshore Cable Corridor to a natural gas processing plant at Point of Ayr.

12.7.4 Future baseline scenario

The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 require that '*an outline of the likely evolution thereof without implementation of the development as far as natural changes from the baseline scenario can be assessed with reasonable effort on the basis of the availability of environmental information and scientific knowledge*' is included within an ES. In the event that the Proposed Development does not come forward, an assessment of the future baseline conditions has been carried out and is described within this section.

The future baseline scenario for recreational activities is considered unlikely to change substantially from that presented in section 12.4, in the absence of the Proposed Development. The future baseline scenario for offshore cables and marine aggregates is subject to gradual change as new projects and sites are identified. The future baseline scenario for oil and gas activities and associated development (including platforms, wells, and pipelines) is considered to be subject to the greatest degree of change, which will depend upon currently unknown outcomes of, for example, acquisitions, exploration and development, and decommissioning.

12.7.5 Data limitations

The data sources used in this chapter are detailed in Table 12.3. The data used is the most up to date publicly available information which can be obtained from the applicable data sources as cited. The data is therefore limited by what is available and by what has been made available at the time of writing this chapter.

Given the level of activity in the east Irish Sea, it is considered that the data employed in the assessment is of a robust nature and is sufficient for the purposes of the impact assessment presented.

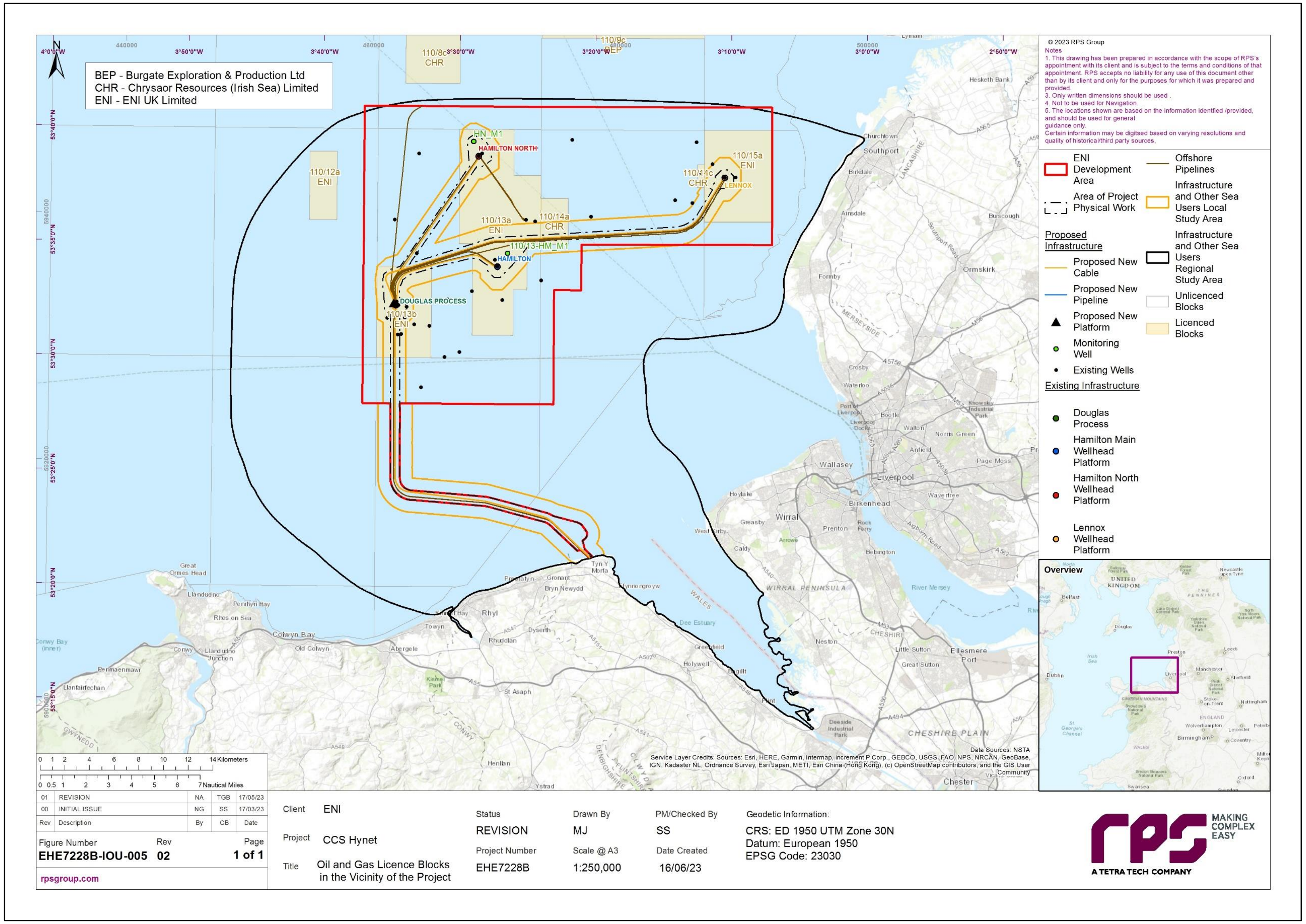

Figure 12.5: Oil And Gas Licence Blocks In The Vicinity Of The Proposed Development

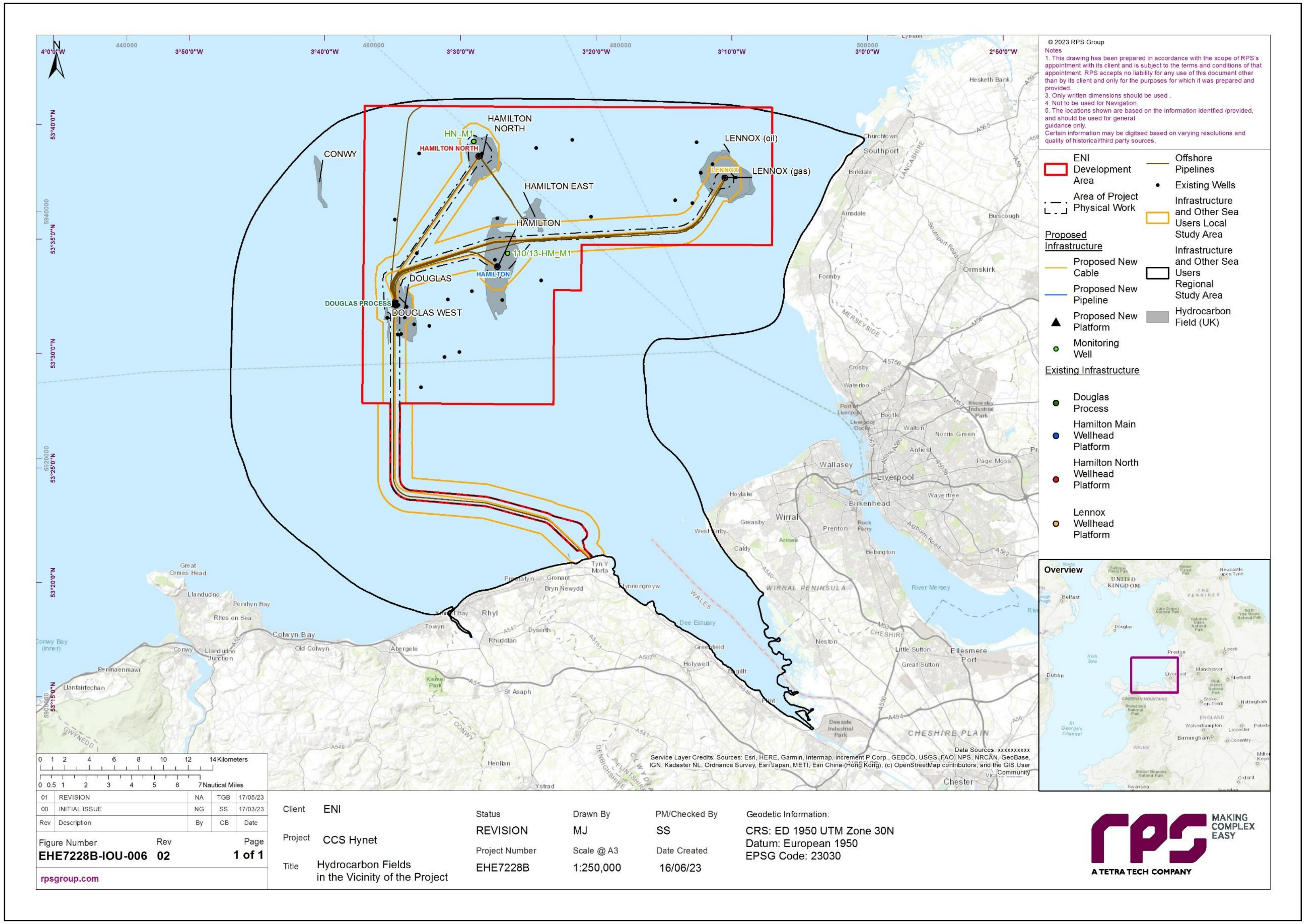

Figure 12.6: Offshore Oil And Gas Platforms, Installations, And Pipelines In The Vicinity Of The Proposed Development

12.8 Impact assessment methodology

12.8.1 Overview

The other sea users impact assessment has followed the methodology set out in volume 1, chapter 5. Specific to the other sea users impact assessment, the following guidance documents have also been considered:

- The Royal Yachting Association's (RYA) position on offshore renewable energy developments: Paper 1 (of 4) – Wind Energy, June 2019 (RYA, 2019).
- European Subsea Cables UK Association (ESCA) guideline no 6, the proximity of offshore renewable energy installations and submarine cable infrastructure in UK waters (ESCA, 2016).
- International Cable Protection Committee (ICPC) recommendations:
  - Recommendation No.2-11B: Cable routing and reporting criteria (ICPC, 2015).
  - Recommendation No.3-10C: Telecommunications cable and oil pipeline/power cables crossing criteria (ICPC, 2014).
- Pipeline crossing agreement and proximity agreement pack (Oil and Gas UK, 2021).
- Submarine cables and offshore renewable energy installations proximity study (TCE, 2012).

12.8.2 Impact assessment criteria

The criteria for determining the significance of effects is a two-stage process that involves defining the magnitude of the impacts and the sensitivity of the receptors. This section describes the criteria applied in this chapter to assign values to the magnitude of potential impacts and the sensitivity of the receptors. The terms used to define magnitude and sensitivity are based on those which are described in further detail in volume 2, chapter 5.

The criteria for defining magnitude in this chapter are outlined in Table 12.5 below.

Table 12.5: Definition Of Terms Relating To The Magnitude Of An Impact

Magnitude	Definition
High	Loss of resource and/or quality and integrity of resource; severe damage to key characteristics, features or elements (Adverse)
	Large scale or major improvement or resource quality; extensive restoration or enhancement; major improvement of attribute quality (Beneficial)
Medium	Loss of resource, but not adversely affecting integrity of resource; partial loss of/damage to key characteristics, features or elements (Adverse)
	Benefit to, or addition of, key characteristics, features or elements; improvement of attribute quality (Beneficial)
Low	Some measurable change in attributes, quality or vulnerability, minor loss or, or alteration to, one (maybe more) key characteristics, features or elements (Adverse)
	Minor benefit to, or addition of, one (maybe more) key characteristics, features or elements; some beneficial impact on attribute or a reduced risk of negative impact occurring (Beneficial)
Negligible	Very minor loss or detrimental alteration to one or more characteristics, features or elements (Adverse)
	Very minor benefit to, or positive addition of one or more characteristics, features or elements (Beneficial)
No change	No loss or alteration of characteristics, features or elements; no observable impact either adverse or beneficial

The criteria for defining sensitivity in this chapter are outlined in Table 12.6.

Table 12.6: Definition Of Terms Relating To The Sensitivity Of The Receptor

Sensitivity	Definition
Very High	High value/importance and vulnerability and limited potential for recoverability for recreational activities, cable/pipeline activities, aggregate extraction or oil and gas operations resulting from: • Very low spatial adaptability due to extent of operational range and/or limited ability to operate in other areas • Very low spatial tolerance due to dependence upon a limited number of sites • Very low recoverability with some ability to mitigate loss of area by operating in alternative areas.
High	High value/importance and vulnerability and limited potential for recoverability for recreational activities, cable/pipeline activities, aggregate extraction or oil and gas operations resulting from: • Low spatial adaptability due to extent of operational range and/or limited ability to operate in other areas • Low spatial tolerance due to dependence upon a limited number of sites • Low recoverability with some ability to mitigate loss of area by operating in alternative areas.
Medium	High or medium value/importance and vulnerability and moderate potential for recoverability for recreational activities, cable/pipeline activities, aggregate extraction or oil and gas operations resulting from: • Limited spatial adaptability due to extent of operational range and/or limited ability to operate in other areas • Limited spatial tolerance due to dependence upon a limited number of sites • Moderate recoverability with some ability to mitigate loss of area by operating in alternative areas.
Low	Low or medium value/importance and vulnerability and moderate potential for recoverability for recreational activities, cable/pipeline activities, aggregate extraction or oil and gas operations resulting from: • Moderate spatial adaptability due to extent of operational range and/or limited ability to operate in other areas • Moderate spatial tolerance due to dependence upon a limited number of sites • Moderate recoverability with some ability to mitigate loss of area by operating in alternative areas.
Negligible	Very low value/importance and vulnerability and high potential for recoverability for recreational activities, cable/pipeline activities, aggregate extraction or oil and gas operations resulting from: • High spatial adaptability due to extent of operational range and/or limited ability to operate in other areas • High spatial tolerance due to dependence upon a limited number of sites • High recoverability with some ability to mitigate loss of area by operating in alternative areas.

The significance of the effect upon other sea users is determined by correlating the magnitude of the impact and the sensitivity of the receptor. The particular method employed for this assessment is presented in Table 12.7. Where a range of significance of effect is presented in Table 12.7, the final assessment for each effect is based upon expert judgement.

For the purposes of this assessment, any effects with a significance level of minor or less have been concluded to be not significant in terms of The Offshore Oil and Gas Exploration, Production, Unloading and Storage

(Environmental Impact Assessment) Regulations 2020, and The Marine Works (Environmental Impact Assessment) Regulations 2007 (as amended)).

Table 12.7: Matrix Used For The Assessment Of The Significance Of The Effect

Sensitivity of Receptor	Magnitude of Impact				
	No Change	Negligible	Low	Medium	High
Negligible	No change	Negligible	Negligible or Minor	Negligible or Minor	Minor
Low	No change	Negligible or Minor	Negligible or Minor	Minor	Minor or Moderate
Medium	No change	Negligible or Minor	Minor	Moderate	Moderate or Major
High	No change	Minor	Minor or Moderate	Moderate or Major	Major
Very High	No change	Minor	Moderate or Major	Major	Major

12.8.3 Maximum design scenario

The Maximum Design Scenarios (MDSs) identified in Table 12.8 have been selected as those having the potential to result in the greatest effect on an identified receptor or receptor group. These scenarios have been selected from the Project Design Envelope (PDE) provided in volume 1, chapter 3. Effects of greater adverse significance are not predicted to arise should any other development scenario, based on details within the PDE (e.g. different infrastructure layout), to that assessed here be taken forward in the final design scheme.

Table 12.8: Maximum Design Scenario Considered For Each Impact As Part Of The Assessment Of Likely Significant Effects On Other Sea Users

[a] C=construction, O&M=operations and maintenance, D=decommissioning

Potential Impact	Phase[a]			Maximum Design Scenario	Justification
	C	O&M	D		
Displacement of recreational activities	✓	✓	✓	**Construction phase** • 2-year construction duration • During the construction phase the displacement of recreational activities will be gradual as the presence of infrastructure increases, reaching the MDS outlined below in the operations and maintenance phase. The MDS in terms of the presence of infrastructure would be on the completion of construction, during the operations and maintenance phase. • Construction safety zones: 500 m safety zones around the proposed new platform, topside updates and drilling of wells during their construction. 50 m safety zone around each infrastructure during the construction phase where no construction works are taking place on that infrastructure (for example, where a construction is incomplete or is in the process of being tested before commissioning). Rolling advisory safety zones of 500 m around vessels installing cables. • Construction vessels: Up to 195 installation vessel movements (return trips) during construction (10 tug/anchor handlers, 76 crew transfer vessels (CTVs), 9 cargo barges, 80 support vessels, 3 survey vessels, 2 pre-comm vessels, 1 seabed preparation vessel, 12 cable installation & support vessels, 2 cable protection and burial installation vessels). • Reduction of access around infrastructure during construction: – Platforms: up to one; – Terminal to Douglas cables: up to 68 km, up to 16 cable crossings; – Inter-Offshore Platform (OP) cables: up to 50 km, up to 10 cable crossings. **Operations and maintenance phase** • 25-year operations and maintenance duration • Operational safety zones: 500 m around during periods of major maintenance • Vessels: Up to a total of 4 operations and maintenance vessels on site at any one time (1 jack-up vessel, 3 other vessels). Up to 330 operations and maintenance vessel movements (return trips) each year (15 jack-up vessels, 300 helicopters, and 15 other vessels)	The greatest amount of the largest infrastructure and the greatest extent of advisory safety zones, over the longest construction, operations and maintenance, and decommissioning phases represents the greatest potential for displacement of recreational activities.

Potential Impact	Phase[a] C	O&M	D	Maximum Design Scenario	Justification
				• Reduction of access in the infrastructure and other sea users local study area due to the presence of infrastructure, such as the proposed platform, as per the construction phase above and cable repair/reburial activities: – Terminal to Douglas cables: no cable repairs anticipated. General inspection works, including high resolution Multibeam Echosounder and Side Scan Sonar of entire cable length cable in one event every two years. Reburial of up to 500 m of cable in one event every 5-10 years. – Inter-OP cables: no cable repairs anticipated. General inspection works, including high resolution Multibeam Echosounder and Side Scan Sonar of entire cable length cable in one event every two years. Reburial of up to 500 m of cable in one event every 5-10 years. **Decommissioning phase** • During the decommissioning phase any displacement of recreational activities would gradually decrease from the operational MDS as structures are removed and/or cut below the seabed.	
Increased SSCs and associated deposition affecting recreational diving and bathing sites	✓	✓	✓	**Construction phase** • 2-year construction duration. Site preparation: • Sand wave clearance activities undertaken over an approximate up to three weeks duration within the wider 2-year construction programme. • Platform foundations: It will be necessary to carry out some pre-lay seabed preparation through this location. The dunes are up to 3 m in height, and a corridor approximately 115 m length, 10 m in width would be created through them. This equates to a total spoil volume of 3,450 m^3 for this location. • West Hoyle Bank: It will be necessary to carry out some pre-lay seabed preparation through this location, which will likely be using mass flow excavator or possibly a jet sled. The dunes are up to 7 m in height, and a corridor approximately 1,000 m length, 21 m in width would be created through them. This equates to a total spoil volume of 147,000 m^3 for this location. Cable installation: • Terminal-Douglas cables: Installation via trenching of up to 68 km of cable, with a trench width of up to 1.5 m and a depth of up to 3 m. Total disturbed area of	Site preparation: The volume of material to be cleared from individual sand waves will vary according to the local dimensions of the sand wave (height, length and shape) and the level to which the sand wave must be reduced. These details are not fully known at this stage, however based on the available data, it is anticipated that the sand waves requiring clearance in the other sea users regional study area are likely to be in the range of 3m in height. Site clearance activities may be undertaken using a range of techniques. The suction hopper dredger will result in the greatest increase in suspended sediment and largest plume extent as

Potential Impact	Phase[a] C	O&M	D	Maximum Design Scenario	Justification
				102,000 m^2. Installed over a period of approximately 22 days in total (11 days per cable), assuming a cable burial rate of 3,000 m/day via ploughing. • Inter-OP cables: Installation via trenching of up to 50 km of cable, with a trench width of up to 1.5 m and a depth of up to 3 m. Total disturbed area of 75,000 m^2. Installed over a period of approximately 17 days in total (approximately 6 days per cable), assuming a cable burial rate of 3,000 m/day via ploughing. Drilling wells: • Well site 1: Hamilton North HN_M3: Total spoil volume of 136.65 m^3 will be released approximately 1 m above the seabed. • Well site 2: Lennox LX-M2_12: Total spoil volume of 136.65 m^3 will be released approximately 1 m above the seabed. **Operations and maintenance phase** • 25-year operations and maintenance duration • Terminal-Douglas cables: no cable repairs anticipated. General inspection works, including high resolution Multibeam Echosounder and Side Scan Sonar of entire cable length cable in one event every two years. Reburial of up to 500 m of cable in one event every 5-10 years. • Inter-OP cables: no cable repairs anticipated. General inspection works, including high resolution Multibeam Echosounder and Side Scan Sonar of entire cable length cable in one event every two years. Reburial of up to 500 m of cable in one event every 5-10 years. **Decommissioning phase** • Removal of foundations (suction bucket): SSC will be temporarily increased due to the overpressure required to release them.	material is released near the water surface during the disposal of material. Boulder clearance activities will result in minimal increases in SSC and have therefore not been considered in the assessment. Cable installation: Cable routes inevitably include a variety of seabed material and in some areas 3 m depth may not be achieved or may be of a coarser nature which settles in the vicinity of the cable route. The assessment therefore considers the upper bound in terms of suspended sediment and dispersion potential. Cables will be buried by ploughing. The use of open trenching in the intertidal area releases the greatest volume of material into the water column and therefore provides the upper bound of impacts as compared with horizontal directional drilling (HDD) installation. Operations and maintenance phase: The greatest foreseeable number of cable reburial and repair events is considered to be the MDS for sediment dispersion.
Impacts to existing cables or pipelines or restrictions on access to cables or pipelines	✓	✓	✓	As for ‘Displacement of recreational activities’ – see above.	This represents the maximum extent of infrastructure and associated construction and

Potential Impact	Phase[a]			Maximum Design Scenario	Justification
	C	O&M	D		
					maintenance activities in the vicinity of existing cables or pipelines.
Increased SSCs and associated deposition affecting aggregate extraction areas	✓	✓	✓	As for 'Increased SSCs and associated deposition affecting recreational diving sites' – see above.	Greatest volume of sediment released into the water column, resulting in greatest potential for impact on aggregate extraction receptors. See 'Increased SSCs and associated deposition affecting recreational diving and bathing sites' above.
Reduction or restriction of oil and gas exploration activities (including surveys, drilling and the placement of infrastructure)	✓	✓	✓	As for 'Displacement of recreational activities' – see above.	The greatest amount of the largest infrastructure and associated minimum spacing and the greatest extent of advisory safety zones, over the longest construction, operations and maintenance, and decommissioning period represents the greatest potential for reduction or restriction of oil and gas exploration activities.

12.9 Impacts scoped out of the assessment

On the basis of the baseline environment and the description of development outlined in volume 1, chapter 3 and volume 2, chapter 6, alterations to sediment transport pathways affecting aggregate extraction areas impacts are proposed to be scoped out of the assessment for infrastructure and other sea users. Platform structures (within the water column) consist of four legs circa 2 m in diameter at a spacing of 17 m. It assumed that, given the sandy nature of the seabed, suitable scour protection will be provided to avoid scour holes developing. Given the diminutive nature of the structure, in comparison to, say a neighbouring wind turbine structure for which suitable published information is available, the impacts on sediment transport pathways would be diminutive and as such are scoped out of the assessment.

12.10 Embedded mitigation

A number of measures (primary and tertiary) have been adopted as part of the Proposed Development to reduce the potential for impacts on infrastructure and other sea users. These are outlined in Table 12.9 below. As there is a secured commitment to implementing these measures for the Proposed Development, they have been considered in the assessment presented in section 12.11 below (i.e. the determination of magnitude and therefore significance assumes implementation of these measures).

