Anasuria Hibiscus UK

HSSE

Teal West Development – Environmental Statement

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00	29/07/2022	Issued for Use	[redacted]	[redacted]	[redacted]
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Rev No.	Rev Date	Revised Pages	Description of Change / Revision Summary	Originator	Reviewed	Approved
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DOCUMENT DISTRIBUTION

Copy No	Company / Department	Name / Position
O (Original)	Teal West Project	

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ENVIRONMENTAL STATEMENT DETAILS

Section A: Administrative Information

A1 – Project Reference Number

Number: ES/2022/006

A2 - Applicant Contact Details

Company name: Anasuria Hibiscus UK Limited

Contact name: [redacted]

Contact title: [redacted]

A3 - ES Contact Details (if different from above)

Company name: Anasuria Hibiscus UK Limited

Contact name: [redacted]

Contact title: [redacted]

A4 - ES Preparation

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

Company	Title	Relevant Qualifications / Experience
AHUK	[redacted]	[redacted]
	[redacted]	[redacted]
	[redacted]	[redacted]
Xodus Group	[redacted]	[redacted]
	[redacted]	[redacted]
	[redacted]	[redacted]
	[redacted]	[redacted]

A5 - Licence Details

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

Licence number(s): P2535

b) Please confirm licensees and current equity

Licensee	Percentage Equity
Anasuria Hibiscus UK Limited	70% (appointed operator)
Neo Energy Production UK Limited	30%

Section B: Project Information

B1 - Nature of Project

a) Please specify the name of the project.

Name: Teal West Development

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

Name: Teal West Development - Environmental Statement

c) Please provide a brief description of the project.

The Teal West development comprises the development of the Teal West field (Licence P2535) in United Kingdom Continental Shelf (UKCS) Blocks 21/24d in the Central North Sea. AHUK plans to develop the Teal West field by drilling up to two production wells and one water injection well which will be tied back to the Anasuria FPSO where oil will be exported by offtake tankers and gas will be exported by the Fulmar gas pipeline.

B2 - Project Location

a) Offshore location(s) of the main project elements (both the start and end locations).

Quadrant number(s): 21

Block number(s): 21/24d and 21/25.

Drill Centre Location (wells will be in the very close vicinity of this):

Latitude: 57° 16' 31.994" N Longitude: 00° 46' 25.646" E

Distance to nearest United Kingdom (UK) coastline: 155 km

Distance to nearest international median line: 87 km to UK/Norway median line.

B3 - Previous Applications

N/A

DEFINITIONS AND ABBREVIATIONS

Term	Definition
ACA	Action Co-ordinating Authority
ACOPS	Advisory Committee on Protection of the Sea
AHUK	Anasuria Hibiscus UK Limited
ALARP	As Low as Reasonably Practical
AOC	Anasuria Operating Company
API	American Petroleum Institute
AWF	Auditory Weighting Functions
BAT	Best Available Technique
bbls	Barrels
BEIS	Business, Energy & Industrial Strategy
BEP	Best Environmental Practice
BOE	Barrel of Oil Equivalent
BOP	Blow-out Preventer
Bscf	Billions of standard cubic feet
BS&W	Basic Sediment and Water
CAPEX	Capital Expenditure
CCS	Carbon Capture and Storage
CEO	Chief Executive Officer
CoP	Cessation of Production
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO2e	Carbon Dioxide Equivalent
CNS	Central North Sea
CNSFTC	Central North Sea Fibre Telecommunications Company
Csac	Candidate Special Area of Conservation
CSV	Construction Support Vessel
DC	Drill Centre
DCVS	Drill Centre Valve Skid
DP	Dynamic Positioning
DREAM	Dose-Related Risk and Effect Assessment Model
DSP	Drilling Support Vessel
DSV	Dive Support Vessel
DUTA	Dynamic Umbilical Termination Assembly
ECA	Emission Control Areas
EEA	European Environment Agency
EEMS	Environmental and Emissions Monitoring System
EIA	Environmental Impact Assessment
EIAPP	Engine International Air Pollution Prevention Certifications
EIAR	Environmental Impact Assessment Report
EIF	Environmental Impact Factor
EMSA	European Maritime Safety Agency
ENVID	Environmental Issues Identification
EPS	European Protected Species
ERRV	Emergency Response and Rescue Vessel
ES	Environmental Statement
EUNIC	European Union Nature Information System
FDP	Field Development Planning
FEAST	Feature Activity Sensitivity Tool
FLIR	Forward-looking infrared