Table 12.9: Measures Adopted As Part Of The Proposed Development

Mitigation measures adopted as part of the Proposed Development	Justification	How the measure will be secured
Primary measures: Measures included as part of the project design		
Application for safety zones of up to 500m during construction.	The Proposed Development intends to apply for a standard 500 m safety zone (as per the 2007 Safety Zone regulations cited in the justification column), around the proposed new platform whilst construction/decommissioning works are ongoing. Safety zones of 50 m will be sought for incomplete structures where construction/decommissioning activity may be temporarily paused (and therefore the 500 m safety zone has lapsed). Details of safety zones will also be set out within the emergency response and cooperation plan. Safety zones are established in the interests of safety to infrastructure and other sea users receptors, in accordance with Section 22 of the Petroleum Act 1987, and The Electricity (Offshore Generating Stations) (Safety Zones) (Application Procedures and Control of Access) Regulations 2007.	Proposed to be secured within the marine licence, and Carbon Storage Permit.
Tertiary measures: Measures required to meet legislative requirements, or adopted standard industry practice		
Where the Proposed Development cables/ pipelines will be required to cross an active cable, it is intended that a commercial ‘crossing agreement’ will be entered into with the cable operator. A crossing agreement based upon the ICPC Recommendation 3-10C ‘Telecommunications Cable and Oil	This is a formal arrangement that establishes the responsibilities and obligations of both parties and allows operations to be managed safely and to reduce potential conflict at cable crossing locations. This is a formal arrangement that establishes the responsibilities and	In line with standard industry practice crossing agreements would be negotiated and agreed with operators as required.

Mitigation measures adopted as part of the Proposed Development	Justification	How the measure will be secured
Pipeline/Power Cables Crossing Criteria' (ICPC, 2014) will be used for any cable crossings. Where a cable is inactive, the Applicant will consult with the cable operator to ascertain if such a crossing agreement is required.	obligations of both parties and allows operations to be managed safely.	
Promulgation of information advising on the nature, timing and location of activities, including through Notices to Mariners.	To ensure other marine users are aware of operations associated with the Proposed Development.	Secured within a Marine Licence condition.
Development of and adherence to a Navigational Safety Plan (NSP). The NSP will describe measures put in place by the Project related to navigational safety, including information on Safety Zones, charting, construction buoyage, temporary lighting and marking, and means of notification of Project activity to other sea users (e.g., via Notice to Mariners).	To ensure other marine users are aware of operations and infrastructure associated with the Proposed Development.	Proposed to be secured within the marine licence.
Consultation with oil and gas operators and other energy infrastructure operators to promote and maximise cooperation between parties and minimise both spatial and temporal interactions between conflicting activities.	Licence blocks will be relinquished and acquired by different operators over the duration of the project life, and oil and gas operations will change according to the project phase. By continued consultation with the oil and gas operators both parties will keep informed of planned activities in order to minimise disruption to either party's operations and to maximise coexistence.	In line with standard industry practice.
Development and adherence to a Cable Specification and Installation Plan (CSIP) post consent which will include cable burial where possible (in accordance with the specific policies set out in the North West Inshore and North West Offshore Coast Marine Plans (MMO, 2021)) and cable protection, as necessary.	There is a potential for cable exposure to occur due to interactions between Metocean regime (wave, sand and currents). The sediment transport can lead to exposure of cables and infrastructure, the use of a cable burial depth alongside the cable installation strategy should provide sufficient depth to avoid exposure.	The CSIP will be conditioned in the Marine Licence.
Development and adherence to a pipeline Specification and Installation Plan which will include pipeline burial where possible and pipeline protection as necessary.	To ensure that the pipeline remains secure, is not a hazard to other sea users and does not risk becoming exposed and damaged by tidal currents.	In line with standard industry practice.
Installation of infrastructure over or adjacent to existing cables or pipelines will be subject to crossing or proximity agreements between the two parties, prior to the start of the construction phase.	To reduce potential conflict at crossing locations. Cable and pipeline crossing/proximity agreements will be based on previously referenced guidance from the ICPC and Oil and Gas UK.	In line with standard industry practice crossing/proximity agreements would be negotiated and agreed with operators as required.
Application for safety zones of up to 500m during periods of major maintenance.	Details of safety zones will also be set out within the emergency response and cooperation plan. Safety zones are established in the interests of safety to infrastructure and other sea users receptors, in accordance with Section 22 of the Petroleum Act 1987, and The Electricity (Offshore Generating Stations) (Safety Zones) (Application Procedures and Control of Access) Regulations 2007	Proposed to be secured within the marine licence, and Carbon Storage Permit.

12.11 Assessment of significance

12.11.1 Overview

The impacts of the construction, operations and maintenance, and decommissioning phases of the Proposed Development have been assessed on infrastructure and other sea users. The potential impacts arising from the construction, operations and maintenance, and decommissioning phases of the Proposed Development are listed in Table 12.8, along with the MDS against which each impact has been assessed.

A description of the potential effect on other sea users receptors caused by each identified impact is given below.

12.11.2 Displacement of recreational activities

Construction, operations and maintenance, and decommissioning of the Proposed Development may lead to the displacement of recreational activities such as sailing and motor cruising, recreational fishing and inshore water sports. The MDS is represented by the greatest amount of the largest infrastructure and associated greatest extent of advisory safety zones, over the longest construction and decommissioning phases. This is summarised in Table 12.8.

12.11.2.1 Construction phase

Magnitude of impact

The installation of infrastructure and the presence of safety zones may result in the displacement of recreational activities from the Proposed Development.

The Proposed Development has a construction phase of up to 2 years. The spatial extent of the infrastructure and other sea users local study area is 205.0 km^2. There is also potential for safety zones to extend 500 m beyond this area. The impact of safety zones is mostly reversible as once each structure has been installed and commissioned these will be removed. The infrastructure and other sea users local study area extends to the shoreline and therefore frequency of impact within is low. Up to 195 installation vessel movements will be required during construction, with 500 m rolling advisory safety zones around cable installation vessels.

There is low to medium recreational vessel activity in the nearshore area of the infrastructure and other sea users local study area, with a general boating area and water sports clubs in the vicinity. There is the potential for temporary loss of recreational resource during nearshore/inshore cable installation activities.

Underwater sound associated with the construction of the Proposed Development has the potential to affect fish and shellfish, which subsequently has the potential to impact upon recreational fishing. Further information on underwater sound is presented in Underwater Noise Technical Report (RPS Group and Seiche, 2023). Potential impacts on fish and shellfish behaviour associated with underwater sound have been assessed as minor adverse in volume 2, chapter 7.

The impact is predicted to be of local spatial extent, short to medium term duration and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **negligible**.

Sensitivity of receptor

Recreational vessels are able to alter their route, dependent on the target destination. Notices to Mariners will be promulgated regularly during the construction phase, advising of the location and nature of construction works, and information and notices will be posted at the landfall location, ensuring that recreational activities can be planned accordingly.

The receptor is deemed to be of low vulnerability, high recoverability and moderate value. The sensitivity of the receptor is therefore, considered to be **negligible**.

Significance of the effect

Overall, it is predicted that the sensitivity of the receptor is considered to be **low** and the magnitude is deemed to be **negligible**. As set out in Table 12.7, the effect will therefore be of **negligible adverse** significance, which is not significant in EIA terms.

12.11.2.2 Operations and maintenance phase

Magnitude of impact

The presence of infrastructure, including the proposed platform, may result in the displacement of recreational craft and recreational fishing vessels from the infrastructure and other sea users local study area.

The Proposed Development has an operations and maintenance phase of up to 25 years. 500 m safety zones will be established around infrastructure such as the proposed platform during periods of major maintenance. Up to 330 operations and maintenance vessel movements may be required each year. As stated in the description of the magnitude of this impact during the construction phase, frequency of impact within the infrastructure and other sea users local study area is low. Recreational vessels will be able to access and transit through the infrastructure and other sea users local study area, so displacement due to the presence of infrastructure will not occur.

As previously stated, there is low to medium recreational vessel activity in the nearshore area of the infrastructure and other sea users local study area (Figure 12.3) and a general boating area and water sports clubs along the shoreline within the infrastructure and other sea users regional study area. During the operations and maintenance phase, no cable repairs are anticipated, as the cable will be buried, and installed as a single, unjointed length offshore. Where the cable cannot be buried e.g. at crossings, it will have external cable protection. General inspection works will be carried out, including high resolution Multibeam Echosounder and Side Scan Sonar of entire cable length cable in one event every two years. From experience of existing operations, reburial of up to 500 m of cable in one event every 5-10 years is anticipated. For the Terminal-Douglas cables, a similar inspection programme is anticipated.

The impact is predicted to be of local spatial extent, long term duration, continuous and irreversible over the 25-year operations and maintenance phase of the Proposed Development. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Sensitivity of receptor

Recreational vessels are able to alter their route, dependent on the target destination. Notices to Mariners will be promulgated regularly during the operations and maintenance phase, advising of the location and nature of major maintenance works, and information and notices will be posted at the landfall location, ensuring that recreational activities can be planned accordingly.

The receptor is deemed to be of low vulnerability, high recoverability and moderate value. The sensitivity of the receptor is therefore, considered to be **negligible**.

Significance of effect

Overall, it is predicted that the sensitivity of the receptor is considered to be **low** the magnitude is deemed to be negligible. As set out in Table 12.7, the effect will therefore be of **negligible adverse** significance, which is not significant.

12.11.2.3 Decommissioning phase

The effects of decommissioning activities are expected to be the same or similar to the effects from construction. As set out in Table 12.7, the effect will therefore be of **negligible adverse** significance, which is not significant. The effect has been defined as minor rather than negligible as there will still be a perceptible effect, although it is unlikely to be critical in the decision-making process.

12.11.3 Increased SSCs and associated deposition affecting recreational diving and bathing sites

Construction, operations and maintenance, and decommissioning of the platform, wells, pipelines and cables have the potential to increase SSCs, affecting recreational diving and bathing sites. The MDS is represented by the maximum volume of sediment disturbed and is summarised in Table 12.8.

12.11.3.1 Construction phase

Magnitude of impact

Volume 2, chapter 6 considers potential elevations in SSC and deposition to the seabed as a result of a number of activities proposed to occur within the other sea users regional study area. More specifically these activities are:

- Well drilling and cementing.
- Cable/pipeline installation via trenching.
- Cable/pipeline removal and reburial.

Drilling wells will include:

- Well site 1: Hamilton North HN_M3: Total spoil volume of 136.65 m^3 will be released approximately 1 m above the seabed.
- Well site 2: Lennox LX-M2_12: Total spoil volume of 136.65 m^3 will be released approximately 1 m above the seabed.

Cable installation will include:

- Up to 3 weeks of installing inter-PC cables via trenching will create a total spoil volume of 3,450 m^3
- Up to 3 weeks of installing the Terminal-Douglas cables via trenching will create a total spoil volume of 147,000 m^3.

There is potential that sediment plumes from resuspended sediment could impact recreational areas through changes to water quality. Recreational areas would only be affected if the amount of fine sediments suspended in the water or settling in the area are significantly above any background levels or contain any contaminants which would not usually be expected in the area. However, in volume 2, chapter 6 it is anticipated that any deposited fine sediments would be subject to redistribution under the prevailing coastal processes.

The impact is predicted to be of regional spatial extent, medium term duration, high frequency and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Sensitivity of receptor

There are six identified recreational diving sites within the infrastructure and other sea users regional study area. Nine recreational bathing sites (Southport, Ainsdale, Formby, West Kirby, Prestatyn, Rhyl, Rhyl East, Marine Lake (Rhyl) and Kinmel Bay (Sandy Cove)) are also within the infrastructure and other sea users regional study area. These sites may be impacted by an increase in SSCs in the short term, although as stated it is anticipated that any deposited fine sediments would be subject to redistribution under the prevailing coastal processes. Figure 12.3 shows other recreational diving and bathing sites in the east Irish Sea region which may provide alternative sites during operations resulting in SSCs, however sea conditions and water depth for accessibility may prevent this.

Notices to Mariners will be promulgated regularly during the construction phase, advising of the location and nature of construction works, and information and notices will be posted at the landfall location, ensuring that recreational activities can be planned accordingly.

The receptor is deemed to be of moderate vulnerability, moderate recoverability, and low value. The sensitivity of the receptor is therefore, considered to be **low**.

Significance of effect

Overall, it is predicted that the sensitivity of the receptor is considered to be low and the magnitude is deemed to be low. As set out in Table 12.7, the effect will therefore be of **minor adverse** significance, which is **not significant**.

12.11.3.2 Operations and maintenance phase

Magnitude of impact

The Proposed Development has an operations and maintenance phase of 25 years. During the operations and maintenance phase, the greatest foreseeable number of cable reburial and repair events is considered to be the MDS for sediment dispersion.

From Table 12.8, during these 25 years, experience from existing operations indicates, there would be an average reburial of up to 500 m of cable in one event every 5-10 years. No cable repairs are anticipated, as the cable will be buried, and installed as a single, unjointed length offshore. Where the cable cannot be buried e.g. at crossings, it will have external cable protection. This makes it unlikely that there would be regular or significant disturbance to the recreational the dive site located within the infrastructure and other sea users local study area. It is anticipated that any deposited fine sediments would be subject to redistribution under the prevailing coastal processes.

The impact is predicted to be of local spatial extent, short term duration, intermittent and reversible. The magnitude is therefore, considered to be **negligible**.

Sensitivity of receptor

Six identified recreational diving sites and nine recreational bathing sites (Southport, Ainsdale, Formby, West Kirby, Prestatyn, Rhyl, Rhyl East, Marine Lake (Rhyl) and Kinmel Bay (Sandy Cove)) are within the are within the infrastructure and other sea users regional study area. These sites may be impacted by an increase in SSCs in the short term, although as stated it is anticipated that any deposited fine sediments would be subject to redistribution under the prevailing coastal processes. Figure 12.3 shows other recreational diving and bathing sites in the east Irish Sea region which may provide alternative sites during operations resulting in SSCs, however sea conditions and water depth for accessibility may prevent this.

Notices to Mariners will be promulgated regularly during the operations and maintenance phase, advising of the location and nature of major maintenance works, and information and notices will be posted at the landfall location, ensuring that recreational activities can be planned accordingly.

The receptor is deemed to be of moderate vulnerability, moderate recoverability and low value. The sensitivity of the receptor is therefore considered to be **low**.

Significance of effect

Overall, it is predicted that the sensitivity of the receptor is considered to be **low** and the magnitude is deemed to be **negligible**. As set out in Table 12.7, the effect will therefore be of **negligible adverse** significance, which is not significant. The effect has been defined as **negligible**, rather than minor, because any effect will be beneath levels of perception, within normal bounds of variation or within the margin of forecasting error.

12.11.3.3 Decommissioning phase

The effects of decommissioning activities are expected to be the same or similar to the effects from construction. As set out in Table 12.7, the effect will therefore be of **minor adverse** significance, which is not significant. The effect has been defined as **minor**, rather than negligible, as there will still be a perceptible effect, although it is unlikely to be critical in the decision-making process.

12.11.4 Impacts to existing cables or pipelines or restrictions on access to cables or pipelines

Construction, operations and maintenance, and decommissioning of the platform, pipelines, wells and cables may lead to impacts on existing cables and pipelines, or restrictions on access to cables and pipelines. The MDS is represented by the greatest amount of the largest infrastructure and associated minimum spacing and the greatest extent of safety zones, over the longest construction, operations and maintenance, and decommissioning phases. This is summarised in Table 12.8.

12.11.4.1 Construction phase

Magnitude of impact

The Proposed Development has a construction phase of up to two years. The spatial extent of the other sea users local study area has an area of 205.0 km^2. There is also potential for safety zones to extend 500 m beyond this area. The impact of safety zones is mostly reversible as once each structure has been installed and commissioned these will be removed.

Up to 195 installation vessel movements will be required during construction, with 500 m rolling advisory safety zones around cable installation vessels. As stated in Figure 12.4, four active cables intersect the infrastructure and other sea users local study area. No pipelines overlap with the infrastructure and other sea users local study area.

Infrastructure, safety zones and activities associated with the Proposed Development may restrict access to the existing cables mentioned above, in addition to the planned MaresConnect cable. Cable crossing and proximity agreements as per the ICPC Recommendation 3-10C ‘Telecommunications Cable and Oil Pipeline/Power Cables Crossing Criteria’ will be established with relevant cable operators and will include the ability of a cable operator to access their infrastructure during the construction of the Proposed Development as far as practical.

The impact is predicted to be of regional spatial extent, short to medium term duration, high frequency and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Sensitivity of receptor

Restriction of access to an active cable for inspection and maintenance activities could be critical to the operator of that cable. However, crossing and proximity agreements are common across the UKCS and there are established mechanisms for controlling the level of impact to both parties, in the form of the ICPC Recommendation 3-10C guidance. No active pipelines other than those operated by the Applicant exist within the infrastructure and other sea users local study area.

The receptor is deemed to be of moderate vulnerability, moderate recoverability and high value. The sensitivity of the receptor is therefore, considered to be **medium**.

Significance of effect

Overall, it is predicted that the sensitivity of the receptor is considered to be **medium** and the magnitude is deemed to be **low**. As set out in Table 12.7, the effect will therefore be of **minor adverse** significance, which is **not significant**.

12.11.4.2 Operations and maintenance phase

Magnitude of impact

As described earlier, there are four power cables which intersect the infrastructure and other sea users local study area. Infrastructure, safety zones and activities associated with the Proposed Development may restrict access to these existing cables.

Loss of access to cables associated with any temporary safety zones during the operations and maintenance phase is considered to be limited in extent and infrequent. Loss of access to cables associated with the presence of structures would be considered in the crossing/proximity agreements to the extent that such a scenario would not be an impediment to operations.

Crossing and proximity agreements will be established with relevant cable operators, to minimise the potential for any impact in accordance with recognised industry best practice. These agreements will ensure close communication and planning between both parties to ensure disruption of activities is minimised.

The impact is predicted to be of local spatial extent, short term duration, intermittent and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be **low**.

Sensitivity of receptor

Major maintenance activities associated with the Proposed Development will be publicised via Notices to Mariners. The terms of the crossing and proximity agreements will ensure communication between both parties and that loss of access is minimised.

Restriction of access to an active cable for inspection and maintenance activities could be critical to the operator of that cable. However, crossing and proximity agreements are common across the UKCS and there are established mechanisms for controlling the level of impact to both parties in the form of the guidance.

The receptor is deemed to be of moderate vulnerability, moderate recoverability and high value. The sensitivity of the receptor is therefore, considered to be **medium**.

Significance of effect

Overall, it is predicted that the sensitivity of the receptor is considered to be **medium** and the magnitude is deemed to be **low**. As set out in Table 12.7, the effect will therefore be of **minor adverse** significance, which is **not significant**.

12.11.4.3 Decommissioning phase

The effects of decommissioning activities are expected to be the same or similar to the effects from construction. As set out in Table 12.7, the effect will therefore be of **minor adverse** significance, which is **not significant**.

12.11.5 Increased SSCs and associated deposition affecting aggregate extraction and deposit areas

Construction, operations and maintenance, and decommissioning of the platform, pipelines, wells and cables have the potential to increase SSCs, affecting aggregate extraction areas. The MDS is represented by the maximum volume of sediment disturbed and is summarised in Table 12.8.

12.11.5.1 Construction phase

Magnitude of impact

Volume 2, chapter 6 considers potential elevations in SSC and deposition to the seabed as a result of a number of activities proposed to occur within the infrastructure and other sea users regional study area. More specifically these activities are:

- Well drilling and cementing.
- Cable/pipeline installation via trenching.
- Cable/pipeline removal and reburial.

Drilling wells will include:

- Well site 1: Hamilton North HN_M3: Total spoil volume of 136.65 m^3 will be released approximately one m above the seabed.
- Well site 2: Lennox LX-M2_12: Total spoil volume of 136.65 m^3 will be released approximately one m above the seabed.

Cable installation will include:

- Up to 3 weeks of installing inter-PC cables via trenching will create a total spoil volume of 3,450 m^3.
- Up to 3 weeks of installing the Terminal-Douglas cables via trenching will create a total spoil volume of 147,000 m^3.

In terms of drilled materials within the infrastructure and other sea users regional study area, the volumes of material being displaced and deposited locally are relatively limited (136.65 m^3 within Liverpool Bay Area 457 marine aggregate extraction site and 136.65 m^3 within Site Y marine aggregate disposal site). This also limits the thickness of any resulting deposition. Any such deposition would also be expected to be localised and as such would have limited interact with the aggregate extraction and deposition areas.

For sand wave clearance prior to cable installation, the majority of sediment would be deposited locally. Finer grained material may enter into suspension and be advected away from the point of release up to distances of several tens of kilometres. However, concentrations would be very low and within natural variability. Deposition of sediments to a thickness that is measurable is likely to remain limited.

In terms of cable installation within the infrastructure and other sea users regional study area, the volumes of material being displaced and deposited locally are relatively limited (A total disturbed area of 1,020 m^2 for the Terminal – Douglas cables and 750 m^2 for the Inter-OP cables). Of this volume, it is estimated that 0.0825 km^2 will directly impact the Liverpool Bay Area 457 marine aggregate extraction site (based upon Inter-OP cables traversing the site for 5.5 km) and 0.0825 km^2 will directly impact the Site Y marine aggregate disposal site (based upon Inter-OP cables traversing the site for 5.5 km).

The cable laying method also limits the thickness of any resulting deposition; the plough 'slices' a trench approximately 1-1.5 m in width, while simultaneously burying the cable. Any deposition from this process would also be expected to be localised and as such would not be expected to interact with the aggregate extraction areas in a significant way.

As well as the impact related to the above activities overlapping the aggregate extraction and deposit areas, there is also potential that sediment plumes from resuspended sediment could impact the extraction and deposit areas within the infrastructure and other sea users regional study area through sedimentation and the potential that this could affect the quality of aggregate (coarse sand deposits). Aggregate would only be affected if the amount the sediment fines that are settling in the area are significantly above any background levels or contain any contaminants which would not usually be expected in the aggregate area. There is no evidence of fine-grained sand within the Liverpool Bay 457 and Hilbre Swash 393 dredging areas, although it seems likely that it does pass through it. This indicates that present-day tidal currents and waves are capable of carrying fine grained sand across the area (Sefton Council executive report, 2007). Therefore, given this characteristic and the overlap with the infrastructure and other sea users regional study area, a small proportion of the total spoil volume could settle within Liverpool Bay 457 and Hilbre Swash 393. It is also anticipated that any deposited fine sediments would be subject to redistribution under the prevailing coastal processes.

The impact is predicted to be of regional spatial extent, medium term duration, high frequency and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Sensitivity of receptor

Westminster Gravels Ltd dredge coarse sand deposits from the Liverpool Bay 457 dredging area and Mersey Sand Suppliers dredge coarse sand deposits from Hilbre Swash 393, a resource of value to the regional economy. Dredging operators are adaptable as they are able, to some extent, to screen out unwanted fine sediment load. Furthermore, it is known that the existing tidal currents and waves are capable of carrying fine grained sand across the area (Sefton Council executive report, 2007).

The receptor is deemed to be of low vulnerability, moderate recoverability and moderate value. The sensitivity of the receptor is therefore, considered to be **medium**.

Significance of effect

Overall, it is predicted that the sensitivity of the receptor is considered to be **medium** and the magnitude is deemed to be **low**. As set out in Table 12.7, the effect will therefore be of **minor adverse** significance, which is **not significant**.

12.11.5.2 Operations and maintenance phase

Magnitude of impact

The Proposed Development has an operations and maintenance phase of 25 years. During the operations and maintenance phase, the greatest foreseeable number of cable reburial and repair events is considered to be the MDS for sediment dispersion.

Table 12.8 states that over the operations and maintenance phase, experience from existing operations indicates, there would be an average reburial of up to 500 m of cable in one event every 5-10 years. No cable repairs are anticipated, as the cable will be buried, and installed as a single, unjointed length offshore. Where the cable cannot be buried e.g. at crossings, it will have external cable protection. It is anticipated that any deposited fine sediments would be subject to redistribution under the prevailing coastal processes. Liverpool Bay 457 and Hilbre Swash 393 dredging areas are located across 5.5 km stretches of the Inter-OP cable routes respectively and thus where reburial may occur. There is also potential that sediment plumes from reburial activities elsewhere along cable lengths could resuspend sediment that could impact the aggregate extraction areas within the infrastructure and other sea users regional study area through sedimentation and the potential that this could affect the quality of aggregate (coarse sand deposits). Aggregate would only be affected if the amount the sediment fines that are settling in the area are significantly above any background levels or contain any contaminants which would not usually be expected in the aggregate area. There is no evidence of fine-grained sand within the Liverpool Bay 457 and Hilbre Swash 393 dredging areas, although it seems likely that it does pass through it. This indicates that present-day tidal currents and waves are capable of carrying fine grained sand across the area (Sefton Council executive report, 2007). Therefore, given this characteristic and the overlap with the infrastructure and other sea users regional study area, a small proportion of the total spoil volume could settle within Liverpool Bay 457 and Hilbre Swash 393. It is also anticipated that any deposited fine sediments would be subject to redistribution under the prevailing coastal processes.

The impact is predicted to be of local spatial extent, short term duration, intermittent and reversible. The magnitude is therefore, considered to be **negligible**.

Sensitivity of receptor

Westminster Gravels Ltd dredge coarse sand deposits from the Liverpool Bay 457 dredging area and Mersey Sand Suppliers dredge coarse sand deposits from Hilbre Swash 393, a resource of value to the regional economy. Dredging operators are adaptable as they are able, to some extent, to screen out unwanted fine sediment load. Furthermore, it is known that the existing tidal currents and waves are capable of carrying fine grained sand across the area (Sefton Council executive report, 2007).

The receptor is deemed to be of low vulnerability, moderate recoverability and moderate value. The sensitivity of the receptor is therefore, considered to be **medium**.

Significance of effect

Overall, it is predicted that the sensitivity of the receptor is considered to be **medium** and the magnitude is deemed to be **negligible**. As set out in Table 12.7, the effect will therefore be of **minor adverse** significance, which is not significant. The effect has been defined as minor rather than negligible as there will still be a perceptible effect, although it is unlikely to be critical in the decision-making process.

12.11.5.3 Decommissioning phase

The effects of decommissioning activities are expected to be the same or similar to the effects from construction. As set out in Table 12.7, the effect will therefore be of **minor adverse** significance, which is **not significant**.

12.11.6 Reduction or restriction of oil and gas exploration activities (including surveys, drilling and the placement of infrastructure)

Construction, operations and maintenance, and decommissioning of the platform, pipelines, wells and cables may lead to impacts and restrictions on oil and gas activities within the other sea users local study area. The MDS is represented by the greatest amount of the largest infrastructure and the greatest extent of safety zones, over the longest construction, operations and maintenance and decommissioning phases. This is summarised in Table 12.8.

12.11.6.1 Construction phase

Magnitude of impact

The Proposed Development has a construction phase of up to two years. The spatial extent of the other sea users local study area is 205.0 km^2, which is not large in the context of the east Irish Sea. There is also potential for safety zones to extend 500 m beyond this area. The impact of safety zones is mostly reversible as once each structure has been installed and commissioned these will be removed. Therefore, frequency of impact within the other sea users local study area is low.

Up to 195 installation vessel movements will be required during construction, with 500 m rolling advisory safety zones around cable installation vessels. One platform will be installed.

As infrastructure is installed, the area available for seismic surveys and drilling will be restricted, and the presence of safety zones around infrastructure and vessels may also further restrict the ability to use certain alternative survey methods.

The impact is predicted to be of local spatial extent, long term duration, high frequency and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **medium**.

Sensitivity of receptor

As shown in Figure 12.5, there are five currently licensed blocks overlapping with the infrastructure and other sea users local study area. These are blocks 110/13b, 11013a, 110/15a (all operated by the Applicant) and blocks 110/14a and 110/14c (both operated by Chrysaor Resources (Irish Sea) Limited (part of Harbour Energy)). There is also potential for blocks to become licenced in future (i.e. through Oil and Gas Licensing Rounds), but the assessment of this potential impact is complicated by a degree of uncertainty.

The receptor is deemed to be of negligible vulnerability, moderate recoverability and low value. The sensitivity of the receptor is therefore, considered to be **negligible**.

Significance of effect

Overall, it is predicted that the sensitivity of the receptor is considered to be **negligible** and the magnitude is deemed to be **medium**. As set out in Table 12.7, the effect will therefore be of **minor adverse** significance, which is **not significant**. The effect has been defined as **minor**, rather than negligible, as there will still be a perceptible effect, although it is unlikely to be critical in the decision-making process.

12.11.6.2 Operations and maintenance phase

Magnitude of impact

The Proposed Development has an operations and maintenance phase of up to 25 years. 500 m safety zones will be established around infrastructure such as the proposed platform during periods of major maintenance. Up to 330 operations and maintenance vessel movements may be required each year, with up to four vessels on site at any one time.

Due to these vessel movements, the presence of this infrastructure and the safety zones, the area available for seismic surveys, alternative surveys and drilling will be restricted.

The impact is predicted to be of local spatial extent, long term duration, continuous and of low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **medium**.

Sensitivity of receptor

As shown in Figure 12.5, there are five currently licensed blocks overlapping with the infrastructure and other sea users local study area. These are blocks 110/13b, 11013a, 110/15a (all operated by the Applicant) and blocks 110/14a and 110/14c (both operated by Chrysaor Resources (Irish Sea) Limited (part of Harbour Energy)). There is also potential for blocks to become licenced in future (i.e. through Oil and Gas Licensing Rounds), but the assessment of this potential impact is complicated by a degree of uncertainty.

The receptor is deemed to be of negligible vulnerability, moderate recoverability and low value. The sensitivity of the receptor is therefore, considered to be **negligible**.

Significance of effect

Overall, it is predicted that the sensitivity of the receptor is considered to be **negligible** and the magnitude is deemed to be **medium**. As set out in Table 12.7, the effect will therefore be of **minor adverse** significance, which is **not significant**. The effect has been defined as **minor**, rather than negligible, as there will still be a perceptible effect, although it is unlikely to be critical in the decision-making process.

12.11.6.3 Decommissioning phase

The effects of decommissioning activities are expected to be the same or similar to the effects from construction. As set out in Table 12.7, the effect is therefore, considered to be of **minor adverse** significance, which is **not significant**. The effect has been defined as **minor**, rather than negligible, as there will still be a perceptible effect, although it is unlikely to be critical in the decision-making process.

12.12 Cumulative Effects Assessment (CEA) methodology

12.12.1 Methodology

The Cumulative Effects Assessment (CEA) takes into account the impact associated with the Proposed Development together with other projects, plans and activities. The projects, plans and activities selected as relevant to the CEA presented within this chapter are based upon the results of a screening exercise carried out to determine those which may have a cumulative effect when considered alongside the Proposed Development. Each project, plan or activity has been considered on a case-by-case basis for screening in or out of this chapter's assessment based upon data confidence, effect-receptor pathways and the spatial/temporal scales involved.

As part of the assessment, all projects, plans and activities considered alongside the Proposed Development have been allocated into 'tiers' reflecting their current stage within the planning and development process.

The tiered approach uses the following categorisations:

- Tier 1
  - Under construction.
  - Permitted application.
  - Submitted application.
  - Those currently operational that were not operational when baseline data were collected, and/or those that are operational but have an ongoing impact.
- Tier 2
  - Scoping report has been submitted and is in the public domain.
- Tier 3
  - Scoping report has not been submitted.
  - Identified in a relevant development plan.
  - Identified in other plans and programmes.

This tiered approach is adopted to provide a clear assessment of the Proposed Development alongside other projects, plans and activities.

The specific projects, plans and activities scoped into the CEA, are outlined in Table 12.10 and shown in Figure 12.7. All of the projects, plans and activities scoped into the CEA may temporally overlap with the Proposed Development.

Table 12.10: List Of Other Projects, Plans And Activities Considered Within The CEA For Infrastructure And Other Sea Users

Project/Plan	Status	Distance from the regional study area (km)	Distance from the local study area (km)	Description of project/plan	Dates of construction (if applicable)	Dates of operation (if applicable)
Tier 1						
Awel y Môr	Submitted	Overlaps	1.1	Awel y Môr offshore wind farm, planning to comprise up to 50 wind turbines.	Anticipated to commence in 2026	1 January 2030 to 1 January 2055
Liverpool 2 and River Mersey Approach Channel Dredging	Operational	Overlaps	Overlaps	Dredging activities and dredge disposal sites	N/A	1 July 2019 to 30 June 2028
Mersey Channel and River Maintenance Dredge Disposal Renewal	Operational	Overlaps	Overlaps	Dredging activities and dredge disposal sites	N/A	22 October 2021 to 22 October 2031
Conwy River Dredging	Operational	12.3	20.3	Dredging activities and dredge disposal sites	N/A	10 August 2022 to 10 August 2037
Dee River Dredging	Operational	Overlaps	8.2	Dredging activities and dredge disposal sites	N/A	10 August 2022 to 10 August 2037
Port of Barrow maintenance dredging disposal licence	Operational	34.2	33.9	Dredging activities and dredge disposal sites	N/A	13 September 2016 to 12 September 2026
Liverpool Marina Maintenance Dredging – Sustainable Relocation of Dredged Material to the River Mersey	Operational	11.4	22.2	Dredging activities and dredge disposal sites	N/A	19 February 2021 to 31 March 2030
RNLI Regional Maintenance	Operational	Overlaps	16.4	Dredging activities and dredge disposal sites	N/A	18 April 2019 to 17 April 2029
Tier 2						
Morgan Offshore Wind Project	Pre-application	31.5	36.2	Morgan Offshore Wind Project, an offshore wind farm planning to	1 January 2028 to 31 December 2029	1 January 2030 to 31 December 2065

Project/Plan	Status	Distance from the regional study area (km)	Distance from the local study area (km)	Description of project/plan	Dates of construction (if applicable)	Dates of operation (if applicable)
				comprise up to 107 wind turbines.		
Mona Offshore Wind Project	Pre-application	0	8.2	Mona Offshore Wind Project, an offshore wind farm planning to comprise up to 107 wind turbines.		
Morecambe Offshore Windfarm	Pre-application	7.3	9.4	Morecambe Offshore Windfarm, an offshore wind farm planning to comprise up to 40 wind turbines.	1 January 2028 to 31 December 2029	1 January 2030 to 31 December 2065
Tier 3						
MaresConnect	Permitted	Overlaps	Overlaps	MaresConnect is a proposed 750 Megawatt (MW) subsea and underground electricity interconnector system linking the electricity grids in Ireland and Great Britain.	N/A	N/A

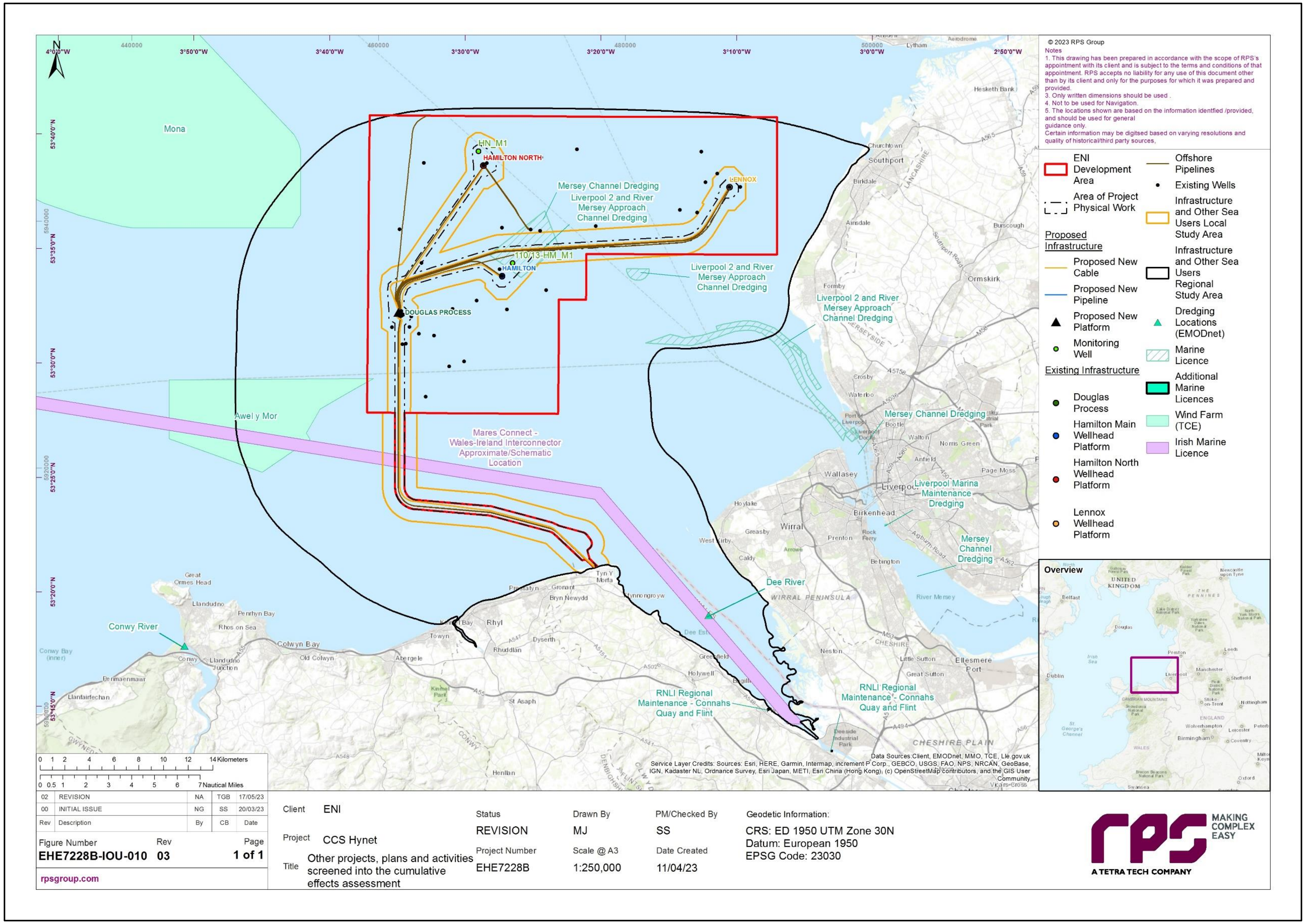

Figure 12.7: Other Projects, Plans And Activities Screened Into The CEA For Infrastructure And Other Sea Users

12.12.2 Cumulative maximum design scenario

The MDSs identified in Table 12.11 have been selected as the design options having the potential to result in the greatest effect on an identified receptor or receptor group. The cumulative effects presented and assessed in this section are based on the PDE as well as the information available on other projects, plans and activities in order to inform an MDS. Effects of greater adverse significance are not predicted to arise if the development scenario to be taken forward in the final design scheme is within the PDE.

The range of potential cumulative impacts identified in Table 12.11 below is a subset of those considered for the Proposed Development alone assessment (Table 12.8). This is for one of two reasons:

- The potential impacts identified and assessed for the Proposed Development alone are relatively localised and have limited, or no, potential to interact with similar impacts associated with other projects.
- The potential significance of impact has been assessed as negligible for the Proposed Development alone and therefore has limited or no potential to interact with similar impacts associated with other projects.

Of the impacts set out in Table 12.11, the following have not been included in the CEA:

- Displacement of recreational activities during the construction and decommissioning phases is considered to be a localised effect, with no potential to interact with similar impacts associated with other projects.
- Increased SSCs and associated deposition affecting recreational diving and bathing sites is considered to be either of minor or negligible adverse effect, and impacts will be localised with limited potential to interact with similar impacts associated with other projects.
- Impacts to existing cables or pipelines or restrictions on access to cables or pipelines is considered to be a localised effect, with no potential to interact with similar impacts associated with other projects.
- Reduction or restriction of oil and gas exploration activities (including surveys, drilling and the placement of infrastructure) is considered to be a localised effect, with no potential to interact with similar impacts associated with other projects.

Table 12.11: Maximum Design Scenario Considered For The Assessment Of Potential Cumulative Effects On Infrastructure And Other Sea Users

[a] C=construction, O&M=operations and maintenance, D=decommissioning

Potential cumulative effect	Phase[a]			Maximum Design Scenario	Justification
	C	O&M	D		
Displacement of recreational activities	×	✓	×	MDS as described for the Proposed Development (Table 12.8) assessed cumulatively with the following other projects/plans: **Tier 1** • Awel y Môr. **Tier 2** • Mona Offshore Wind Project • Morecambe Offshore Windfarm • Morgan Offshore Wind Project.	Outcome of the CEA will be greatest when the greatest amount of the largest infrastructure and associated minimum spacing and the greatest extent of advisory safety zones are considered in-combination. Plans and projects which have the potential to displace recreational activities have been included.
Increased SSCs and associated deposition affecting aggregate extraction areas	✓	✓	✓	MDS as described for the Proposed Development (Table 12.8Table 12.8) assessed cumulatively with the following other projects/plans: **Tier 1** • Liverpool Marina Maintenance Dredging – Sustainable Relocation of Dredged Material to the River Mersey • Liverpool 2 and River Mersey Approach Channel Dredging • Mersey Channel and River Maintenance Dredge Disposal Renewal • Castletown Bay Dredging, Isle of Man • Douglas Harbour Dredging, Isle of Man • Conwy River Dredging • Dee River Dredging • Port of Barrow maintenance dredging disposal licence • RNLI Regional Maintenance • Awel y Môr. **Tier 2** • Mona Offshore Wind Project • Morecambe Offshore Windfarm • Morgan Offshore Wind Project. **Tier 3** • MaresConnect.	Outcome of the CEA will be greatest when the greatest number of other plans and projects are considered in-combination. Activities from plans and projects that potentially increase suspended sediment concentrations during the temporal overlap with the Proposed Development phases have been included as these may create a cumulative impact on aggregate extraction areas.

12.13 Cumulative effects assessment

A description of the significance of cumulative effects upon other sea users receptors arising from each identified impact is given below.

12.13.1 Displacement of recreational activities

The presence of the platform, wells, pipelines and cables and the advisory safety zones associated with these may lead to the displacement of recreational activities such as sailing and motor cruising, recreational fishing and inshore water sports. Should the Proposed Development exist at the same as the other projects cited, there is the potential for a cumulative effect.

12.13.1.1 Operations and maintenance phase: Tier 1 and Tier 2

Magnitude of impact

The magnitude of the displacement of recreational activities arising from the presence of infrastructure associated with the Proposed Development during the operations and maintenance phase has been assessed as medium for the Proposed Development alone.

The operations and maintenance phase of the Proposed Development coincides with the operational phase of Awel y Môr. The proposed Awel y Môr development will comprise up to 50 wind turbines. Combined with the platform for the Proposed Development there will be a cumulative effect on recreational activities due to displacement.

The proposed developments of the Mona Offshore Wind Project, the Morgan Offshore Wind Project and the Morecambe Offshore Windfarm, comprising up to 107, 107 and 40 wind turbines respectively, will be in operation during the operations and maintenance phase of the Proposed Development. The Mona Offshore Wind Project is 8.2 km from the infrastructure and other sea users study area, the Morgan Offshore Wind Project is 36.2 km from the infrastructure and other sea users local study area and the Morecambe Offshore Windfarm is 9.4 km from the infrastructure and other sea users local study area.

The impact is predicted to be of regional spatial extent, long term duration, continuous and irreversible over the 25-year operations and maintenance phase of the Proposed Development. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **medium**.

Sensitivity of the receptor

The sensitivity of the receptor has been assessed and it is considered to be **low**.

Significance of effect

Overall, the magnitude of the cumulative impact is deemed to be medium and the sensitivity of the receptor is considered to be low. As set out in Table 12.7, the effect will therefore be of **minor adverse** significance, which is not significant. The effect has been defined as minor rather than negligible as there will still be a perceptible effect, although it is unlikely to be critical in the decision-making process.

12.13.2 Increased SSCs and associated deposition affecting aggregate extraction areas

Increased SSCs may arise due to seabed preparation involving sand wave clearance, the installation of the platform foundations, the installation and/or maintenance of cables and associated decommissioning activities. Should the other projects cited take place concurrently with the Project (construction or operations and maintenance), there is the potential for a cumulative effect of increased turbidity levels impacting on aggregate extraction areas.

12.13.2.1 Construction phase: tier 1, tier 2 and tier 3

Magnitude of impact

The magnitude of the increase in SSCs and associated deposition arising from activities during the construction phase has been assessed as low for the Proposed Development alone.

The construction phase of the Proposed Development coincides with the operational phases of all dredging and disposal projects presented in Table 12.10. If offshore cable installation and sand wave clearance associated with the Proposed Development and dredging and disposal coincide, both resultant plumes would be advected on the tidal currents; they would travel in parallel, and not towards one another. They are unlikely to interact if offshore cable installation coincides with the use of licensed dredging and disposal sites.

As per Figure 12.2, none of these dredging and disposal projects are located in close proximity to the Proposed Development. The dredging and disposal activities carried out at these sites are also maintenance-related, and therefore are likely to be small-scale which reduces the likelihood and significance of any cumulative effect. As per volume 2, chapter 6, both the residual current and levels of potential sediment transport are low within the infrastructure and other sea users local study area, also reducing the likelihood and significance of any cumulative effect.

The construction phase of the Proposed Development also coincides with the construction phase of Awel y Môr. This project is in close proximity to the infrastructure and other sea users local study area, and interaction of SSC plumes may occur should trenching / piling / drilling activities be undertaken simultaneously. As per volume 2, chapter 6, plumes produced during drilling and sand wave clearance activities within the Awel y Môr Array Area may reach the Proposed Development's area of project physical work at up to 50mg/l on flood tides, with greater interaction at spring tides. Likewise, plumes produced through pre-lay cable trenching within the Awel y Môr Export Cable Corridor may overlap directly with the Proposed Development's area of project physical work though do so at lower values *c*.5mg/l and are only likely to occur if trenching activities occur simultaneously. Cumulative deposition may occur between the POA to Douglas cable trenching and the foundation drilling with the Awel y Môr Array Area, however, interaction is expected to occur at *c*. <1 mm. As such, the magnitude of the cumulative change would be minimal with suspended sediment concentrations from Awel y Môr construction activities reaching the receptors at background values. These cumulative impacts are expected to remain of limited magnitude due to the rapid decrease in SSC and deposition with distance from the source of sediment disturbance.

The Mona Offshore Wind Project, the Morgan Offshore Wind Project and the Morecambe Offshore Windfarm construction phases will also overlap with the Proposed Development construction phase. Construction activities from these other projects may result in increased SSC, but these activities would be of limited spatial extent and frequency and therefore unlikely to interact with sediment plumes from the Proposed Development.

Finally, the construction phase of the Proposed Development may overlap with the construction or operational phase of MaresConnect. This project overlaps with the Offshore Cable Corridor, and similarly to Awel y Môr interaction of SSC plumes on spring tide events may occur should trenching activities be undertaken simultaneously. The concentration of suspended sediment reduces significantly moving further from activity so the potential for overlap of resultant plumes with MaresConnect would be low.

SSC plumes are localised to within the immediate vicinity of the construction activity and returning to background levels, therefore travelling on the tide in parallel will most likely avoid interception of the most concentrated suspended sediment part of each plume. As per volume 2, chapter 6, both the residual current and levels of potential sediment transport are low within the infrastructure and other sea users local study area, also reducing the likelihood and significance of any cumulative effect.

The cumulative effect is predicted to be of regional spatial extent, medium term duration, intermittent and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.

Sensitivity of receptor

The sensitivity of the receptor has been assessed and it is considered to be medium.

Significance of effect

Overall, the magnitude of the cumulative impact is deemed to be low and the sensitivity of the receptor is considered to be medium. As set out in Table 12.7, the effect will therefore be of minor adverse significance, which is not significant.

12.13.2.2 Operations and maintenance phase

Magnitude of impact

The magnitude of the increase in suspended sediment concentrations and associated deposition arising from activities during the operations and maintenance phase has been assessed as negligible for the Proposed Development alone.

The operations and maintenance phase of the Proposed Development coincides with the operational phases of all of the dredging and disposal projects presented in Table 12.10 other than the Liverpool 2 and River Mersey Approach Channel Dredging and RNLI Regional maintenance. If activities such as cable repair and reburial associated with the Proposed Development and dredging and disposal coincided, both resultant plumes would be advected on the tidal currents, they would travel in parallel, and not towards one another. They are unlikely to interact if cable repair and reburial coincides with the use of licensed dredging and disposal sites.

As per Figure 12.2, none of these dredging and disposal projects are located in close proximity to the Proposed Development. The dredging and disposal activities carried out at these sites are also maintenance-related, and therefore are likely to be small-scale which reduces the likelihood and significance of any cumulative effect. As per volume 2, chapter 6, both the residual current and levels of potential sediment transport are low within the infrastructure and other sea users local study area, also reducing the likelihood and significance of any cumulative effect.

The operations and maintenance phase of the Proposed Development also coincides with the operational phase of Awel y Môr. Cumulative effects arising from construction activities from this project is likely to be low. Maintenance activities are both intermittent and a smaller scale than that of the construction phase and therefore any potential cumulative impacts are less likely to occur and be on a smaller scale.

The Mona Offshore Wind Project, the Morgan Offshore Wind Project and the Morecambe Offshore Windfarm operations and maintenance phases will also overlap with the Proposed Development operations and maintenance phase. Maintenance activities are both intermittent and a smaller scale than that of the construction phase and therefore any potential cumulative impacts are less likely to occur and be on a smaller scale.

Similarly to the above, the operations and maintenance phase of the Proposed Development may coincide with the construction, operational or decommissioning phases of MaresConnect. Maintenance activities are both intermittent and a smaller scale than that of the construction phase and therefore any potential cumulative impacts are less likely to occur and be on a smaller scale.

As per volume 2, chapter 6, both the residual current and levels of potential sediment transport are low within the infrastructure and other sea users local study area, also reducing the likelihood and significance of any cumulative effect.

The cumulative effect is predicted to be of regional spatial extent, long term duration, low frequency and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **negligible**.

Sensitivity of receptor

The sensitivity of the receptor has been assessed and it is considered to **be medium**.

Significance of effect

Overall, the magnitude of the cumulative impact is deemed to be negligible and the sensitivity of the receptor is considered to be medium. As set out in Table 12.7, the effect will therefore be of **minor adverse** significance, which is not significant. The effect has been defined as minor rather than negligible as there will still be a perceptible effect, although it is unlikely to be critical in the decision-making process.

12.13.2.3 Decommissioning phase

Significance of effect

The effects of decommissioning activities are expected to be the same or similar to the effects from construction. As set out in Table 12.7, the effect is therefore considered to be of **minor adverse** significance, which is not significant.

12.14 Transboundary effects

A screening of transboundary impacts has been carried out and has identified that there was no potential for significant transboundary effects with regard to other sea users from the Proposed Development upon the interests of other states.

12.15 Summary of impacts, mitigation measures and monitoring

Information on infrastructure and other sea users within the infrastructure and other sea users local and regional study areas was collected through desktop reviews of available datasets.

- Table 12.12 presents a summary of the potential impacts, measures adopted as part of the Proposed Development and residual effects in respect to infrastructure and other sea users. Overall, it is concluded that there will be no significant effects arising from the Proposed Development during the construction, operations and maintenance, or decommissioning phases.
- Table 12.13 presents a summary of the potential cumulative impacts, mitigation measures and residual effects. Overall, it is concluded that there will be no significant cumulative effects from the Proposed Development alongside other projects/plans.
- No potential transboundary impacts have been identified in regard to effects of the Proposed Development.

Table 12.12: Summary of Potential Environmental Effects, Mitigation and Monitoring

[a] C=construction, O&M=operations and maintenance, D=decommissioning

Potential impact	Phase[a]			Measures adopted as part of the Proposed Development	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual effect	Proposed monitoring
	C	O&M	D							
Displacement of recreational activities	✓	✓	✓	Promulgation of information advising on the nature, timing and location of activities, including through Notices to Mariners, safety zones.	C: Low O: Medium D: Low	C: Low O: Low D: Low	C: Minor O: Minor D: Minor	N/A	N/A	N/A
Increased SSCs and associated deposition affecting recreational diving and bathing sites	✓	✓	✓	Promulgation of information advising on the nature, timing and location of activities, including through Notices to Mariners, safety zones.	C: Low O: Negligible D: Low	C: Low O: Low D: Low	C: Minor O: Negligible D: Minor	N/A	N/A	N/A
Impacts to existing cables or pipelines or restrictions on access to cables or pipelines	✓	✓	✓	Safety zones, cable and pipeline crossing/proximity agreements, consultation with oil and gas operators.	C: Low O: Low D: Low	C: Medium O: Medium D: Medium	C: Minor O: Minor D: Minor	N/A	N/A	N/A
Increased SSCs and associated deposition affecting aggregate extraction areas	✓	✓	✓	Promulgation of information advising on the nature, timing and location of activities, including through Notices to Mariners, safety zones.	C: Low O: Negligible D: Low	C: Medium O: Medium D: Medium	C: Minor O: Minor D: Minor	N/A	N/A	N/A
Reduction or restriction of oil and gas	✓	✓	✓	Safety zones, consultation with oil and gas operators.	C: Medium O: Medium	C: Negligible O: Negligible	C: Minor O: Minor	N/A	N/A	N/A

Potential impact	Phase[a]			Measures adopted as part of the Proposed Development	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual effect	Proposed monitoring
	C	O&M	D							
exploration activities (including surveys, drilling and the placement of infrastructure)					D: Medium	D: Negligible	D: Minor			

Table 12.13: Summary of Potential Cumulative Environmental Effects, Mitigation and Monitoring

[a] C=construction, O&M=operations and maintenance, D=decommissioning

Potential impact	Phase[a]			Measures adopted as part of the Proposed Development	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual effect	Proposed monitoring
	C	O&M	D							
Tier 1, Tier 2 and Tier 3										
Displacement of recreational activities	×	✓	×	Promulgation of information advising on the nature, timing and location of activities, including through Notices to Mariners, safety zones.	O: Medium	O: Low	O: Minor	N/A	N/A	N/A
Increased SSCs and associated deposition affecting aggregate extraction areas	✓	✓	✓	Promulgation of information advising on the nature, timing and location of activities, including through Notices to Mariners, safety zones.	C: Low O: Negligible D: Low	C: Medium O: Medium D: Medium	C: Minor O: Minor D: Minor	N/A	N/A	N/A

12.16 References

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Liverpool Bay CCS Ltd

HYNET CARBON DIOXIDE TRANSPORTATION AND STORAGE PROJECT – OFFSHORE

Environmental Statement
Volume 2, chapter 13: Climate Change

EHE7228B
Liverpool Bay CCS Limited
Final
February 2024
Offshore ES
Climate Change

rpsgroup.com

Glossary

Term	Meaning
Carbon Budgets	A carbon budget places restrictions on the total amount of greenhouse gases that can be emitted from a nation. The budget balances the input of CO_2 to the atmosphere by emissions from human activities, by the storage of carbon (i.e. in carbon reservoirs on land or in the ocean).
Cumulative Effects Assessment	Assessment of the likely effects arising from the offshore components of the HyNet CO_2 Transportation and Storage Project ('Proposed Development') alongside the likely effects of other development activities in the vicinity of the Proposed Development.
Effect	The consequence of an impact.
Environmental Impact Assessment	A statutory process by which certain planned projects must be assessed before a formal decision to proceed can be made. It involves the collection and consideration of environmental information, which fulfils the assessment requirements of the EIA Directive and EIA Regulations, including the publication of an Environmental Statement (ES).
Impact	A change that is caused by an action.
Magnitude	Size, extent, and duration of an impact.
Maximum Design Scenario	The maximum design parameters of each Proposed Development asset (both on and offshore) considered to be a worst case for any given assessment but within the range of the Project Description Envelope.
Mitigation Measure	Measure which would avoid, reduce, or remediate an impact.
Nationally Determined Contribution	A climate action plan to cut emissions and adapt to climate impacts. A requirement of the Paris Agreement.
Non-statutory stakeholder	Organisations with whom the regulatory authorities may choose to engage who are not designated in law but are likely to have an interest in a Proposed Development.
Project	The HyNet Carbon Dioxide Transportation and Storage Project.
Proposed Development	The offshore components of the Project which are subject of this Environmental Statement, as described in Chapter 3: Proposed Development Description.
Scoping Opinion	Sets out the Secretary of State's response to the Applicants Scoping Report and contains the range of issues that the Secretary of State, in consultation with statutory stakeholders, has identified should be considered within the EIA.
The Applicant	This is Liverpool Bay CCS Ltd.
Transboundary effects	Impacts from a project within one state affect the environment of another state(s).

Acronyms and Initialisations

Acronyms and Initialisations	Description
CCS	Carbon Capture and Storage
CEA	Cumulative Effects Assessment
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
Defra	The Department for Environment, Food and Rural Affairs
DESNZ	The Department for Energy Security and Net Zero, preceded by the Department for Business, Energy, and Industrial Strategy (2016 to 2023) and the Department of Energy and Climate Change (2008 to 2016)
EIA	Environmental Impact Assessment
ES	Environmental Statement
EU	European Union
GHG	Greenhouse Gas

Acronyms and Initialisations	Description
HRA	Habitats Regulations Appraisal
LDAR	Leak Detection and Repair
MDS	Maximum Design Scenario
MHWS	Mean High Water Springs
MMO	Marine Management Organisation
NDC	Nationally Determined Contribution
NPS	National Policy Statement
O&M	Operations and Maintenance
OP	Offshore Platform
OPRED	Offshore Petroleum Regulator for Environment & Decommissioning
PDE	Project Design Envelope
PoA	Point of Ayr
UK	United Kingdom
UNFCCC	United Nations Framework Convention on Climate Change
WBCSD	World Business Council for Sustainable Development
WNMP	Welsh National Marine Plan
WRI	World Resources Institute

Units

Unit	Description
%	Percent
km	Kilometres (distance)
m	Metres (distance)
Mt	Million tonnes (weight)
t	tonnes (weight)

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13 CLIMATE CHANGE

13.1 Introduction

This chapter of the Offshore ES presents the assessment of the likely significant effects (as per the 'Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020 (The '2020 EIA Regulations'), and 'The Marine Works (Environmental Impact Assessment) Regulations 2007 (as amended)) on the environment of the Proposed Development on climate change. Specifically, this chapter considers the potential impacts from the construction, operation and maintenance, and decommissioning of the offshore and intertidal components (seaward of the Mean High Water Springs (MHWS) mark) of the development area, which includes the pipelines and cables leading to MHWS.

Likely significant effect is a term used in both the 'EIA Regulations', and in IEMA's guidance on Assessing Greenhouse Gas Emissions (IEMA, 2022) and Climate Change Resilience and Adaptation (IEMA, 2020). Reference to likely significant effect in this Offshore ES refers to 'likely significant effect' as used by the 'EIA Regulations'.

This chapter is supported by information contained within:

- Greenhouse Gas Assessment Technical Report (RPS Group, 2023)

13.2 Purpose of this chapter

The primary purpose of the Offshore ES is outlined in volume 1, chapter 1. It is intended that the Offshore ES will provide the statutory and non-statutory stakeholders, with sufficient information to determine the likely significant effects of the Proposed Development on the receiving environment.

Climate change in the context of EIA can be considered broadly in two parts:

- the potential effect of greenhouse gas emissions (GHGs) caused directly or indirectly by the Proposed Development, which may have the potential to contribute to climate change; and
- the potential effect of changes in climate on the Proposed Development, which could affect it directly or could modify its other environmental impacts.

In particular, this climate change ES chapter:

- presents the existing environmental baseline established from desk studies;
- identifies any assumptions and limitations encountered in compiling the environmental information;
- presents the likely significant environmental impacts on climate arising from the Proposed Development and reaches a conclusion on the likely significant effects on climate change, based on the information gathered and the analysis and assessments undertaken; and
- highlights any necessary monitoring and/or mitigation measures which are recommended to prevent, minimise, reduce or offset the likely significant adverse environmental effects of the Proposed Development on climate change.

13.3 Study area

The Proposed Development climate change study area is defined as the area encompassing the development area, which will include the following infrastructure.

- Offshore Platforms (OPs), specifically Douglas Process platform, and Hamilton North, Hamilton Main, and Lennox wellhead platforms.
- Offshore carbon dioxide (CO_2) injection wells connected to the wellhead platforms, and CO_2 monitoring and sentinel wells, located within the Hamilton, Hamilton North and Lennox fields.

- Offshore pipelines connecting the Point of Ayr (PoA) Terminal to Douglas OP and connecting Douglas OP to the Hamilton North, Hamilton Main and Lennox OPs.
- Offshore inter-platform power and fibre optic cables.
- Offshore power and fibre optic cables connecting the PoA Terminal to Douglas OP (seawards of MHWS).

GHG emissions have a global (international) effect rather than directly affecting any specific local receptor. The impact of GHG emissions occurring due to the Proposed Development on the global atmospheric concentration of the relevant GHGs, expressed in CO_2-equivalents (CO_2e), is therefore considered within this assessment.

With regards to the Cumulative Effects Assessment (CEA), all developments that emit, avoid or sequester GHGs have the potential to impact the atmospheric mass of GHGs as a receptor, and so may have a cumulative impact on climate change and upon the development. Consequently, cumulative effects due to other specific local development projects are not considered individually but are taken into account when considering the impact of the Proposed Development. However, the potential effects from the wider HyNet project are considered in order to account for the potential effect of the whole carbon capture and storage (CCS) project, as informed by the HyNet Carbon Dioxide Pipeline Town and Country Planning Act (TCPA) (WSP UK, 2023b) and Development Consent Order (DCO) (WSP UK, 2023a) applications which detail the onshore CO_2 transmission and compression elements of the CCS project. Therefore, the study area for the assessment of Cumulative Effects incorporates the Proposed Development's development area, alongside the red line boundaries associated with the HyNet Carbon Dioxide Pipeline TCPA and DCO applications. These are shown within Figure 13.1 in green and blue, respectively. Whole lifetime emissions (i.e. emissions resulting from construction, operation and maintenance, and decommissioning) arising from such elements of the wider HyNet project within the Cumulative Effects study area have been considered.

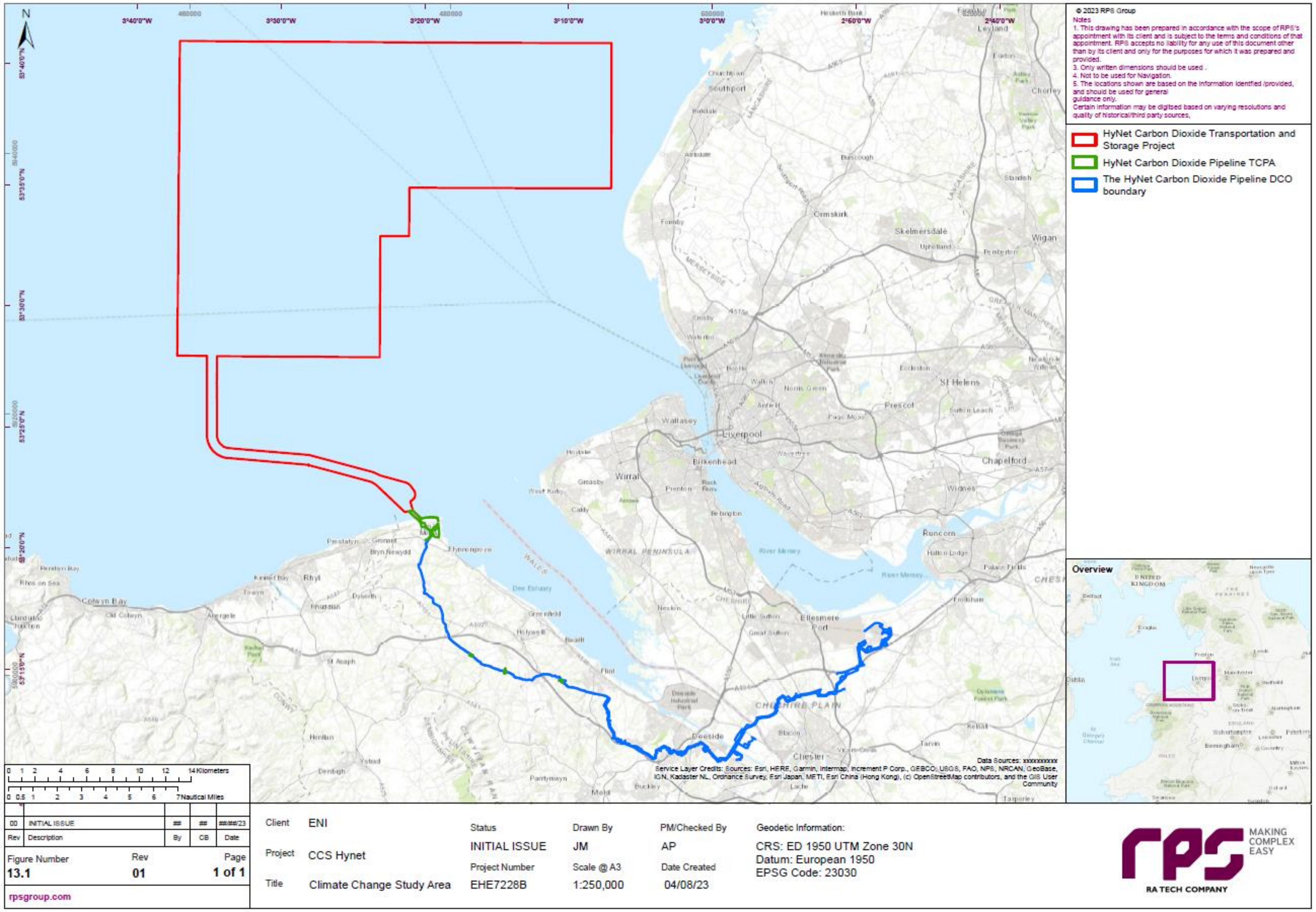

Figure 13.1: Climate Change Study Area

13.4 Policy and legislative context

The policy context for the HyNet Carbon Dioxide Transportation and Storage Project is set out in volume 1, chapter 2. Within this chapter, policy specifically in relation to climate change, is contained in section 2.2 Climate Change and Energy Policy and Legislation and section 2.3 Marine policy.

13.4.1 Marine plans

Table 13.1 sets out a summary of the specific policies in the North West Inshore and North West Offshore Marine Plan (MMO, 2021), and Welsh National Marine Plan (Welsh Government, 2019), relevant to this chapter.

Table 13.1: Summary Of Inshore And Offshore Marine Plan Policies Relevant To This Chapter

Policy	Key Provisions	How and Where Considered in the Offshore ES
North West Inshore and North West Offshore Marine Plan		
NW-CC-2	Proposals should demonstrate for the lifetime of the project that they are resilient to the impacts of climate change and coastal change.	Climate change risk to the Proposed Development, including the consideration of resilience/adaptation measures has been scoped out of this assessment (as detailed within section 13.8.2). The assessment of climate risk to the Proposed Development has been scoped out as effects are anticipated to not be significant. Studies conducted from Liverpool Bay have shown that extreme wind and wave climates are not expected to change significantly from those that are currently exhibited. Additionally, long-term analyses have illustrated that although there was a slight increase in the severity of most extreme events, there was little change in the extreme wave climate predicted for Liverpool Bay. The Proposed Development will be re-using and refurbishing existing offshore infrastructure, and introducing a new offshore platform that have been designed for resilience to storms in Liverpool Bay and have been proven operationally. The design of construction and refurbishment works to the sea-surface infrastructure will be to appropriate engineering and safety standards taking into account metocean data for this location. The pipeline and gas injection well are all undersea (and indeed under the seabed in the case of the sequestration volume) with minimal vulnerability to storm events.
NW-AIR-1	Proposals must assess their direct and indirect emissions of GHGs. Where proposals are likely to result in increased emissions of GHGs, it must be demonstrated that they will be avoided, minimised, and mitigated.	This chapter provides an assessment of CO_2e emissions resultant from the Proposed Development over its construction, operation and maintenance, and decommissioning phases within section 13.11.
Welsh National Marine Plan		
SOC_10	Proposals should demonstrate how they, in order of preference: a) Avoid the emission of greenhouse gases; and/or b) Minimise them where they cannot be avoided; and/or c) Mitigate them where they cannot be minimised. Where significant emission of greenhouse gases cannot be	This chapter provides an assessment of CO_2e emissions resultant from the Proposed Development over its construction, operation and maintenance, and decommissioning phases within section 13.11.

Policy	Key Provisions	How and Where Considered in the Offshore ES
	avoided, minimised or mitigated, proposals for regulated activities must present a clear and convincing case for proceeding.	
SOC_11	Proposals must demonstrate that they have considered the impacts of climate change and have incorporated appropriate adaptation measures, taking into account Climate Risk Assessments for Wales. Proposals that contribute to climate change adaptation and/or mitigation are encouraged.	Climate change risk to the Proposed Development, including the consideration of resilience/adaptation measures has been scoped out of this assessment (as detailed within section 13.8.2). The assessment of climate risk to the Proposed Development has been scoped out as effects are anticipated to not be significant. Studies conducted from Liverpool Bay have shown that extreme wind and wave climates are not expected to change significantly from those that are currently exhibited. Additionally, long-term analyses have illustrated that although there was a slight increase in the severity of most extreme events, there was little change in the extreme wave climate predicted for Liverpool Bay. The Proposed Development will be re-using and refurbishing existing offshore infrastructure, and introducing a new offshore platform that have been designed for resilience to storms in Liverpool Bay and have been proven operationally. The design of construction and refurbishment works to the sea-surface infrastructure will be to appropriate engineering and safety standards taking into account metocean data for this location. The pipeline and gas injection well are all undersea (and indeed under the seabed in the case of the sequestration volume) with minimal vulnerability to storm events.

Table 13.2 Summary Of Policies Relevant To Climate Change Within The National Policy Statements

Summary of Relevant Legislation	How and Where Considered in the Offshore ES
NPS EN-1: This NPS sets out how the energy sector can help deliver the Government's climate change objectives by clearly setting out the need for new low carbon energy infrastructure to contribute to climate change mitigation (paragraph 2.2.11 of NPS EN-1) (DECC, 2011).	Detailed within volume 1, chapter 2, section 2.2 Climate Change Policy and the need for the Development.
NPS EN-1: 'CO2 emissions are a significant adverse impact from some types of energy infrastructure which cannot be totally avoided', 'any ES on air emissions will include an assessment of CO2 emissions' (paragraph 5.2.2 of NPS EN-1) (DECC, 2011).	This chapter provides an assessment of CO_2e emissions resultant from the Proposed Development over its construction, operation and maintenance, and decommissioning phases within section 13.11.
Draft NPS EN-1: 'Applicants should include a carbon assessment as part of their ES, including a whole life carbon assessment (including the carbon impacts from construction, operation, and decommissioning). Alongside this, applicants should explain any steps taken to reduce climate change impacts at each of these stages (paragraph 5.3.4 if the draft NPS EN-1) (DESNZ, 2023).'	This chapter provides an assessment of CO_2e emissions resultant from the Proposed Development over its construction, operation and maintenance, and decommissioning phases within section 13.11.

13.5 Consultation

A summary of the key issues raised during consultation activities undertaken to date specific to climate change is presented in Table 13.3 below, together with how these issues have been considered in the production of this Offshore ES chapter.

Table 13.3: Summary Of Key Consultation Of Relevance To Climate Change

Date	Consultee and type of response	Issue raised	Response to issue raised and/or where considered in this chapter
27 January 2023	Scoping Opinion, Offshore Petroleum Regulator for Environment & Decommissioning (OPRED)	The following comments were listed under the heading *'Air Quality and Climate Change Adaptation':* *'The ES should take account of the risks of air pollution from the Project and how these can be managed or reduced'.* *'The England Biodiversity Strategy published by Defra establishes principles for the consideration of biodiversity and the effects of climate change. It is recommended that the ES reflects the principles outlined in this strategy and should aim to identify the effect of the development on climate change and how ecological networks will be maintained'.*	The risks of air pollution from the Proposed Development is scoped out of the EIA due to no likely significant effect in EIA terms or no effect-receptor pathways identified. Justification for scoping out this topic is provided in Air Quality Technical Report (RPS Group, 2023). This climate change chapter of the ES assesses the effect of the Proposed Development on climate change through GHG emissions resultant from the construction, operation and maintenance, and decommissioning phases, in addition to considering avoided emissions resultant from the cumulative effect of the wider HyNet project. This climate change chapter of the ES does not consider the impact of climate change on biodiversity and ecological networks. Such in-combination effects have been assessed in the applicable topic chapters within the ES (volume 2, chapter 7) where relevant, through consideration of how climate change is likely to affect the future baseline environment and sensitivity of receptors.

13.6 Methodology to inform the baseline

13.6.1 Desktop study

Information regarding GHG emissions leading to climate change within the climate change study area has been collated through detailed and comprehensive review of currently accessible studies and datasets. Key data sources are listed in Table 13.4 below, noting that this list is not exhaustive.

Table 13.4: Summary Of Key Desktop Reports

Title	Source	Year	Author
UK Government GHG Conversion Factors for Company Reporting.	Department for Energy Security and Net Zero (DESNZ) and Department for Environment, Food and Rural Affairs (Defra)	2023	DESNZ and Defra
Inventory of Carbon and Energy (ICE) database.	Circular Ecology, University of Bath.	2019	Jones and Hammond

13.6.2 Identification of designated sites

There are no relevant designated sites for climate change for the purpose of this EIA assessment.

13.6.3 Site-specific surveys

No site-specific surveys have been undertaken to inform the EIA for climate change.

13.7 Existing baseline description

13.7.1 Climate change

The current baseline environment for the Proposed Development comprises three existing OPs and connecting submarine pipelines and cables. These OPs form part of the Douglas OP Complex, comprising the current Douglas OP which is the control hub for operations and contains facilities for personnel; alongside the Lennox, Hamilton North, and Hamilton Main OPs, which are all unmanned oil and gas wellhead platforms.

Such infrastructure has been used for the extraction and transport of natural gas from gas reservoirs in Liverpool Bay to the PoA gas terminal. As emissions associated with such activity are attributed to the existing Douglas OP, where changes to its operation and decommissioning not included within the scope of this application, current baseline emissions are considered to be zero.

Land within the climate change study area that is not currently occupied by OP foundations, pipelines and cables, consists of various subtidal habitats of mixed sediments (including coarse sediment, sandy mud, fine sand, muddy sand, and deep sand) supporting diverse benthic communities. This is confirmed in volume 2, chapter 7.

13.8 Key parameters for assessment

13.8.1 Maximum design scenario

A range of potential Proposed Development impacts on climate change have been identified which could potentially occur during the construction, operation and maintenance, and decommissioning phases of the Proposed Development.

Impacts that have been scoped into the assessment are outlined in Table 13.5 along with the identified maximum design scenarios. The maximum design scenarios have been selected as those having the potential to result in the greatest effect on an identified receptor or receptor group. These scenarios have been selected from the details provided in volume 1, chapter 3. Effects of greater adverse significance are not predicted to arise should any other development scenario, based on details within the Project Design Envelope (PDE) (e.g. different infrastructure layout), to that assessed here, be taken forward in the final design scheme.

Table 13.5: Maximum Design Scenario Considered For Each Impact As Part Of The Assessment Of Likely Significant Effects On Climate Change

Potential Impact	Phase			Maximum Design Scenario	Justification
	C	O&M	D		
The impact of GHG emissions arising from the manufacturing and installation of the Proposed Development, including materials, transport and use of plant / offshore marine vessels.	✓	×	×	**Construction Phase** • Greatest number of transport vehicles and vessels for the installation of the Proposed Development (2 no. heavy lift vessel return trips, 4 no. tug/anchor handler vessel return trips, 3 no. cargo barge return trips, 1 no. diving support vessel return trip, and 28 no. crew boat return trips for the installation of the New Douglas platform; 10 no. tug/anchor handler vessel return trips, 9 no. cargo barge return trips, 80 no. support vessel return trips, 3 no. survey vessel return trips, 2 no. pre-comm vessel return trips, 1 no. seabed preparation vessel return trips, 76 no. crew transfer vessel return trips for the installation of the Hamilton Main, Hamilton North and Lennox OP topsides; and 4 no. cable lay installation and support vessel return trips, 1 no jack-up vessel return trip, 2 no. multicat vessel return trips, 3 no. working boat return trips, 1 no. support vessel return trips, 4 no. crew transfer vessel return trips, 1 no. cable protection installation vessel return trip, 1 no. cable burial installation vessel return trip for the installation of cables and pipeline). • The greatest weight of materials for the construction of the New Douglas OP (jacket – 2,940 tonnes, topsides – 2,290 tonnes). • The greatest number of OPs to be renovated (3), and their maximum weight for deck replacement (Hamilton Main – 1,100 tonnes, Hamilton North – 950 tonnes, Lennox – 1,400 tonnes). • The maximum length of new pipeline (592 m from existing PoA to New Douglas, 175 m from existing Hamilton Main OP gas export to New Douglas, 128 m from existing Lennox OP gas export to New Douglas, 195 m from existing Lennox gas injection to New Douglas, 68 m from existing Hamilton North to New Douglas). • The maximum length of cable routes (33.99 km for cable no. 1 from PoA Terminal to Douglas OP, 33.95 km for cable no. 2 from PoA Terminal to Douglas OP, 10.87 km cable from Douglas OP to Hamilton OP, 14.89 km cable from Douglas OP to Hamilton North OP, 32.34 km cable from Douglas OP to Lennox OP). • The maximum weight number of cable crossings (10) alongside the maximum weight of cable protection rock aggregate and area of crossing protection concrete.	**Construction phase** • The greatest number and size of structures and maximum length of the pipeline and cables will result in the greatest consumption of fuel and materials, representing the greatest potential for GHG emissions.

Potential Impact	Phase C	Phase O&M	Phase D	Maximum Design Scenario	Justification
				• The maximum number of new CO_2 injection wells (13).	
The impact of GHG emissions arising from materials and use of offshore marine vessels required for operation and maintenance.	×	✓	×	**Operation and Maintenance Phase** • The greatest number of maintenance vehicles and machinery across the lifetime of the Proposed Development (15 no. jack-up vessel return trips, 15 no. other vessel return trips, and 300 no. helicopter return trips).	**Operation and maintenance phase** • The greatest number vehicle movements will result in the greatest consumption of fuel and materials, representing the greatest potential for GHG emissions.
The impact of GHG emissions associated with energy and fuel use during the operation phase.	×	✓	×	**Operation and Maintenance Phase** • The greatest number of offshore platforms (4 no. including New Douglas OP).	**Operation and maintenance phase** • The greatest number of offshore platforms will result in the greatest consumption of energy and fuel, representing the greatest potential for GHG emissions.
The impact of GHG emissions from decommissioning works (plant, fuel, and vessel use) and recovery or disposal of materials.	×	×	✓	**Decommissioning phase** • Greatest number of transport vehicles and vessels for the decommissioning of the Proposed Development (5 no. main decommissioning and support vessel return trips, 8 no. tug/anchor handler return trips, 5 no. cargo barge return trips, 20 no. cable decommissioning and support vessel return trips, 108 no. crew transfer vessel return trips). • The greatest weight of materials for the construction of the New Douglas OP (jacket – 2,940 tonnes, topsides – 2,290 tonnes). • The greatest number of OPs to be renovated (3), and their maximum weight for deck replacement (Hamilton Main – 1,100 tonnes, Hamilton North – 950 tonnes, Lennox – 1,400 tonnes), alongside materials from their foundations. • The maximum length of new pipeline (592 m from existing PoA to New Douglas, 175 m from existing Hamilton Main OP gas export to New Douglas, 128 m from existing Lennox OP gas export to New Douglas, 195 m from existing Lennox gas injection to New Douglas, 68 m from existing Hamilton North to New Douglas), alongside lengths of pre-existing pipeline. • The maximum length of cable routes (33.99 km for cable no. 1 from PoA Terminal to Douglas OP, 33.95 km for cable no. 2 from PoA Terminal to Douglas OP, 10.87 km cable from Douglas OP to Hamilton OP, 14.89 km cable from Douglas OP to Hamilton North OP, 32.34 km cable from Douglas OP to Lennox OP).	**Decommissioning phase** • GHG emissions arising from decommissioning works (e.g. plant, fuel and vessel use) and the recovery (or disposal) of materials would contribute to the lifecycle total and net GHG balance of the Proposed Development.

Potential Impact	Phase C	Phase O&M	Phase D	Maximum Design Scenario	Justification
				• The maximum weight number of cable crossings (10) alongside the maximum weight of cable protection rock aggregate and area of crossing protection concrete. • The maximum number of CO_2 injection wells (13).	
The impact of CO_2 transportation, sequestration and long-term storage.	×	✓	✓	**Operation and Maintenance, and Decommissioning Phases** • The maximum amount (by volume) of CO_2 storage across the lifetime of the Proposed Development.	The purpose of the Proposed Development is to enable CO_2 transportation, sequestration, and storage. The wells will be sealed at the decommissioning stage of the Proposed Development, ensuring all stored CO_2 injected over the lifetime of the Proposed Development will remain stored within subsea reservoirs. No further assessment beyond that detailed for the operation and maintenance phases is provided.

13.8.2 Impacts scoped out of the assessment

On the basis of the baseline environment and the Proposed Development Description outlined in volume 1, chapter 3, three impacts are proposed to be scoped out of the assessment for climate change. Such impacts were proposed to be scoped out in the HyNet Carbon Dioxide transportation and Storage Project - Offshore Scoping Report (Eni, 2022) and no concerns were raised by key consultees. These impacts are outlined, together with a justification for scoping them out, in Table 13.6, below.

Table 13.6 Impacts Scoped Out Of The Assessment For Climate Change (Tick Confirms The Impact Is Scoped Out)

Potential Impact	Phase			Justification
	C	O&M	D	
GHG emissions from leaks and/or damage to the Proposed Development components within the development area into the environment during operation or during long-term sequestration use following decommissioning of the infrastructure	×	✓	✓	• Emissions from potential leaks and damage to the structural integrity of the development area offshore components could lead to increases in surrounding CO_2 pollution and concentration, causing impacts to environmental and human health in the immediate vicinity and/or partial or full reversal of the sequestration benefits of the development. • However, these are not considered to be likely or expected effects of the Proposed Development. Engineering and geological studies undertaken in the planning of the sequestration facility to date have shown its suitability for stable, long-term storage and the purpose of the engineering design of the facility will be to ensure this is achieved. • Further, during the operation of the facility, fugitive emissions will be monitored through a Leak Detection and Repair (LDAR) programme as part of preventative maintenance activities, to ensure any unplanned CO_2 release is avoided or minimised as much as is reasonably practicable. • Any material amount of CO_2 leakage is therefore considered to be possible in an accident or disaster scenario. However, such an event is considered highly unlikely (given the above designed-in protection). The risk assessment carried out by the Applicant for the project identified that there is no significant risk of CO_2 leakage from the storage complexes, or of harm to the environment or human health. The risk assessment identified and evaluated the leak paths via which CO_2 can leave the subsurface storage complexes, and included a register itemising each foreseeable leak scenario, its associated risk levels and prevention and mitigation control measures. Of all the scenarios considered, loss of containment due to an in-field legacy well providing a leak path was judged the highest risk, but even so was judged “unlikely” once the project-specific prevention and mitigation measures are taken into account. All other scenarios were considered less likely, being ranked either “rare” or “practically non-credible”. The risk assessment took account of the Measurement, Monitoring and Verification plan (MMV) that will be implemented during operation.
In-combination effects of climate change with other environmental impact pathways	✓	✓	✓	• In-combination effects will be assessed in the applicable topic chapters within the ES, through consideration of how climate change is likely to affect the future baseline environment and sensitivity of

Potential Impact	Phase C	Phase O&M	Phase D	Justification
				receptors, and it will not be duplicated within the scope of the climate change ES chapter.
Climate change risk to the Proposed Development and resilience/adaptation measures	✓	✓	✓	• Studies conducted from Liverpool Bay have shown that extreme wind and wave climates are not expected to change significantly from those that are currently exhibited in present day. Additionally, long-term analyses have illustrated that although there was a slight increase in the severity of most extreme events, there was little change in the extreme wave climate predicted for Liverpool Bay. • The Proposed Development will be re-using and refurbishing existing offshore infrastructure, and introducing a new offshore platform that have been designed for resilience to storms in Liverpool Bay and have been proven operationally. The design of refurbishment works to the sea-surface infrastructure will be to appropriate engineering and safety standards taking into account metocean data for this location. The pipeline and gas injection well are all undersea (and indeed under the seabed in the case of the sequestration volume) with minimal vulnerability to storm events.

13.9 Methodology for assessment of effects

The climate change impact assessment has followed the methodology set out in volume 1, chapter 5. Specific to the climate change impact assessment, the following guidance documents has also been considered:

- IEMA guidance on 'Assessing Greenhouse Gas Emissions and Evaluating their Significance' (IEMA, 2022).

In order to undertake a climate change impact assessment, information gathered in Greenhouse Gas Assessment Technical Report (RPS Group, 2023) has been utilised. This information is sourced from primary calculations and secondary sources to calculate the effect of the Proposed Development on climate change.

13.9.1 Assessment methodology

GHG emissions have been estimated by applying published emissions factors to activities required for the Proposed Development. The emissions factors relate to a given level of activity, or amount of fuel, energy or materials used, to the mass of GHGs released as a consequence. The GHGs considered in this assessment are those in the 'Kyoto basket' of global warming gases expressed as their CO_2-equivalent (CO_2e) global warming potential (GWP). This is denoted by CO_2e units in emissions factors and calculation results. GWPs used are typically the 100-year factors in the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (IPCC, 2013) or as otherwise defined for national reporting under the United Nations Framework Convention on Climate Change (UNFCCC).

Additional guidance used for the quantification of GHG emissions includes:

- UK Government GHG Conversion Factors for Company Reporting (Department for Energy Security and Net Zero (DESNZ)) and Department for Environment, Food and Rural Affairs (Defra), 2023); and
- the Greenhouse Gas Protocol suite of documents (World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD), 2004).

GHG emissions caused by an activity are often categorised into 'scope 1', 'scope 2' or 'scope 3' emissions, following the guidance of the WRI and the WBCSD Greenhouse Gas Protocol suite of guidance documents (WRI and WBSCD, 2004).

- Scope 1 emissions: direct GHG emissions from sources owned or controlled by the company, (e.g. from combustion of fuel at an installation).
- Scope 2 emissions: caused indirectly by consumption of purchased energy, (e.g. from generating electricity supplied through the UK Grid to an installation).
- Scope 3 emissions: all other indirect emissions occurring as a consequence of the activities of the company e.g. in the upstream extraction, processing and transport of materials consumed or the use of sold products or services.

This assessment has sought to include emissions from all three scopes, where this is material and reasonably possible from the information and emissions factors available, to capture the impacts attributable most completely to the Proposed Development. These emissions shall not be separated out by defined scopes (scopes 1, 2 or 3) in the assessment.

The assessment has considered:

- the GHG emissions arising from the Proposed Development; and
- the net impact on climate change due to these changes in GHG emissions overall.

The majority of the construction-stage GHG emissions associated with the manufacturing of components are likely to occur outside the territorial boundary of the UK and hence outside the scope of the UK's national carbon budget. However, in recognition of the climate change effect of GHG emissions (wherever occurring) and the need, as identified in national policy, to avoid 'carbon leakage' overseas when reducing UK emissions, the full life cycle GHG emissions of the Proposed Development, including construction-stage emissions, have been evaluated where possible when determining the significance of effects.

13.9.2 Impact assessment criteria

Determining the overall significance of the effect of the Proposed Development on GHG emissions is a three-stage process that involves defining:

- Magnitude of the impact
  - In accordance with the IEMA Guidance (2022) GHG emissions can be quantified directly and expressed based on their GWP as tonnes of CO_2e emitted, the magnitude of impact is reported numerically. Where a quantifiable figure is not possible this is expressed qualitatively.
- Sensitivity of receptor
  - GHG emissions have a global effect rather than directly affecting any specific local receptor to which a level of sensitivity can be assigned. The global atmospheric mass of the relevant GHGs and consequent warming potential, expressed in CO_2e, has therefore been treated as a single receptor of high sensitivity (given the importance of the global climate as a receptor).
- Significance of effect
  - Assessment guidance for GHG emissions (IEMA, 2022) describes five levels of significance for emissions resulting from a development, each based on whether the GHG emission impact of the development will support or undermine a science-based 1.5°C compatible trajectory towards net zero. To aid in considering whether effects are significant, the guidance recommends that GHG emissions should be contextualised against pre-determined carbon budgets, or applicable existing and emerging policy and performance standards where a budget is not available. It is a matter of professional judgement to integrate these sources of evidence and evaluate them in the context of significance.

Taking the guidance into account, the following have been considered in contextualising Proposed Development GHG emissions:

- the magnitude of net GHG emissions as a percentage of national and local carbon budgets (where feasible); and
- whether the Proposed Development contributes to, and is in line with, the UK's policy for GHG emissions reductions, where these are consistent with science-based commitments to limit global climate change to an internationally-agreed level (as determined by the UK's nationally determined contribution (NDC) to the Paris Agreement (BEIS, 2022a).

Effects from GHG emissions are described in this chapter as adverse, negligible or beneficial based on the following definitions, which closely follow the examples in Box 3 of the IEMA guidance (IEMA, 2022) as detailed in Table 13.7.

Table 13.7: IEMA (2022) Guidance Definitions Of Significance

Significance	Definition
Major adverse	The Proposed Development's GHG impacts are not mitigated or are only compliant with do-minimum standards set through regulation, and do not provide further reductions required by existing local and national policy for projects of this type.
Moderate adverse	The Proposed Development's GHG impacts are partially mitigated and may partially meet the applicable existing and emerging policy requirements but would not fully contribute to decarbonisation in line with local and national policy goals for projects of this type.
Minor adverse	The Proposed Development's GHG impacts would be fully consistent with applicable existing and emerging policy requirements and good practice design standards for projects of this type.
Negligible	The Proposed Development's GHG impacts would be reduced through measures that go well beyond existing and emerging policy and design standards for projects of this type, such that radical decarbonisation or net zero is achieved well before 2050.
Beneficial	The Proposed Development's net GHG impacts are below zero and it causes a reduction in atmospheric GHG concentration, whether directly or indirectly, compared to the without-project baseline.

Major and moderate adverse effects and beneficial effects are considered to be significant in EIA terms. Minor adverse and negligible effects are not considered to be significant in EIA terms.

GHG emissions associated with a proposed project are often reported as a whole life figure (net emissions) that takes account of all project stages. The net whole life figure is the key element for determining the Proposed Development's whole life impact on climate change. However, it is noted in the IEMA guidance (2022) that due to the nature of GHG emissions, it is good practice to include a section that reports on the whole life GHG emissions of the project, alongside the sections that assess construction, operation and decommissioning effects in isolation.

13.10 Embedded mitigation

As part of the Proposed Development design process, a number of mitigation measures have been proposed to reduce the potential for impacts on climate change (see Table 13.8). As there is a commitment to implementing these measures, they are considered inherently part of the design of the Proposed Development and have therefore been considered in the assessment presented in section 13.11 below (i.e. the determination of magnitude and therefore significance assumes implementation of these measures). These measures are considered standard industry practice for this type of development.

Table 13.8: Mitigation Measures Adopted As Part Of The Proposed Development

Mitigation measures adopted as part of the Proposed Development	Justification
During the construction and operational phases vessel fuel consumption will be minimised by optimising vessel scheduling, with consideration given to the co-ordination of activities and material delivery. Activities will be limited on the speed of vessels, and fuel used will have a low sulphur component (0.1%). Vessels older than 20 years will not be used.	During the construction and operational phase emissions resultant from fuel consumption by vessel movements will be minimised by ensuring the use of lower sulphur content fuel, providing an efficient and optimised vessel schedule to reduce the number of journeys, and avoiding the use of older vessels.
During the operational phase, energy demand associated with the OPs will be reduced through energy efficiency opportunities. These include the use of efficient low loss transformers, variable frequency drives (VFDs) on CO_2 compressors, LED light bulbs, low voltage electrical installations, compressor efficiency specification and optimisation, efficient air coolers, energy monitoring systems (to comply with ISO 50001 certification), and Real Time Monitoring and Advanced Process Control (a computer-based algorithm that automatically optimises the process parameters and promotes a reduction in energy consumption from approximately 3% to 7%).	The implementation of energy efficiency opportunities on the OPs results in the reduced consumption of energy during the operation of the Proposed Development, thereby reducing emissions of GHGs to the atmosphere associated with such energy consumption.
During the operational phase fugitive emissions will be monitored through a Leak Detection and Repair (LDAR) programme as part of the preventative maintenance activities, to avoid or minimise their presence as low as reasonably practicable.	Fugitive emissions may take place during the operational phase of the Proposed Development, but every effort will be made to minimise them. Such gas release would result in the increased concentration of GHGs in the atmosphere, further contributing to the effects of climate change.
At the end of the Proposed Development's lifetime, materials removed during decommissioning will be recycled where practicable.	The recycling of materials at the end of the Proposed Development's lifetime not only prevents materials from being sent to landfills, but also reduces the need for the extraction of primary materials, thereby reducing emissions associated with such processes.

13.11 Assessment of significance

The EIA considered the potential impacts of the construction, operation and maintenance, and decommissioning phases of the Proposed Development within the climate change study area and followed the methodology outlined in section 13.9. Further detail can be found in Greenhouse Gas Assessment Technical Report (RPS Group, 2023).

13.11.1 Emissions to the atmosphere

13.11.1.1 GHG emissions associated with construction/refurbishment activities, including materials, transport and use of plant / offshore marine vehicles

This impact considers the embodied carbon emissions associated with the consumption of materials and fuel required to construct the Proposed Development. This impact entails an assessment of the construction of the New Douglas platform, refurbishment of the Hamilton North, Hamilton Main, and Lennox OPs, and laying of new cables and pipework. Maximum design scenarios were assumed to ensure the greatest potential for GHG emissions were calculated, representing a conservative estimate of impact. The following items are considered within this assessment:

- New Douglas platform foundations and substructure;
- refurbishment of satellite OP topsides (Hamilton North, Hamilton Main, and Lennox), and New Douglas platform topside;

- new sub-sea cables and associated protection;
- new pipelines;
- side-tracking of injection wells; and
- vessel movements.

New Douglas platform foundations and substructure

At this stage in the Proposed Development design, detailed material quantities for the construction of the New Douglas platform foundations and substructure are not yet available. However, as it is an overwhelmingly steel based structure, the estimated shipping lift weight has scaled by the carbon factor for galvanised steel (Jones and Hammond, 2019), totalling 32,458 tCO_2e.

Total weight of steel driven piles used to secure the foundations and substructure have been scaled by an appropriate steel emissions factor (Jones and Hammond, 2019), totalling 2,346 tCO_2e, and bringing the total GHG emissions associated with the construction of the New Douglas platform foundations and substructure to 34,804 tCO_2e.

Refurbishment of satellite OPs (Hamilton North, Hamilton Main, and Lennox), and New Douglas Platform topside.

At this stage in the Proposed Development design, detailed material quantities for the construction of the OP topsides are not yet available. As such, the carbon factor for galvanised steel (Jones and Hammond, 2019), has been scaled by the lift weight of each topside. This estimate provides good coverage of the likely emissions associated with the construction of the OP topsides, as steel is overwhelmingly the most significant material used. GHG emissions associated with the OP topsides is 15,842 tCO_2e.

The potential impact of the proposed transformers to be installed on the OPs has been estimated using an intensity for the manufacturing GWP of 2,190 $kgCO_2e$ per MVA (ABB, 2003). This was scaled by the total transformer rating to be installed, to give an estimated embodied carbon value of 43.8 tCO_2e.

New sub-sea cables and associated protection

Material quantities of cable core (aluminium or copper) for the 33 kV cables and fibre optic cables were estimated based on the total length of each cable, and informed by technical product information (ABB, 2010; Sterlite Technologies Limited, 2020). Emissions factors for each material (Jones and Hammond, 2019) were then scaled by the estimated quantities to give an embodied carbon value of 27,322 tCO_2e.

Two forms of cable protection have been specified: concrete mattressing, and rock protection. The total volume of concrete mattressing has been scaled by a concrete emissions factor totalling 2,981 tCO_2e. The total weight of rock protection required has been scaled by an EPD for rock aggregate, this amounts to 323 tCO_2e.

Total GHG emissions for the construction of sub-sea cabling and associated protection is 30,626 tCO_2e.

New pipelines

Emissions associated with the total length of new pipeline have been calculated using a relevant product EPD for steel pipes (OneClick LCA, 2021). The length of pipeline was converted to weight using a steel pipe weight chart (Octal Steel, 2023) to enable the emissions factor to be applied. GHG emissions associated with the new pipelines required totalled 387 tCO_2e.

Injection wells

Emissions from the construction of injection wells can be broken into two main stages, fuel consumed during the drilling of wellbores, and emissions associated with the materials associated with well completion (predominantly steel and cement).

In relation to GHG emissions associated with the drilling of wells, a conservative assumption for the typical daily diesel fuel consumption for an offshore drilling rig has been utilised (IPIECA, 2013). This has been scaled by the number of drilling days required for each well and the emissions factor for fuel oil (DESNZ and DEFRA, 2023). This results in emissions associated with the fuel required to drill wells amounting to 27,286 tCO_2e.

In relation to the completion stage of well construction, GHG emissions arise from embodied carbon from the quantities of steel and cement used to complete the wellbores. Material quantities provided by the Applicant's design team have been scaled by the relevant emissions factors for steel piping and cement (Jones and Hammond, 2019), totalling 10,932 tCO_2e.

Total GHG emissions associated with the construction of wells is 38,218 tCO_2e.

Vessel movements

Emissions associated with fuel combustion from vessel movements have been calculated based on the maximum number of movements proposed during the construction phase, assuming the longest journey distance travelled to reach a conservative estimate. Anticipated fuel consumption for each movement was scaled by an appropriate emissions factor, to give total estimated emissions of 17,852 tCO_2e during the construction phase.

Summary

Table 13.9: Construction Stage GHG Emissions

Item	Emissions (tCO_2e)
New Douglas Platform foundations and substructure	34,804
Refurbishment of satellite OPs and Douglas OP topside	15,886
New sub-sea cables and associated protection	30,626
New pipelines	387
Injection wells	38,218
Vessel movements	17,852
Total	**137,772**

Magnitude of impact

The impact is predicted to be of international spatial extent, short term duration, intermittent and low reversibility. It is predicted that the impact will affect the receptor indirectly. The magnitude is therefore considered to be 137,772 tCO_2e.

Sensitivity of receptor

In accordance with section 13.9.2, the receptor is deemed to be of high sensitivity, as it is highly vulnerability, of low recoverability and high value.

Significance of the effect

Overall, the magnitude of the impact is deemed to be 137,772 tCO_2e and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **moderate adverse** significance, which is significant in EIA terms.

Secondary mitigation and residual effect

Overall, following mitigation, the magnitude of the impact is deemed to be 137,772 tCO_2e and the sensitivity of the receptor is considered to be high. The effect will, therefore, be **moderate adverse**, which is significant in EIA terms.

Climate change mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in section 13.10) is significant in EIA terms.

13.11.1.2 GHG emissions associated with materials and use of offshore marine vehicles required for operation and maintenance

Emissions during the operational phase of the Proposed Development comprise activities contributing to the operation and maintenance of the Proposed Development. Maintenance can be divided into preventative maintenance and corrective maintenance.

- Preventative maintenance: proactive repair to, or replacement of, known ware components based on routine inspections or monitoring systems.
- Corrective maintenance: reactive repair or replacement of failed or damaged components.

The Proposed Development's maintenance activities largely involve routine inspection, replacement of consumables (e.g. filters, oils, lubricants), minor repairs and replacements, repainting, removal of marine growth, reburial of cables, and geophysical surveys. Emissions associated with such activities are negligible and immaterial, and as such have not been assessed further.

Major component replacement (i.e. transformers and equipment to be included on OPs) is not envisaged to be required during the operational lifetime of the Proposed Development, and as such has not been considered further.

Cable and pipeline repair and replacement may be required over the Proposed Development's lifetime. In the absence of detailed information regarding maintenance programmes of such elements, it has been conservatively assumed that the entire length of new pipeline and cable will be replaced once over the Proposed Development's 25-year lifetime.

Emissions associated with maintenance vessel and helicopter movements have also been captured over the Proposed Development's 25-year lifetime. Emissions associated with fuel combustion from vessel and helicopter movements have been calculated based on the maximum number of movements proposed during the operation and maintenance phase, assuming the longest journey distance travelled to reach a conservative estimate. Anticipated fuel consumption for each movement was scaled by an appropriate current emissions factor, to give total estimated emissions of 23,566 tCO_2e during the construction phase.

The GHG emissions arising from the consumption of materials and activities required to facilitate the operation and maintenance of the Proposed Development are presented in Table 13.10, below.

Table 13.10: Operation And Maintenance Stage GHG Emissions

Item	Emissions (tCO_2e)
Cable replacement	27,323
Pipeline replacement	387
Vessel movements	20,635
Helicopter movements	2,931
Total	**51,275**

Magnitude of impact

The impact is predicted to be of international spatial extent, long term duration, continuous and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be 51,275 tCO_2e.

Sensitivity of receptor

In accordance with section 13.9.2, the receptor is deemed to be of high sensitivity, as it is highly vulnerability, of low recoverability and high value.

Significance of the effect

Overall, the magnitude of the impact is deemed to be 51,275 tCO_2e and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **moderate adverse** significance, which is significant in EIA terms.

Secondary mitigation and residual effect

Overall, following mitigation, the magnitude of the impact is deemed to be 51,275 tCO_2e and the sensitivity of the receptor is considered to be high. The effect will, therefore, be **moderate adverse**, which is significant in EIA terms.

Climate change mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in section 13.10) is significant in EIA terms.

13.11.1.3 GHG emissions associated with energy and fuel use during the operation phase

Activity associated with the OPs results in energy consumption during the operational phase of the Proposed Development. The New Douglas platform will be a Normally Unmanned Installation (NUI), primarily designed to be operated remotely through automated processes. The platform will be the hub for the CCS operations, receiving and distributing CO_2 to the satellite platforms. When necessary, the Douglas platform will provide pressure control and heating prior to distribution of the CO_2. The satellite platforms will include facilities necessary for CO_2 treatment and injection. The Proposed Development includes the construction of new energy supply to the offshore infrastructure, which will supply electricity to the OPs to maintain gas compression, heating, and to meet utility loads, as described above.

The OPs energy demand will be met by grid electricity, provided through a new connection to the grid at the PoA Terminal. This will replace the existing gas turbine generator currently used to generate energy for use at the existing PoA Terminal and OPs, which will be disinvested. This switch to electricity from gas will enable the decarbonisation of the operational energy demand in the long-term – despite emissions associated with grid electricity currently exceeding those from natural gas, under the UK's climate targets and ambitions the power system is intended to be fully decarbonised by 2035. As such, operational emissions resultant from the Proposed Development will be reduced in comparison to the current operational infrastructure (i.e. the existing Douglas Platform and PoA Terminal).

To calculate operational emissions associated with energy consumption, modelled energy demands were scaled by projected grid average electricity conversion factors (BEIS, 2022b), which account for the projected decarbonisation of grid electricity, to give lifetime operational emissions of 30,386 tCO_2e (2025 to 2050) presented in Table 13.11, below.

Table 13.11: Operational GHG Emissions Associated With Energy And Fuel Use

Item	Emissions (tCO_2e)
OP energy consumption	30,386
Total	**30,386**

Magnitude of impact

The impact is predicted to be of international spatial extent, long term duration, continuous and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be 360,998 tCO_2e.

Sensitivity of receptor

In accordance with section 13.9.2, the receptor is deemed to be of high sensitivity, as it is highly vulnerability, of low recoverability and high value.

Significance of the effect

Overall, the magnitude of the impact is deemed to be 30,386 tCO_2e and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Secondary mitigation and residual effect

No further climate change mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in section 13.10) is not significant in EIA terms.

13.11.1.4 GHG emissions from decommissioning works (plant, fuel and vessel use) and recovery or disposal of materials

The majority of emissions during this phase relate to the use of plant for infrastructure decommissioning, disassembly, transportation to a waste site, and ultimate disposal and/or recycling of materials.

While detailed information is not yet available regarding the decommissioning of the New Douglas platform and repurposed satellite platforms at the end of the Proposed Development's operational phase, it is anticipated that the decommissioning of the Proposed Development would be undertaken in accordance with all the environmental legislation and technology available at the time. The components of the OPs, cables and pipelines, are considered to be highly recyclable. When disposing of such elements, recycling is the preferred option. This not only prevents materials from being sent to landfills, but also reduces the need for the extraction of primary materials. Material which cannot be recycled might be used for incineration or energy from waste. As such, emissions associated with the disposal of materials at the end of their lifetime is considered to be immaterial and may even result in future avoided emissions. This impact is not assessed further.

Emissions associated with fuel combustion from vessel movements have been calculated based on the maximum number of movements proposed during the construction phase, assuming the longest journey distance travelled to reach a conservative estimate. Anticipated fuel consumption for each movement was scaled by an appropriate emissions factor, to give total estimated emissions of 2,833 tCO_2e during the construction phase.

The GHG emissions arising from the consumption of fuel required to facilitate the decommissioning of the Proposed Development are presented in Table 13.12, below.

Table 13.12: Decommissioning Stage GHG Emissions

Item	Emissions (tCO_2e)
Vessel movements	2,833
Total	**2,833**

Magnitude of impact

The impact is predicted to be of international spatial extent, short term duration, intermittent and low reversibility. It is predicted that the impact will affect the receptor indirectly. The magnitude is therefore considered to be 2,833 tCO_2e.

Sensitivity of receptor

In accordance with section 13.9.2, the receptor is deemed to be of high sensitivity, as it is highly vulnerability, of low recoverability and high value.

Significance of the effect

Overall, the magnitude of the impact is deemed to be 2,833 tCO_2e and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Secondary mitigation and residual effect

No further climate change mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in section 13.10) is not significant in EIA terms.

13.11.1.5 CO_2 transportation and long-term storage.

During the operational phase of the Proposed Development, venting and fugitive emissions may take place but every effort will be made to minimise these. Fugitive emissions are unintentional leakages of gases or vapours from pressure-containing equipment or facilities and would typically occur at flanges, valves and other equipment interfaces. During the operational phase, fugitive emissions would be monitored through a LDAR programme as part of preventative maintenance activities (as detailed in section 13.10), to avoid or minimise their presence as low as reasonably practicable. As such, fugitive emissions have not been assessed further.

There will be a requirement for periodical venting of CO_2 equipment during planned maintenance activities, such as pigging operations, inspection of equipment, inspection and replacement of filter cartridges, and vent maintenance. Indicative venting emissions have been provided by the Applicant's design team, which total an average of 89.15 tCO_2 per year, or 2,318 tCO_2e over the Proposed Development's operational lifetime.

The purpose of the Proposed Development is to enable the re-purposing of depleted hydrocarbon reservoirs for CO_2 storage, by providing the necessary infrastructure to transport CO_2 from industrial sources captured and transported onshore, to the storage reservoirs offshore. The New Douglas CCS platform will receive CO_2 from the onshore PoA Terminal, and distribute CO_2 to the Hamilton Main, Hamilton North, and Lennox wellhead platforms which will inject CO_2 into the depleted hydrocarbon reservoirs for long term storage.

As informed by the Applicant's design team, the Proposed Development has the potential to capture approximately 4.5 $MtCO_2$ per year from 2027, reaching a total of between 110,250,000 tCO_2 and 116,040,000 tCO_2 reinjected CO_2 over the Proposed Development's lifetime. The former has been used to inform the assessment in order to provide the most conservative approach of CO_2 removed and stored.

It must be noted that GHG chapters included within the onshore environmental assessments for both the HyNet Carbon Dioxide Pipeline DCO application (which assesses the onshore CO_2 pipeline, connection to PoA

Terminal, installation of Block Valve Stations, utility connection, and other above ground infrastructure) and HyNet Carbon Dioxide Pipeline TCPA application (which assesses the modification to the PoA Terminal, foreshore works, and installation of Block Valve Stations) acknowledge the CO_2 stored as a result of the CCS project as a whole. Both chapters include such an effect within their assessment of significance for the operational phase. As such, it should be understood that the quantity of CO_2 stored has been included and assessed within three ES chapters and as such there is a risk of triple counting. The value of CO_2 stored should be taken as one common value as a result of the entire CCS project, not three independent values of stored CO_2 that can be totalled.

Despite being assessed already within two ES chapters (as described above), the quantity of CO_2 stored has been assessed within this chapter given the inclusion of the gas storage reservoirs within the description of the Proposed Development.

Table 13.13: Emissions Associated With CO_2 Transportation And Storage

Item	Emissions (tCO_2e)
Venting	2,318
CO_2 storage	-110,250,000
Total	**-110,247,682**

Magnitude of impact

The impact is predicted to be of international spatial extent, long term duration, continuous and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be - 110,247,682 tCO_2e.

Sensitivity of receptor

In accordance with section 13.9.2, the receptor is deemed to be of high sensitivity, as it is highly vulnerability, of low recoverability and high value.

Significance of the effect

Overall, the magnitude of the impact is deemed to be -110,247,682 tCO_2e and the sensitivity of the receptor is considered to be high. The effect will, therefore, be **beneficial**, which is significant in EIA terms.

Secondary mitigation and residual effect

No further climate change mitigation is considered necessary because the likely effect in the absence of further mitigation is beneficial in EIA terms.

13.11.2 Net whole life GHG emissions and context

As set out in section 13.9.2, consideration of the Proposed Developments' whole life impact is an important consideration when assessing the Proposed Developments' impacts and subsequent effects on climate change. As such, the consideration of the Proposed Developments' net emissions in the context of existing and emerging policy commitments and UK Carbon budgets is important.

The lifetime GHG emissions arising from the consumption of materials and activities required to facilitate the construction, operation and maintenance, and decommissioning of the Proposed Development are presented in Table 13.14 below.

Table 13.14: Net Whole Life GHG Emissions

Stage	Proposed Development Emissions (tCO_2e)
Construction	137,772
Operation and maintenance	83,979
Decommissioning	2,833
CO_2 stored	-110,250,000
Total	**-110,025,415**

Consideration of the Proposed Developments' net emissions performance can be considered with the following contextualisation:

- it contributes to carbon budget expenditure at a local and national level'; and
- it is in keeping with local and UK energy and climate policy.

The Proposed Developments' net emissions accounting for both construction and operational stages up to the end of the Sixth Carbon Budget are detailed in Table 13.15 below.

Table 13.15: GHG Impacts In The Context Of The UK's Carbon Budgets

	2023-2027	2028-2032	2033-2037	Total
UK Carbon Budget (tCO_2e)	1,950,000,000	1,730,000,000	960,000,000	4,640,000,000
Proposed Development GHG impacts (tCO_2e)	-6,605,188	-22,486,356	-22,488,173	-51,579,716
Percentage of UK Carbon Budget (%)	-0.339%	-1.300%	-2.343%	-1.112%

When considering the above magnitude of emissions across the whole lifetime of the Proposed Development and the high sensitivity of the climate as a receptor, the Proposed Development would have a **beneficial** net effect which would be significant in EIA terms.

13.12 Cumulative impact assessment

All developments that emit, avoid or sequester GHGs have the potential to impact the atmospheric mass of GHGs as a receptor, and so may have a cumulative impact on climate change. Consequently, cumulative effects due to other specific local development projects are not individually considered but are taken into account when considering the impact of the Proposed Development by defining the atmospheric mass of GHGs as a high sensitivity receptor. The construction, operational and decommissioning phase effects of the assessment of the Proposed Development takes account of cumulative changes in GHG emissions from other energy generation sources.

However, the Proposed Development forms one element of the CCS Project - a wider proposed network transporting and preparing CO_2 for capture and storage. Applications forming part of the wider CCS network are as follows:

- HyNet Carbon Dioxide Pipeline TCPA – the scope of this application includes the modification of the PoA Terminal, foreshore works, and the installation of three Block Valve Stations.
- HyNet Carbon Dioxide Pipeline DCO – the scope of this application includes onshore gas pipelines, six Block Valve Stations, embedded pipe bridge, utility connection infrastructure and other above ground supporting infrastructure.

The Proposed Development enables the CO_2 captured and compressed upstream in the wider project, as included within the scope of the applications listed above, to be transported to injection wells and stored within subsea reservoirs, enabling emissions to the atmosphere from connected industries to be avoided.

The cumulative effects of the Proposed Development, within the context of the wider Project on the global atmospheric mass of CO_2 has been assessed (Table 13.16). Emissions resultant from the HyNet Carbon Dioxide Pipeline TCPA application, and HyNet Carbon Dioxide Pipeline DCO application have been informed by their respective GHG assessments, included within Chapter 10 of each ES.

Table 13.16: Cumulative Effects

Stage	Element of wider CCS Project (tCO_2e)		
	Proposed Development	**HyNet Carbon Dioxide Pipeline TCPA**	**HyNet Carbon Dioxide Pipeline DCO**
Construction	137,772	18,146	70,899
Operation	81,661	174,296	4,521
Operation (venting and fugitive emissions)	2,318	10,473	1,344
Decommissioning	2,833	2,465	12,754
Sub-total	224,585	205,380	89,518
	519,483		
CO_2 Storage	-110,250,000		
Total	**-109,730,517**		

The quantity of carbon stored over the lifetime of the CCS project is anticipated to far exceed those emissions associated with the construction, operation and decommissioning of each element of the CCS project, and as such will aid in delivering the UK's net zero targets.

Magnitude of impact

The impact is predicted to be of international spatial extent, long term duration, continuous and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be -109,730,517 tCO_2e.

Sensitivity of receptor

In accordance with section 13.9.2, the receptor is deemed to be of high sensitivity, as it is highly vulnerability, of low recoverability and high value.

Significance of the effect

Overall, the magnitude of the impact is deemed to be -109,730,517 tCO_2e and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **beneficial** significance, which is significant in EIA terms.

Secondary Mitigation and residual effect

No further climate change mitigation is considered necessary because the likely effect in the absence of further mitigation is beneficial in EIA terms.

13.13 Conclusion

Information on climate change within the climate change study area was collected through desktop review of currently accessible studies and datasets. Key data sources include the UK Government GHG Conversion Factors for Company Reporting (DESNZ and Defra, 2023) and ICE database (Jones and Hammond, 2019), alongside Proposed Development parameters as informed by the Applicant's design team.

The impacts assessed include:

- GHG emissions arising from the manufacturing and installation of the Proposed Development;
- GHG emissions arising from materials and use of offshore marine vessels required for operation and maintenance;
- GHG emissions associated with energy and fuel use during the operational phase;
- GHG emissions from decommissioning works and recovery or disposal of materials; and
- CO_2 transportation and long term storage.

Overall, it is concluded that there will be the following significant effects arising from the Proposed Development during the construction, operational and maintenance or decommissioning phases:

- **Moderate adverse** effect arising from GHG emissions associated with the manufacture and installation of the Proposed Development. The magnitude of this effect totals 137,772 tCO_2e, the sensitivity of the receptor is considered to be high.
- **Moderate adverse** effect arising from GHG emissions associated with materials and use of offshore marine vessels required for operation and maintenance of the Proposed Development. The magnitude of this effect totals 51,275 tCO_2e, the sensitivity of the receptor is considered to be high.
- **Minor adverse** effect arising from GHG emissions associated with emissions from energy use during the operation of the Proposed Development. The magnitude of this effect totals 30,386 tCO_2e, the sensitivity of the receptor is considered to be high.
- **Beneficial** effect arising from CO_2 transportation and long term storage by the Proposed Development. The magnitude of this effect totals **-**110,247,682 tCO_2, the sensitivity of the receptor is considered to be high.
- **Beneficial** effect arising from the net whole life GHG emissions associated with the Proposed Development. The magnitude of this effect totals **-**110,025,415tCO_2, the sensitivity of the receptor is considered to be high.

The cumulative impacts assessed include:

- The net effects associated with the construction, operation and decommissioning of the Proposed Development alongside those associated with the wider CCS project reported within the HyNet Carbon Dioxide Pipeline TCPA and DCO applications. Such applications assess the onshore gas pipeline, and modification of the PoA Terminal.

Overall, it is concluded that there will be the following significant cumulative effects from the Proposed Development alongside other projects/plans:

- **Beneficial** net effect arising from the CO_2 transportation and long term storage by the Proposed Development, enabled by the onshore transportation and pressurisation of CO_2 undertaken by the onshore elements of the wider CCS project. The magnitude of this effect totals -109,730,517tCO_2, the sensitivity of the receptor is considered to be high.

No potential transboundary impacts have been identified regarding effects of the Proposed Development.

13.14 References

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Liverpool Bay CCS Ltd

HYNET CARBON DIOXIDE TRANSPORTATION AND STORAGE PROJECT - OFFSHORE

Environmental Statement
Volume 2, chapter 14: Inter-Related Effects

EHE7228B
Liverpool Bay CCS Limited
Final
February 2024
Offshore ES
Inter-Related Effects

rpsgroup.com

Glossary

Term	Meaning
Effect	The consequence of an impact
Environmental Impact Assessment	A statutory process by which certain planned projects must be assessed before a formal decision to proceed can be made. It involves the collection and consideration of environmental information, which fulfils the assessment requirements of the EIA Directive and EIA Regulations, including the publication of an Environmental Impact Assessment (EIA) Report.
Impact	A change that is caused by an action
Magnitude	Size, extent, and duration of an impact.
Maximum Design Scenario	The maximum design parameters of each Proposed Development asset considered to be a worst case for any given assessment but within the range of the Project Description Envelope.
Mitigation Measure	Measure which would avoid, reduce, or remediate an impact
Non-statutory stakeholder	Organisations with whom the regulatory authorities may choose to engage who are not designated in law but are likely to have an interest in a proposed development.
Project	The HyNet Carbon Dioxide Transportation and Storage Project.
Project lifetime effects	Effects that occur throughout more than one phase of the project (construction, operations and maintenance, and decommissioning) interacting to potentially create a more significant effect upon a receptor than if just assessed in isolation in a single phase.
Proposed Development	The offshore components of the Project which are subject of this Environmental Statement, as described in volume 1, chapter 3.
Receptor-led effects	Effects that interact spatially and/or temporally resulting in inter-related effects upon a single receptor.

Acronyms and Initialisations

Acronym and Initialisations	Description
CCS	Carbon Capture and Storage
DECC	Department of Energy and Climate Change
EIA	Environmental Impact Assessment
ES	Environmental Statement
INNS	Invasive and Non-Native Species
NPS	National Policy Statement
NRA	Navigation Risk Assessment
PTS	Permanent Threshold Shifts
SAC	Special Area of Conservation
SAR	Search And Rescue
SOLAS	Safety Of Life At Sea
SPA	Special Protection Area
SSC	Suspended Sediment Concentration
SSSI	Site of Special Scientific Interest
TTS	Temporary Thresholds Shift
UK	United Kingdom
UXO	Unexploded Ordinance
ZOI	Zone Of Influence

Units

Unit	Description
km	Kilometres
km^2	Kilometres squared
m	Metres (distance)

Contents

Tables

14 INTER-RELATED EFFECTS

14.1 Introduction

This chapter of the Offshore Environmental Statement (ES) presents the assessment of offshore inter-related effects associated with potential impacts of the Project (known as the 'Proposed Development). Specifically, this chapter considers the potential offshore impacts during the construction, operations and maintenance, and decommissioning phases. The onshore impacts of the Project are addressed in chapter 19.

The assessment presented has taken into account other relevant impact assessments in this ES including:

- Chapter 6: Physical processes.
- Chapter 7: Marine biodiversity.
- Chapter 8: Ornithology.
- Chapter 9: Shipping and navigation.
- Chapter 10: Commercial fisheries.
- Chapter 11: Marine archaeology.
- Chapter 12: Infrastructure and other sea users.

14.1.1 Purpose of this chapter

The primary purpose of the Offshore ES is outlined in volume 1, chapter 1: Introduction. It is intended that the Offshore ES will provide the statutory and non-statutory stakeholders, with sufficient information to determine the likely significant effects of the Proposed Development on the receiving environment.

This inter-related effect chapter presents:

- the receptor groups considered within the inter-related assessment;
- the potential for effects on receptor groups across the three key Proposed Development phases (construction, operations and maintenance, and decommissioning); and
- the potential for multiple effects on a receptor group, as presented within the topic-specific chapters, to interact to create inter-related effects.

14.1.2 Study area

Due to the differing spatial extent of effects experienced by different offshore receptors, the study area for potential inter-related effects for the Proposed Development varies according to topic and receptor. The potential inter-related effects considered in this chapter are, therefore, also limited to the study areas defined in each of the topic-specific chapters.

14.1.3 Chapter structure

This chapter is structured as follows:

- Section 14.2: Policy and legislative context.
- Section 14.3: Consultation.
- Section 14.4: Data sources.
- Section 14.5: Assessment methodology.
- Section 14.6: Receptor based inter-related effects assessment.

- Section 14.7: Summary and conclusions.

14.2 Policy and legislative context

Planning policy on Carbon Capture and Storage (CCS) infrastructure is presented in volume 1, chapter 2. Planning policy on CCS, specifically in relation to inter-related effects for the Proposed Development, is contained in the Overarching National Policy Statement (NPS) for Energy (NPS EN-1; DECC, 2011a), the NPS for Fossil Fuel Electricity Generating Infrastructure (NPS EN-2; DECC, 2011b) and the NPS for Renewable Energy Infrastructure (NPS EN-3; DECC, 2021).

NPS EN-1 includes guidance on what matters are to be considered in the assessment. This is summarised in Table 14.1 below. If the NPSs are updated prior to the submission of the Marine Licence application, the revised NPSs will be fully considered in relation to inter-related effects within the ES, provided there is suitable time to ensure the changes can be made.

Table 14.1: Summary Of The NPS EN-1 Provisions Relevant To Inter-Related Effects

Summary of NPS EN-1 provision	How and where considered in the chapter
The Secretary of State should consider how the accumulation of, and interrelationship between, effects might affect the environment, economy or community as a whole, even though they may be acceptable when considered on an individual basis with mitigation measures in place. (EN-1, paragraph 4.2.6)	Proposed Development lifetime effects and receptor-led effects are assessed throughout this chapter of the ES.

14.3 Consultation

No challenges were raised in consultation activities undertaken to date (Liverpool Bay CCS Limited, 2022) specific to inter-related effects for the Proposed Development.

14.4 Data sources

The baseline environments for the receptor groups considered in this chapter are specific to each receptor group and are, therefore, set out in the relevant topic-specific chapters. This chapter draws on the conclusions made within the individual chapters for the assessment of impacts acting in isolation on the receptor groups. The relevant sections drawn upon in these inter-related effects assessment are presented in the ES chapters outlined in section 14.1.

14.5 Assessment methodology

The inter-related impact assessment has followed the methodology set out in volume 1, chapter 5. The following definition of inter-related effects has been applied throughout this chapter:

"Multiple effects upon the same receptor arising from the Hynet Carbon Dioxide Transportation and Storage Project. These occur either where a single effect acts upon a receptor over time to produce a potential additive effect or where a number of separate effects, such as underwater noise from impact piling and an increase in suspended sediments from laying cable, can affect a single receptor, for example fish and shellfish ecology".

14.5.1 Guidance

Specific to the inter-related impact assessment, the Planning Inspectorate Advice Note 9 (The Planning Inspectorate, 2018) has been considered, with specific regard to the following text (paragraph 4.13):

"ensure that interactions (interactions between aspect assessments includes where a number of separate impacts, e.g. noise and air quality, affect a single receptor such as fauna) between aspect (the Planning Inspectorate refers to 'aspects' as meaning the relevant descriptions of the environment identified in accordance with the Environmental Impact Assessment (EIA) Regulations) assessments are taken into account relevant to the worst case scenario(s) established and that careful consideration is given to how these are assessed."

The approach also serves to accommodate Planning Inspectorate Advice Note 9 regarding the need to consider the assessment as a whole and not as a series of unconnected specialist reports.

14.5.2 Approach to assessment

The approach to assessing inter-related effects within this chapter has followed a four-stage process, as summarised in Table 14.2 and outlined below. Further details on the approach summarised above and used to develop this chapter are presented in volume 1, chapter 5.

Table 14.2: Summary Of Staged Approach To The Inter-Related Effects Assessment For The Proposed Development

Stage	Description
1	Assessment of effects undertaken for individual ES topic areas within chapters 6 to 12.
2	Review of assessments undertaken within chapters 6 to 12 to identify 'receptor groups' requiring assessment.
3	Identification of potential inter-related (offshore) effects on receptor groups through review of the topic-specific assessments in the ES chapters.
4	Assessment undertaken on how individual effects may combine to create inter-related effects on each receptor group for: • 'Project lifetime effects' (i.e. during construction, operations and maintenance and decommissioning phases). • 'Receptor-led effects' (i.e. multiple effects on a single receptor).

14.5.2.1 Stage 1: Topic-specific assessments

The first stage of the assessment of inter-related effects is presented in each of the individual ES topic chapters and comprises the individual assessments of effects on receptors across the construction, operations and maintenance and decommissioning phases of the Proposed Development.

14.5.2.2 Stage 2: Identification of receptor groups

Stage 2 involved a review of the assessments undertaken in the topic-specific chapters to identify 'receptor groups' requiring assessment within the inter-related effects assessment. The term 'receptor group' is used to highlight that the approach taken for the inter-related effects assessment will not assess every individual receptor assessed at the Environmental Statement stage, but rather potentially sensitive groups of receptors. The receptor groups assessed can be broadly categorised as those relating to the physical environment, the biological environment, and the human environment, as follows:

- Physical environment:
  - Physical processes.

- Biological environment:
  - Marine biodiversity (including benthic subtidal and intertidal ecology, fish and shellfish, and marine mammals); and
  - Ornithology.
- Human environment:
  - Shipping and navigation;
  - Commercial fisheries;
  - Marine archaeology; and
  - Infrastructure and other sea users.

It is important to note that the significance of effects on different receptors in the same receptor group (i.e. different species of birds in 'ornithology') may vary according to the sensitivity of receptors. Therefore, where a number of species have been considered within the assessments in this chapter, a range is provided for significance of effect.

For some other individual topic chapters, an assessment of potential inter-related effects is inherent within the chapter itself and as such, is not covered in this inter-related effects assessment. The topics where this applies are shown below in Table 14.3.

Table 14.3: Topics Not Included In The Inter-Related Effects Assessment

Topic	Definition
Marine Nature Conservation Sites*	The assessment of inter-related effects is central to the assessment of potential effects on the integrity of designated sites and has therefore already been assessed within the individual chapters of the ES, and within the Report to Inform the Appropriate Assessment. No additional levels of inter-related or receptor led effects are therefore considered to occur at the site level beyond those identified in the topic specific chapters of the ES and the Report to Inform the Appropriate Assessment.

*Items listed in the topic column do not necessarily correspond to a specific ES chapter. The Topic name presented refers to individual topics of receptors within a chapter.

14.5.2.3 Stage 3: Identification of potential inter-related effects on receptor groups

Following the identification of receptor groups, the potential inter-related effects on these receptor groups were identified via review of the impact assessment sections for each topic chapter. The judgement as to which impacts may result in inter-related effects upon receptors associated with the Proposed Development was based on the professional judgement and experience of the project team.

Linked receptor groups

It is important to recognise potential linkages between the topic-specific chapters within this ES, whereby effects assessed in each chapter have the potential for secondary effects on any number of other receptors.

Where such linked relationships arise, these have been fully assessed within the individual topic chapters. This chapter on inter-related effects (offshore) therefore summarises the consideration of these inter-related effects on linked receptors already set out in the preceding, topic-specific chapters.

It should be noted that it is considered that there are unlikely to be any receptor led effects from combined onshore and offshore activities, and as a result this has not been considered further in this inter-related effects chapter or the onshore inter-related effects chapter (chapter 19).

14.5.2.4 Stage 4: Assessment of inter-related effects on each receptor group

Individual effects on each of the key receptors were identified across the three Proposed Development phases (i.e. project lifetime effects) as well as the interaction of multiple effects on a receptor (i.e. receptor-led effects), as defined in Table 14.4. This information has been presented within the assessment tables in section 14.6: Receptor based inter-related effects assessment.

Table 14.4: Definitions Of Project Lifetime And Receptor-Led Inter-Related Effects

Effect type	Definition
Project lifetime effects	Assessment of the scope for effects that occur throughout more than one phase of the Proposed Development, (construction, operations and maintenance and decommissioning) to interact to potentially create a more significant effect on a receptor than if just assessed in isolation in these three key project stages (e.g. underwater noise effects from construction, disturbance from maintenance work, vessels, and decommissioning).
Receptor-led effects	Assessment of the scope for multiple effects to interact to create inter-related effects on a receptor. As an example, multiple effects on a given receptor such as benthic habitats (e.g. direct habitat loss or disturbance, sediment plumes, scour, jack-up vessel use etc.) may interact to produce a different or greater effect on this receptor than when the effects are considered in isolation. Receptor-led effects might be short term, temporary or transient effects, or incorporate longer term effects.

The significance of the individual effects is presented in the summary of impacts, mitigation measures and monitoring tables for each receptor group within the topic-specific chapters (all conclusions for significance of effect for impacts defined in the topic chapters assume successful implementation of mitigation measures where appropriate (i.e. the residual effect has been used)). A descriptive assessment of the scope for these individual effects to interact to create a different or greater effect is then undertaken. This assessment incorporates qualitative and, where reasonably possible, quantitative assessments. The assignment of significance of effect to any such inter-related effect is not undertaken, rather, any inter-related effects that may be of greater significance than the individual effects acting in isolation on a given receptor are identified and discussed within this chapter.

The inter-related effects assessment presents and utilises the maximum significant adverse effects for the Proposed Development (i.e. the maximum design scenarios including successful implementation of measures adopted as part of the Proposed Development where appropriate), noting that individual effects may not be significant at the topic-specific level but could become significant when their inter-related effect is assessed.

Effects of negligible significance or greater (minor, moderate, major) may occur in only one phase of the project life cycle (e.g. during the construction phase but not the operations and maintenance or decommissioning phases). Where this is the case, it has been made clear that, as a result, there will be no inter-related effects across the Proposed Development phases. Effects of negligible significance identified in the individual topic assessments have been included since there is the potential for inter-related effects to increase the level (significance) of effect when considered with other sources.

14.6 Receptor based inter-related effects assessment

This section describes the potential effects on the receptor groups across all Proposed Development phases, including how the inter-related effects might interact with each other to affect a receptor.

14.6.1 Physical environment

14.6.1.1 Physical processes

For physical processes, the following potential impacts have been considered within the inter-related assessment:

- increased suspended sediment concentrations (SSCs) and sediment deposition; and
- activities affecting surrounding water quality.

Table 14.5 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, operation and maintenance phase, and decommissioning of the Proposed Development, and the inter-related effects (receptor-led effects) that are predicted to arise for physical processes receptors.

As previously noted, effects on physical processes also have the potential to have secondary effects on other receptors and these effects are fully considered in the topic-specific chapters. These receptors and effects are:

- Benthic subtidal and intertidal ecology (chapter 7):
  - Increased SSCs and associated sediment deposition.
- Fish and shellfish ecology (chapter 7):
  - Increased SSCs and associated sediment deposition.
- Marine mammals (chapter 7):
  - Increased SSCs and associated sediment deposition.
- Marine Archaeology (chapter 11):
  - Sediment disturbance and deposition.
- Infrastructure and other sea users (chapter 12):
  - Increased SSCs and associated sediment deposition.

Table 14.5: Summary Of Potential Inter-Related Effects For Physical Processes

Description of impact	Phase[1] C	O	D	Likely significant inter-related effects	Inter-related significance
Increase in suspended sediments due to construction, operation and maintenance and/or decommissioning related activities, and the potential impact to physical features.	✓	✓	✓	Increases in SSC during construction phase would not extend into the operation and maintenance phase. Similarly, those increases which occur in the operation and maintenance phase due to maintenance activities would not extend to decommissioning. This is because SSC increases are temporary in nature (i.e. do not last for more than one or two tidal cycles) and return quickly to background levels during slack water.	No change resulting from inter-related assessment
Activities affecting surrounding water quality.	✓	✓	✓	Releases of contaminated sediments and accidental pollution from vessel activity during the construction phase will not extend into the operation and maintenance phase. Similarly, contaminated sediments and vessel pollution which may occur in the operation and maintenance phase due to maintenance activities would not extend into the decommissioning phase. Furthermore, embedded mitigation measures adopted to minimise the effects of this impact, such as development and adherence to an EMP (including a MPCP), which sets out pollution prevention methods and the requirement for all vessels to comply with the MARPOL regulations.	No change resulting from inter-related assessment.
Receptor-led effects					
West Hoyle Bank and Dee Estuary Special Area of Conservation (SAC)/Special Protection Area (SPA)/Site of Special Scientific Interest (SSSI): During principally the construction phase increased suspended sediment concentrations and associated deposition on physical features may occur. Concurrently SSC plumes may cause toxicity effects through the mobilisation of contaminated sediments within the SSC plume. The vessels used in the construction phase may additionally cause accidental pollution. Construction activities are sporadic, with the impacts predicted to be of local spatial extent, short term duration and intermittent. Over West Hoyle Bank and within the Dee Estuary SAC/SPA/SSSI these impacts would be indistinguishable from background variations and would therefore not be significant in EIA terms.					

[1] C – Construction; O – Operation; and D – Decommissioning

14.6.2 Biological environment

14.6.2.1 Marine biodiversity

Benthic subtidal and intertidal ecology

For benthic subtidal and intertidal ecology, the following potential impacts have been considered within the inter-related assessment:

- temporary and long term habitat loss/disturbance;
- increased SSCs and associated sediment deposition;
- increased risk of introduction and spread of invasive and non-native species (inns); and
- impacts resulting from the release of sediment bound contaminants.

Table 14.6 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, operations and maintenance and decommissioning phases of the Proposed Development, and the inter-related effects (receptor-led effects) that are predicted to arise for benthic ecology receptors.

As previously noted, effects on benthic ecology also have the potential to have secondary effects on other receptors and these effects are fully considered in the topic-specific chapters. These receptors and effects are:

- Commercial fisheries:
  - Increased risk of introduction and spread of INNS.

Table 14.6: Summary Of Potential Inter-Related Effects For Benthic Subtidal And Intertidal Ecology

Description of impact	Phase C	Phase O	Phase D	Likely significant inter-related effects	Inter-related significance
Temporary and long-term habitat loss/disturbance.	✓	✓	✓	The total area of habitat potentially affected, when disturbance and loss are considered additively across all phases, is greater than for each individual phase (e.g. just the construction phase). However, temporary habitat loss/disturbance arising during each phase of the Proposed Development will be highly localised to the vicinity of the activities being undertaken (i.e. limited to the immediate footprint) during each phase (i.e. construction, operations and maintenance and decommissioning). Individual activities (e.g. jack-up activities, cable burial etc.) resulting in temporary habitat loss/disturbance will occur intermittently throughout this time with only a small proportion of the total area of habitat being impacted at any one time. The predominantly mixed sediment habitats present within the Proposed Development are typical of, and widespread throughout, the United Kingdom (UK) and in the east Irish Sea. All sediments and associated benthic communities are predicted to recover. Whilst there is the potential for repeat disturbance to occur during the operations and maintenance phase to habitats previously disturbed during the construction phase (e.g. as a result of jack-up activities and cable repair/reburial etc.) it is predicted that the benthic communities will have fully recovered from construction impacts by this time. Across the Proposed Development lifetime, the effects on benthic ecology receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the ES.	No change resulting from inter-related assessment
Increased SSCs and associated sediment deposition	✓	×	✓	Activities with the potential to result in the greatest level seabed disturbance and, therefore, highest increases in SSC/deposition, will occur during the construction phase. Any effects on benthic communities during this time will be intermittent, temporary and short term. The benthic subtidal Important Ecological Features (IEFs) potentially affected by increased SSC and deposition are predicted to have recovered in the intervening period between phases (i.e. prior to any localised increases in SSC during construction activities in the construction phase). Across the construction and decommissioning phases, the effects on benthic ecology receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the ES.	No change resulting from inter-related assessment
Increased risk of introduction and spread of invasive and non-native species	✓	✓	✓	Although the presence and movement of construction/maintenance/decommissioning vessels in the area may facilitate the introduction and spread of INNS across all phases of the Proposed Development, this effect will predominantly arise during the operations and maintenance phase. This is because, the presence of the hard substrate associated with the infrastructure will be present in the operations and maintenance phase which may provide INNS with the necessary substrate on which to settle. However, the measures adopted as part of the Proposed Development include the implementation of an Invasive Non-Native Species Management Plan. This will ensure that the risk of potential introduction and spread of INNS will be minimised across all phases. Across the Proposed Development lifetime, the effects on benthic ecology receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the Environmental Statement.	No change resulting from inter-related assessment

Description of impact	Phase C	Phase O	Phase D	Likely significant inter-related effects	Inter-related significance
Impacts resulting from the release of sediment bound contaminants	✓	×	✓	This impact is expected to occur in the construction and decommissioning phases of the Proposed Development during activities that disturb seabed sediments. However, additive effects across the lifetime of the Proposed Development are considered highly unlikely on the basis of the physical processes modelling outputs which have shown that increases in SSC (and therefore associated contaminants) will be temporary and will return to baseline within a few tidal cycles. This is not predicted to result in any significant combined impact across phases greater than what has been assessed for each individual phase. For example, remobilisation as a result of construction activities will only result in low concentrations of sediment-bound contaminants which as noted above will have been dispersed over a large area. Across the Proposed Development lifetime, the effects on benthic ecology receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the ES.	No change resulting from inter-related assessment
Receptor-led effects					
There is the potential for spatial and temporal interactions between the effects arising from habitat loss/disturbance/alteration and increased SSC and associated sediment deposition and resuspension of contaminants on benthic habitats during the lifetime of the Proposed Development. Based on current understanding, and expert knowledge, the greatest potential for inter-related impacts is predicted to arise through the interaction of direct (both temporary and permanent) habitat loss/disturbance from seabed preparation, foundation installation/jack-up/anchor placement/scour, indirect habitat disturbance due to sediment deposition and indirect effects of changes in physical processes due to the Proposed Development. These individual impacts were assigned a significance of negligible to minor as individual impacts and although potential combined impacts may arise (i.e. spatial and temporal overlap of habitat disturbance), it is not predicted that this will result in effects of more significance than the individual impacts in isolation. This is because the combined extent of habitat potentially affected would be typically restricted to the Proposed Development and wider Zone of Influence (ZOI), the habitats affected are widespread across the UK and east Irish Sea and, where temporary disturbance occurs, full recovery of the benthos is predicted. In addition, any effects due to changes in the physical processes are likely to be limited, both in extent and in magnitude, with benthic ecology receptors having low sensitivity or high recoverability to the scale of the changes predicted. Across the project lifetime, the additive effects on benthic ecology receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the ES.					

Fish and shellfish ecology

For fish and shellfish ecology, the following potential impacts have been considered within the inter-related assessment:

- temporary and long term habitat loss/disturbance;
- underwater noise impacting fish and shellfish receptors; and
- increased SSCs and associated sediment deposition.

Table 14.7 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, operations and maintenance and decommissioning phases of the Proposed Development and the inter-related effects (receptor-led effects) that are predicted to arise for fish and shellfish ecology receptors.

As previously noted, effects on fish and shellfish ecology also have the potential to have secondary effects on other receptors and these effects are fully considered in the topic-specific chapters. These receptors and effects are:

- Marine mammals and marine turtles:
  - Effects on Marine Mammals and Marine Turtles due to changes in prey availability.
- Ornithology:
  - Indirect impacts from underwater noise affecting prey species; and
  - Changes in fish and shellfish communities affecting prey availability.
- Commercial fisheries:
  - Impacts on commercially important fish and shellfish resources.

Table 14.7: Summary Of Potential Inter-Related Effects For Fish And Shellfish Ecology

Description of impact	Phase			Likely significant inter-related effects	Inter-related significance
	C	O	D		
Temporary and long-term habitat loss/disturbance	✓	✓	✓	When subtidal habitat loss (temporary and long term) is considered additively across all phases of the Proposed Development, although the total area of habitat affected is larger than for the individual Proposed Development stages, similar habitats are widespread across the fish and shellfish ecology study area and the wider Irish Sea. During the operational and maintenance phase, most of the disturbance will be highly localised, and the habitats affected are predicted to recover quickly following completion of maintenance activities with fish and shellfish IEFs recovering in the affected areas. Also, many operations and maintenance activities will be located in the same areas affected during construction (e.g. jack up operations, or reburial of exposed cables). Decommissioning will also be impacting the same locations, to a lesser degree than during construction. Across the Proposed Development lifetime, the effects on fish and shellfish ecology receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the Environmental Statement.	No change resulting from inter-related assessment
Underwater noise impacting fish and shellfish receptors	✓	×	×	The impact of underwater noise will only arise during the construction phase and as such there will be no inter-related effects across the Proposed Development phases. Across the Proposed Development lifetime, the effects on fish and shellfish ecology receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the Environmental Statement.	No change resulting from inter-related assessment

Description of impact	Phase C	Phase O	Phase D	Likely significant inter-related effects	Inter-related significance
Increased suspended SSCs and associated sediment deposition	✓	×	✓	The majority of the seabed disturbance (resulting in highest SSC/deposition) will occur during the construction and decommissioning phases. IEFs and associated spawning/nursery habitats potentially affected by increased SSC and deposition will recover quickly following impact exposure such that there will be no inter-related effects across the construction and decommissioning phases. Across the Proposed Development lifetime, the effects on fish and shellfish ecology receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the Environmental Statement.	No change resulting from inter-related assessment

Receptor-led effects

Potential exists for spatial and temporal interactions between habitat loss or disturbance, underwater noise, increased SSC/deposition during the lifetime of the Proposed Development.

Based on current understanding, and expert knowledge, the greatest scope for potential impacts is predicted to arise through the interaction of habitat loss (temporary and long term), increased SSC, underwater noise during the construction phase, and operations and maintenance phase.

These individual impacts were assigned a significance of negligible to minor adverse as standalone impacts and although potential combined impacts may arise, it is important to recognise that some of the activities potentially resulting in combined effects are mutually exclusive. For example, most effects associated with an increase in SSC/deposition will arise from seabed preparation and installation of the Proposed Development's cables and pipelines, whereas most noise effects will at a different time or local. In addition, these impacts will be temporary and reversable following cessation of construction or decommissioning, with fish and shellfish communities expected to recover into the Proposed Development area. Furthermore, underwater noise is predicted to result in the displacement of mobile fish from areas which in turn will mean that these species will not be exposed to the greatest predicted increases in SSC. There may be localised changes in fish and shellfish communities in the areas affected by long term habitat loss, due to potential changes in substrate type and foraging opportunities. Any shifts in baseline assemblage will be limited to these areas and, therefore, effects of greater significance than the individual impacts in isolation (i.e. negligible to moderate) are not predicted.

Overall, the evidence presented in chapter 7, indicates that impacts on fish and shellfish receptors from construction operations are temporary and reversible and that fish and shellfish communities are not significantly adversely affected by the presence of infrastructure and therefore additive effects across impacts and phases are not expected to occur.

Across the Proposed Development lifetime, the additive effects on fish and shellfish ecology receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the ES.

Marine mammals and marine turtles

For marine mammals and marine turtles, the following potential impacts have been considered within the inter-related assessment:

- injury, disturbance, and displacement from underwater noise generated during piling;
- injury, disturbance, and displacement from underwater noise generated during unexploded ordinance (UXO) clearance;
- injury, disturbance, and displacement from underwater noise generated during geophysical and seismic site investigation surveys;
- injury, disturbance, and displacement from vessel activity and other noise producing activities;
- injury due to collision with marine vessels; and
- effects on marine mammals and marine turtles due to changes in prey availability.

Table 14.8 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, operations and maintenance, and decommissioning phases of the Proposed Development and the inter-related effects (receptor-led effects) that are predicted to arise for marine mammal and marine turtle receptors.

As previously noted, marine mammals and marine turtles, and fish and shellfish ecology are linked receptor groups and the inter-related effects associated with a change in the distribution and/or abundance of prey species for marine mammals and marine turtles across each phase of the Proposed Development has been fully assessed in chapter 7 of the ES, with effects of negligible/minor adverse significance predicted for all Proposed Development phases.

Table 14.8: Summary Of Potential Inter-Related Effects For Marine Mammals And Marine Turtles

Description of impact	Phase C	Phase O	Phase D	Likely significant inter-related effects	Inter-related significance
Injury, Disturbance, and Displacement from Underwater Noise Generated during Piling	✓	×	×	The impact of elevated underwater noise during piling will only arise during the construction phase and as such there will be no inter-related effects across the project phases of the Proposed Development. Across the Proposed Development lifetime, the effects on marine mammal and marine turtle receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the ES.	No change resulting from inter-related assessment
Injury, Disturbance, and Displacement from Underwater Noise Generated during UXO Clearance	✓	×	×	The impact of elevated underwater noise during UXO clearance will only arise during the construction phase and as such there will be no inter-related effects across the Proposed Development phases. Across the Proposed Development lifetime, the effects on marine mammal and marine turtle receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the ES.	No change resulting from inter-related assessment
Injury, Disturbance, and Displacement from Underwater Noise Generated during Geophysical and Seismic Site Investigation Surveys	✓	×	×	The impact of elevated underwater noise during site investigation surveys will only arise during the construction phase and intermittently throughout the operation and maintenance phase. As such there will be no inter-related effects across the project phases of the Proposed Development. Across the Proposed Development lifetime, the effects on marine mammal and marine turtle receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the ES.	No change resulting from inter-related assessment
Injury, Disturbance, and Displacement from Vessel Activity and other Noise Producing Activities	✓	✓	✓	Vessels will be used throughout all stages of the Proposed Development and therefore the impact of injury and disturbance to marine mammals and marine turtles from elevated underwater noise due to vessel use throughout all stages could cause additional disturbance to the receptor compared to considering each stage separately. For other activities, including drilling (foundation installation) and cable trenching/laying, the effect will only arise during the construction phase. Across the Proposed Development lifetime, the effects on marine mammal and marine turtle receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the ES.	No change resulting from inter-related assessment

Description of impact	Phase C	Phase O	Phase D	Likely significant inter-related effects	Inter-related significance
Injury due to Collision with Marine Vessels	✓	✓	✓	Over the lifetime of the Proposed Development there will be an ongoing risk of collision associated with vessel activity throughout all phases. If injury to marine mammals and marine turtles from collisions did occur this could lead to losses of individuals and potentially have an effect at the population-level, particularly for species with smaller populations. However, there is a high likelihood that marine mammals and marine turtles will avoid vessels, as they will be disturbed by underwater noise from the vessel, thereby reducing collision risk. In addition, with designed-in measures the risk of collisions will be further reduced through an Environmental Management Plan (EMP) with provisions for vessels and vessel movements, which includes provisions for vessels and vessel transit corridors to minimise the potential for collision risk. Across the Proposed Development lifetime, the effects on marine mammal and marine turtle receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the ES.	No change resulting from inter-related assessment
Effects on Marine Mammals and Marine Turtles due to changes in Prey Availability	✓	✓	✓	Fish and shellfish communities may be impacted through all phases of the Proposed Development and therefore could present a long-term effect on receptors through changes to prey availability. Inter-related effects on fish and shellfish receptors are described in more detail in Table 14.7 and in chapter 7. For all potential impacts and at all phases of the Proposed Development the effects are, however, predicted to be very localised and unlikely to lead to significant effects on marine mammals and marine turtles. Even in the context of longer-term impacts there is unlikely to be an additive effect as receptors can exploit a suite of prey species and only a small area will be affected when compared to available foraging habitat in the east Irish Sea. Across the Proposed Development lifetime, the effects on marine mammal and marine turtle receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the ES.	No change resulting from inter-related assessment

Receptor-led effects

There is the potential for spatial and temporal interactions between the effects arising from elevated underwater noise (due to piling, UXO clearance, site investigation surveys, and vessel use and other (non-piling) activities), collision risk with vessels and changes in prey availability during the lifetime of the Proposed Development.

Based on current understanding and expert knowledge, the greatest potential for inter-related effects is predicted to arise through the interaction of injury and disturbance from elevated underwater noise during piling, elevated underwater noise during UXO clearance, elevated underwater noise due to vessel use and other (non-piling) activities and elevated underwater noise during site investigation surveys, due to the Proposed Development.

These impacts were assigned a significance of negligible/minor as individual impacts and although potential combined effects may arise (i.e. spatial and temporal overlap of noise impacts) it is not predicted that this will result in effects of greater significance than the individual impacts in isolation. Whilst individual impacts could add to the overall duration of elevated underwater noise spatially, the extent of noise disturbance will be restricted to the Proposed Development and the extent of the largest Zone of Influence (i.e. piling). As Permanent Threshold Shifts (PTS) are not predicted to occur in any of the receptors, with the implementation of designed in measures, and Temporary Thresholds Shift (TTS) is a recoverable impact, it is predicted that there would be no inter-related effect. With respect to disturbance, the potential for inter-related effects is

Description of impact	Phase C O D	Likely significant inter-related effects	Inter-related significance
considered to be minimal as individual animals are likely to be disturbed over a range dictated by the 'loudest' noise (i.e. leading to the greatest disturbance range) such that the potential for secondary (additive) effects from other activities that result in smaller ranges is reduced where animals are already disturbed over the largest effect range.			
Across the Proposed Development lifetime, the effects on marine mammal and marine turtle receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the ES.			

14.6.2.2 Ornithology

For ornithology, the following potential impacts have been considered within the inter-related assessment:

- temporary habitat loss leading to displacement/disturbance of birds;
- disturbance and displacement from airborne sound and presence of vessels and infrastructure;
- collision with static offshore infrastructure;
- indirect impacts to birds from changes in prey availability; and
- accidental pollution in the surrounding area.

Table 14.9 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, operations and maintenance phase, and decommissioning of the Proposed Development and the inter-related effects (receptor-led effects) that are predicted to arise for offshore ornithology receptors.

As previously noted, ornithological receptors and fish and shellfish receptors are linked and the inter-related effects associated with a change to the prey resources of ornithological receptors has been fully assessed in chapter 8: Ornithology, with effects of negligible/moderate significance predicted during construction, effects of no change to minor adverse significance predicted during the operations and maintenance phase and effects of negligible to moderate adverse significance during decommissioning.

Table 14.9: Summary Of Potential Inter-Related Effects For Ornithological Receptors

Description of impact	Phase C	Phase O	Phase D	Likely significant inter-related effects	Inter-related significance
Temporary habitat loss leading to displacement/disturbance of birds	✓	×	✓	During construction and decommissioning, seabirds may be indirectly disturbed and displaced as a result of direct impacts on habitat, which may result in the loss of a food resource to birds in the Proposed Development. This will lead to temporary habitat loss/disturbance at a local scale. The prey species and habitats potentially affected by construction and decommissioning are likely to recover during the operations and maintenance phase when no impacts are expected. The effects on ornithology receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the ES.	No change resulting from inter-related assessment
Disturbance and displacement from airborne sound and presence of vessels and infrastructure	✓	✓	✓	The impact of disturbance and displacement caused by construction activities and associated vessel movements is predicted to be of no change to minor significance depending on species, which is not significant in EIA terms. The birds disturbed during the construction phase are expected to return as soon as the specific and locally active works are completed at the operations and maintenance phase. Although the shorter construction period has a displacement impact of lower magnitude than operation, it slightly extends the period over which displacement impacts may occur overall. During the operations and maintenance phase, the presence of infrastructure and vessels has the potential to directly disturb receptors, leading to displacement from the Proposed Development including an area of variable size or buffer (depending on species' sensitivity) around it. However, this effect was predicted to be of no change significance. Whilst the operations and maintenance phase will feature a much-reduced level of boat activity in comparison to the construction phase, the decommissioning phase will require similar number of vessels to the construction phase. The effects of decommissioning activities are expected to be similar magnitude to those arising from construction. Like the construction phase, the decommissioning phase has a displacement impact of lower magnitude than operation. Yet, it slightly extends the period over which displacement impacts may occur during the lifetime of the Proposed Development. Across the Proposed Development lifetime, the effects on ornithology receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the ES.	No change resulting from inter-related assessment

Description of impact	Phase C	Phase O	Phase D	Likely significant inter-related effects	Inter-related significance
Collision with static offshore infrastructure	✗	✓	✗	Across the Proposed Development lifetime, the effects on ornithology receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the ES.	No change resulting from inter-related assessment
Indirect impacts to birds from changes in prey availability	✓	✓	✓	Indirect impacts caused by a change in prey species (e.g. cod, sprat, herring, and sandeel) will occur during the construction, operation and maintenance and decommissioning phases. Across the Proposed Development lifetime, the effects on ornithology receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the ES.	No change resulting from inter-related assessment
Accidental pollution in the surrounding area	✓	✓	✓	Across the Proposed Development lifetime, the effects on ornithology receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the ES.	No change resulting from inter-related assessment

Receptor-led effects

There are the potential spatial and temporal interactions between the effects arising from temporary habitat loss, disturbance and displacement, indirect impacts to birds from changes in prey availability and accidental pollution in the surrounding area during the Proposed Development's lifetime.

However, based on current understanding and expert knowledge, the greatest scope for potential interaction impacts is predicted to arise through the following:

- Combined disturbance and displacement, and indirect impacts to birds from changes in prey species during construction; and
- Combined disturbance and displacement, and collision risk during operation and maintenance.

Individual impacts were assigned a significance of negligible to minor adverse as standalone impacts. Although potential combined impacts may arise, it is essential to acknowledge that some of the activities potentially resulting in combined effects would not be additive. For instance, the displacement effect on seabirds is expected to be very localised, intermittent, and short during the construction phase. Prey availability and habitats might also be altered during the construction phase, forcing the birds to re-distribute. In this scenario, the inter-related effects are expected to cancel each other out to a degree: a re-distribution of prey due to indirect disturbance/displacement will reduce the direct displacement effect of seabirds caused by construction activities. Compounding inter-related effects will only occur if seabirds continued to use the site where prey have been displaced from.

Individual impacts were assigned a significance of negligible to minor as standalone impacts and although potential combined impacts may arise, it is important to recognise that some of the activities potentially resulting in combined effects are mutually exclusive. Species cannot simultaneously exhibit a high level of avoidance (displacement effect) and a high level of collision risk (collision effect). Furthermore, there are differences in the species' susceptibility to the collision and displacement effects. Typically, species that forage on the wing (surface feeders (e.g. gulls)) will be more susceptible to collision risk and less affected by displacement as they move quickly between feeding opportunities. In contrast, sub-surface feeders and in particular species diving at great depths (e.g. Manx shearwater, divers and auks) would be more susceptible to displacement/disturbance: they feed for a prolonged period of time and fly less frequently between feeding patches, and thus at much-reduced level of collision risk.

Two species were assessed for the combined impact of displacement and collision risk: black-legged kittiwake and northern gannet. For both these species, the combined impact was of minor adverse significance, which is not significant in EIA terms.

Description of impact	Phase			Likely significant inter-related effects	Inter-related significance
	C	O	D		
Across the Proposed Development lifetime, the effects on offshore ornithology receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the ES.					

14.6.3 Human environment

14.6.3.1 Shipping and navigation

For shipping and navigation, the following potential impacts have been considered within the inter-related assessment:

- vessel displacement leading to increased vessel to vessel collision risk between third-party vessels;
- increased vessel to vessel collision risk between a third-party vessel and a project vessel;
- reduced access to local ports;
- anchor interaction with subsea cable;
- fishing gear interaction with subsea cable;
- vessel grounding due to reduced under keel clearance; and
- reduction of emergency response capability due to increased incident rates for SAR (search and rescue) responders and increased demand on the available resources.

Table 14.10 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, operations and maintenance and decommissioning phases of the Proposed Development and the inter-related effects (receptor-led effects) that are predicted to arise for shipping and navigation receptors.

As previously noted, effects on shipping and navigation, due to an increase in vessels numbers also has the potential to have direct effects on marine mammals which has been fully assessed in chapter 7, with effects of minor adverse significance predicted across all Proposed Development phases and chapter 8 with effects of no greater than minor adverse significance across all Proposed Development phases.

Table 14.10: Summary Of Potential Inter-Related Effects For Shipping And Navigation

Description of impact	Phase C	Phase O	Phase D	Likely significant inter-related effects	Inter-related significance
Vessel displacement leading to increased vessel to vessel collision risk between third-party vessels	✓	✓	✓	Displacement of third-party vessels due to the presence of the Proposed Development increases the risk of collision or allision between third-party vessels. The Navigation Risk Assessment (NRA) conducted in chapter 9 was of sufficient detail that interactions between effects were considered, both from different phases and different receptors. This impact is expected to be greater during the construction and decommissioning phases. Across the Proposed Development lifetime, the effects on shipping and navigation receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the ES.	No change resulting from inter-related assessment
Increased vessel to vessel collision risk between a third-party vessel and a project vessel	✓	✓	✓	Increase collision risk between third-party vessels and project vessels, due to the presence of vessels associated with the Proposed Development. The NRA conducted in chapter 9 was of sufficient detail that interactions between effects were considered, both from different phases and different receptors. This impact is expected to be greater during the construction and decommissioning phases. Across the Proposed Development lifetime, the effects on shipping and navigation receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the ES.	No change resulting from inter-related assessment
Reduced access to local ports	✓	✓	✓	Reduced access to local ports will be relevant to all phases of the development, however the impact during the operation and maintenance phase is minimal due to the limited disruption associated with any maintenance required. Across the Proposed Development lifetime, the effects on shipping and navigation receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the ES.	No change resulting from inter-related assessment
Anchor interaction with subsea cable	✓	✓	×	This impact is expected to be greater during the construction phase if there is a period of time when the cable is surface-laid prior to burial works. During the operation and maintenance phase, cable burial (or other protection measures) will reduce the impact. Across the Proposed Development lifetime, the effect of anchor interaction on shipping and navigation receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the ES.	No change resulting from inter-related assessment

Description of impact	Phase C	Phase O	Phase D	Likely significant inter-related effects	Inter-related significance
Fishing gear interaction with subsea cable	✓	✓	×	This impact is expected to be greater during the construction phase if there is a period of time when the cable is surface-laid prior to burial works. During the operation and maintenance phase, cable burial (or other protection measures) will reduce the impact from fishing gear. Across the Proposed Development lifetime, the effect of fishing gear interaction on shipping and navigation receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the ES.	No change resulting from inter-related assessment
Vessel grounding due to reduced under keel clearance	×	✓	×	This impact will only arise during the operation and maintenance phase and as such there will be no inter-related effects across the Proposed Development phases. Across the Proposed Development lifetime, the effects on shipping and navigation receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the Environmental Statement.	No change resulting from inter-related assessment
Reduction of emergency response capability due to increased incident rates for SAR (search and rescue) responders and increased demand on the available resources	✓	✓	✓	Project vessels will be managed through marine coordination and compliant with Flag State regulations. Additionally, should an incident occur, project vessels will be well equipped to assist, either through self-help capability or – for an incident involving a nearby third-party vessel – through The International Convention for the Safety of Life at Sea (SOLAS) obligations, all in liaison with the Maritime and Coastguard Agency. The NRA undertaken as part of the shipping and navigation chapter, NRA Technical Report (Anatec Limited and RPS Group, 2023), was of sufficient detail that interactions between effects were considered, both from different phases and different receptors, and therefore the results would be the same. Across the Proposed Development lifetime, the effects on shipping and navigation receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the ES.	No change resulting from inter-related assessment

Receptor-led effects

The presence of the construction and decommissioning areas during the construction and decommissioning phases, respectively, may result in the displacement from fishing grounds of commercial fishing vessels. This displacement and the associated reduction in available sea room will increase the vessel to vessel collision risk between third-party vessels. However, it is unlikely that effects will act together and that any interactions between effects will be of any greater significance than those already assessed for the Proposed Development alone.

Across the Proposed Development lifetime, the effects on shipping and navigation receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the ES.

14.6.3.2 Commercial fisheries

For commercial fisheries, the following potential impacts have been considered within the inter-related assessment:

- loss or restricted access to fishing grounds;
- impacts on commercially valuable fish and shellfish species/resources;
- interference with fishing activity; and
- supply chain opportunities for local fishing vessels.

Table 14.11 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, operations and maintenance and decommissioning phases of the Proposed Development and the inter-related effects (receptor-led effects) that are predicted to arise for commercial fisheries receptors.

As previously noted, commercial fisheries receptors and fish and shellfish receptors are linked and the inter-related effects associated with potential impacts on commercially important fish species has been fully assessed in chapter 10, with effects of minor adverse or lower significance predicted for all Proposed Development phases.

Table 14.11: Summary Of Potential Inter-Related Effects For Commercial Fisheries

Description of impact	Phase C	Phase O	Phase D	Likely significant inter-related effects	Inter-related significance
Loss or restricted access to fishing grounds	✓	✓	✓	During the construction and decommissioning phases of the Proposed Development, safety zones, and therefore the areas from which commercial fishing will be excluded, will be highly localised. During construction, for example, fishing will be excluded from 500m safety zones around infrastructure. During operation, fishing will be excluded from 500m safety zones around infrastructure. A minor effect is predicted for all receptor groups. While there will be a small incremental increase in the area in which fishing may be disrupted as the Proposed Development is built out, as fishing activity is likely to be able to continue elsewhere during all Proposed Development phases, effects on commercial fisheries across the phases are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase. Across the Proposed Development lifetime, the effects on commercial fisheries receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the ES.	No change resulting from inter-related assessment
Impacts on commercially valuable fish and shellfish species/resources	✓	✓	✓	Impacts to prey species (i.e. fish and shellfish) will be at their maximum during the construction phase as a result of effects associated with temporary habitat loss and/or disturbance, subsea noise impacting fish and shellfish receptors, increased suspended sediment concentrations and associated deposition, all assessed to be low adverse significance by chapter 7, used to inform chapter 10. Across the Proposed Development lifetime, the effects on commercial fisheries receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the ES.	No change resulting from inter-related assessment
Interference with fishing activity	✓	✓	✓	Smaller vessel sizes associated with inshore static gear vessel and offshore static gear vessel receptor groups may be affected by the presence of construction vessels during the construction and decommissioning phases within the Proposed Development. The marker buoys and actual gear deployed by the inshore static gear vessels are vulnerable to potential interference by construction vessels, due to their poor visibility. Although operational and maintenance vessel traffic will add to the existing level of shipping activity in the area, there are already moderate levels of vessel traffic in the area, and there is co-existence of fishing vessels with other marine traffic. Across the Proposed Development lifetime, the effects on commercial fisheries receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the ES.	No change resulting from inter-related assessment

Description of impact	Phase			Likely significant inter-related effects	Inter-related significance
	C	O	D		
Supply chain opportunities for local fishing vessels	✓	✓	✓	During the construction, operational and maintenance and decommissioning of the Proposed Development, there may the opportunity for commercial fisheries operators to provide support to the Proposed Development, such as guard vessels and scouting surveys. Across the Proposed Development lifetime, the effects on commercial fisheries receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the ES.	No change resulting from inter-related assessment
Receptor-led effects					
There is potential for an inter-related effect from the combination of reduction in loss or restricted access to fishing grounds and supply chain benefits for local fishing vessels; this is because fishing vessels are likely to be providing marine operational support during periods of construction or maintenance works which would have resulted in a loss or restricted access to fishing grounds if the vessel had not been providing support to the Proposed Development. This means that the benefit to the local fishing vessels as a result of the supply chain opportunities is acting more as an alleviation of potential losses than an additional benefit. It is therefore predicted that any potential inter-related effect will reduce the beneficial significance of supply chain opportunities, which would result in a negligible beneficial significance.					

14.6.3.3 Marine archaeology

For marine archaeology, the following potential impacts have been considered within the inter-related assessment:

- sediment disturbance and deposition leading to indirect impacts on marine archaeology receptors (the exposure or burial of receptors).

Table 14.12 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, operations and maintenance and decommissioning phases of the Proposed Development and the inter-related effects (receptor-led effects) that are predicted to arise for marine archaeology receptors.

As previously noted, marine archaeology and physical processes (i.e. sediment deposition) are linked receptors and the inter-related effects associated with a change to marine archaeological receptors has been fully assessed in chapter 11, with effects of minor adverse significance predicted during construction.

Table 14.12: Summary Of Potential Inter-Related Effects For Marine Archaeology

Description of impact	Phase C	Phase O	Phase D	Likely significant inter-related effects	Inter-related significance
Sediment disturbance and deposition leading to indirect impacts on marine archaeology receptors (the exposure or burial of receptors).	✓	✓	✓	The construction, operations and maintenance and decommissioning phases of the Proposed Development may lead to sediment disturbance and deposition leading to indirect impacts on marine archaeology receptors. Impacts of sediment disturbance and deposition during each Proposed Development phase have the potential to expose previously unrecorded marine archaeology receptors, and to bury or partially bury known marine archaeology receptors. Across the Proposed Development lifetime, the effects on marine archaeology receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the ES.	No change resulting from inter-related assessment
Receptor-led effects					
No receptor-led effects are expected for the Proposed Development across all phases.					

14.6.3.4 Infrastructure and other sea users

For other sea users, the following potential impacts have been considered within the inter-related effects assessment:

- displacement of recreational activities;
- increased SSCs and associated deposition affecting recreational diving and bathing sites;
- impacts to existing cables or pipelines or restrictions on access to cables or pipelines;
- increased SSCs and associated deposition affecting aggregate extraction areas; and
- reduction or restriction of oil and gas exploration activities (including surveys, drilling and the placement of infrastructure).

Table 14.13 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, operations and maintenance and decommissioning phases of the Proposed Development and the inter-related effects (receptor-led effects) that are predicted to arise for infrastructure and other sea users receptors.

As previously noted, infrastructure and other sea users receptors and physical processes are linked receptors and the inter-related effects (i.e. a change to the sediment regime) on aggregate receptors has been fully assessed in chapter 12, with effects of negligible/minor significance predicted across all Proposed Development phases.

Table 14.13: Summary Of Potential Inter-Related Effects For Infrastructure And Other Sea Users

Description of impact	Phase C	Phase O	Phase D	Likely significant inter-related effects	Inter-related significance
Displacement of recreational activities	✓	✓	✓	During the construction, operations and maintenance and decommissioning phases, the presence of infrastructure, safety zones and advisory safety distances, may lead to the displacement of recreational activities such as recreational sailing, water sports and fishing from the Proposed Development. The level of recreational activity is low. There is the potential for loss of recreational resource during nearshore/inshore activities in the construction phase. However, any displacement within the Proposed Development area will be temporary and is not likely to result in inter-related effects. Across the Proposed Development lifetime, the effects on infrastructure and other sea users receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the ES.	No change resulting from inter-related assessment
Increased SSCs and associated deposition affecting recreational diving and bathing sites	✓	✓	✓	During the construction, operations and maintenance and decommissioning phases the installation, maintenance and removal of infrastructure has the potential to increase SSC within the water column. There is potential that sediment plumes from resuspended sediment could impact recreational areas through changes to water quality. The impact will be of negligible to minor significance. Across the Proposed Development lifetime, the effects on infrastructure and other sea users receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the ES.	No change resulting from inter-related assessment
Impacts to existing cables or pipelines or restrictions on access to cables or pipelines	✓	✓	✓	During the construction, operations and maintenance and decommissioning phases existing cables and pipelines may be affected where they are crossed by the Proposed Development. In addition, access to existing cables and pipelines may be restricted during construction, maintenance and decommissioning activities due to the presence of the Proposed Development infrastructure, safety zones and advisory safety distances. Across the Proposed Development lifetime, the effects on infrastructure and other sea users receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the ES.	No change resulting from inter-related assessment

Description of impact	Phase C	Phase O	Phase D	Likely significant inter-related effects	Inter-related significance
Increased SSCs and associated deposition affecting aggregate extraction areas	✓	✓	✓	During the construction, operations and maintenance and decommissioning phases of the Proposed Development, the installation, maintenance and removal of infrastructure has the potential to increase SSC within the water column and to deposit disturbed sediments on the surrounding seabed. There is potential that sediment plumes from resuspended sediment could impact aggregate areas through sedimentation and the potential that this could affect the quality of aggregate (coarse sand deposits). Across the Proposed Development lifetime, the effects on infrastructure and other sea users receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the ES.	No change resulting from inter-related assessment
Reduction or restriction of oil and gas exploration activities (including surveys, drilling and the placement of infrastructure)	✓	✓	✓	Drilling and the placement of infrastructure will be restricted within the Proposed Development, with a 500m safety zones around installation vessels during the construction phase, and 500m safety zones established around infrastructure. As infrastructure is installed, the area available for seismic surveys and drilling will be restricted, and the presence of safety zones around infrastructure and vessels may also further restrict the ability to use certain alternative survey methods. The effects of decommissioning activities are expected to be the same or similar to the effects from construction. Across the Proposed Development lifetime, the effects on infrastructure and other sea users receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase or when considered in conjunction with other topics addressed in the ES.	No change resulting from inter-related assessment
Receptor-led effects					
No receptor-led effects are expected for the Proposed Development across all phases.					

14.7 Summary and conclusions

The tables presented within this chapter assess potential inter-related effects arising from the Proposed Development on a range of receptor groups. Much of the content of these tables has been based upon assessments of individual impacts presented in the topic-specific ES chapters. The identification of potential inter-related effects has been based on a largely qualitative assessment using expert judgement, and noting that inter-related effects have already been accounted for, in many instances, within the assessments in the topic-specific chapters. The following conclusions arise in the context of physical, biological and human environments.

This chapter has defined the potential inter-related effects considered to arise from the Proposed Development. Proposed Development lifetime and receptor-led effects have been defined in order to differentiate the two types of inter-related effects that may arise as a result of the Proposed Development.

Based on one or a combination of the following factors: the low sensitivity of receptors; temporary and small-scale nature of effects; availability of alternative habitats; and factoring in proposed mitigation measures adopted as part of the Proposed Development, the overall significance of any inter-related effects is not judged to increase above the significance value assessed for individual effects in the topic-specific chapters.

14.8 References

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