FFS	Fishing Friendly Structure
FPSO	Floating Production Storage and Offloading
GHG	Greenhouse Gas
GPS	Global Positioning System
GWP	Global Warming Potential
HF	High Frequency
HMCS	Harmonised Mandatory Control Scheme
HSE	Health Safety Executive
HS&E	Health Safety and Environment
IAPP	International Air Pollution Prevention Certificate
ICCI	In-Combination Climate Impact
ICES	International Council for the Exploration of the Sea
ID	Inner Diameter
IEEM	Institute of Ecology and Environmental Management
IOGP	International Association of Oil and Gas Producers
IP	Institute of Petroleum
IPCC	Intergovernmental Panel on Climate Change
INTOG	Innovation and Targeted Oil and Gas
ISO	International Standards Organisation
ITOPF	International Tankers Owners Pollution Federation
JNCC	Joint Nature Conservation Committee
kbpd	Thousand Barrels per Day
kWh	Kilowatt-hour
LAT	Lowest Astronomical Tide
LF	Low Frequency
LOF	Likelihood of Failure
LOLER	Lifting Operations and Lifting Equipment Regulations
LSE	Likely Significant Effect
MA	Major Accident
MAH	Major Accident Hazards
MARPOL	Convention for the Prevention of Pollution from Ships
MBES	Multibeam Echosounders
MCA	Maritime and Coastguard Agency
MCCIP	Marine Climate Change Impacts Partnership
MCZs	Marine Conservation Zones
MDAC	Methane Derive Authigenic Carbonate
MEI	Major Environmental Incident
MEMW	Marine Environmental Modelling Workbench
MER	Maximising Economic Recovery
MF	Mid Frequency
MMscfd	Million Standard Cubic Feet per ay
MMstb	Million Stock Tank Barrels
MMO	Marine Mammal Observer
MoD	Ministry of Defence
MODU	Mobile Offshore Drilling Unit
MPI	Major Pollution Incident
MSS	Marine Scotland Science
NCMPA	Nature Conservation Marine Protected Areas
NCP	National Contingency Plan
NDC	Nationally Determined Contribution
NEC	No Effect Concentration
NMFS	National Marine Fisheries Service

NMPI	National Marine Plan Interactive
NMVOC	Non-Methane Volatile Organic Compound
NNS	Northern North Sea
NORM	Naturally Occurring Radioactive Material
NSTA	North Sea Transition Authority
NORBIT	Norwegian/British Oil Spill Response
OCR	Offshore Chemicals Regulations
OEUK	Offshore Energies UK (previously OGUK)
OD	Outer Diameter
OGA	Oil and Gas Authority
OIW	Oil-in-Water
OPEP	Oil Pollution Emergency Plan
OPPC	Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005
OPRC	Oil Pollution, Preparedness, Response and Cooperation
OPRED	Offshore Petroleum Regulator for Environment and Decommissioning
OSCAR	Oil Spill Contingency and Response
Pa	Pascal
PAH	Polycyclic Aromatic Hydrocarbon
PAM	Passive Acoustic Monitoring
PEC	Predicted Effect Concentration
PLONOR	Posing Little or No Risk to the environment
PMFs	Priority Marine Features
PNEC	Predicted No Effect Concentration
PON1	Petroleum Operations Notices 1
ppm	Parts Per Million
ppt	Parts Per Thousand
PSA	Particle Size Analysis
pSPA	Potential Special Protection Areas
Psu	Change In Practical Salinity Unit
PTS	Permanent Threshold Shift
PW	Pinnipeds in Water
QSR	Quality Status Report
RBM	Riser Base Manifold
RCP	Representative Concentration Pathway
RMS	Root Mean Square
ROV	Remote Operated Vehicle
SACs	Special Areas of Conservation
SACFOR	Super abundant, Abundant, Common, Frequent, Occasional, Rare
SBP	Sub-Bottom Profiler
SCANS-III	Small Cetaceans in the European Atlantic and North Sea
SCAP	Supply Chain Action Plan
SCOS	Special Committee on Seals
SECA	Sulfur Oxides Emission Control
SECE	Safety and Environmental Critical Elements
SEL	Sound Exposure Level
SEEMP	Shipboard Energy Efficiency Management Plan
SFF	Scottish Fishermen's Federation
SIMOPS	Simultaneous Operations
SMRU	Sea Mammal Research Unit
SNCBs	Statutory Nature Conservation Bodies
SNS	Southern North Sea
SOBM	Synthetic Oil Based Mud

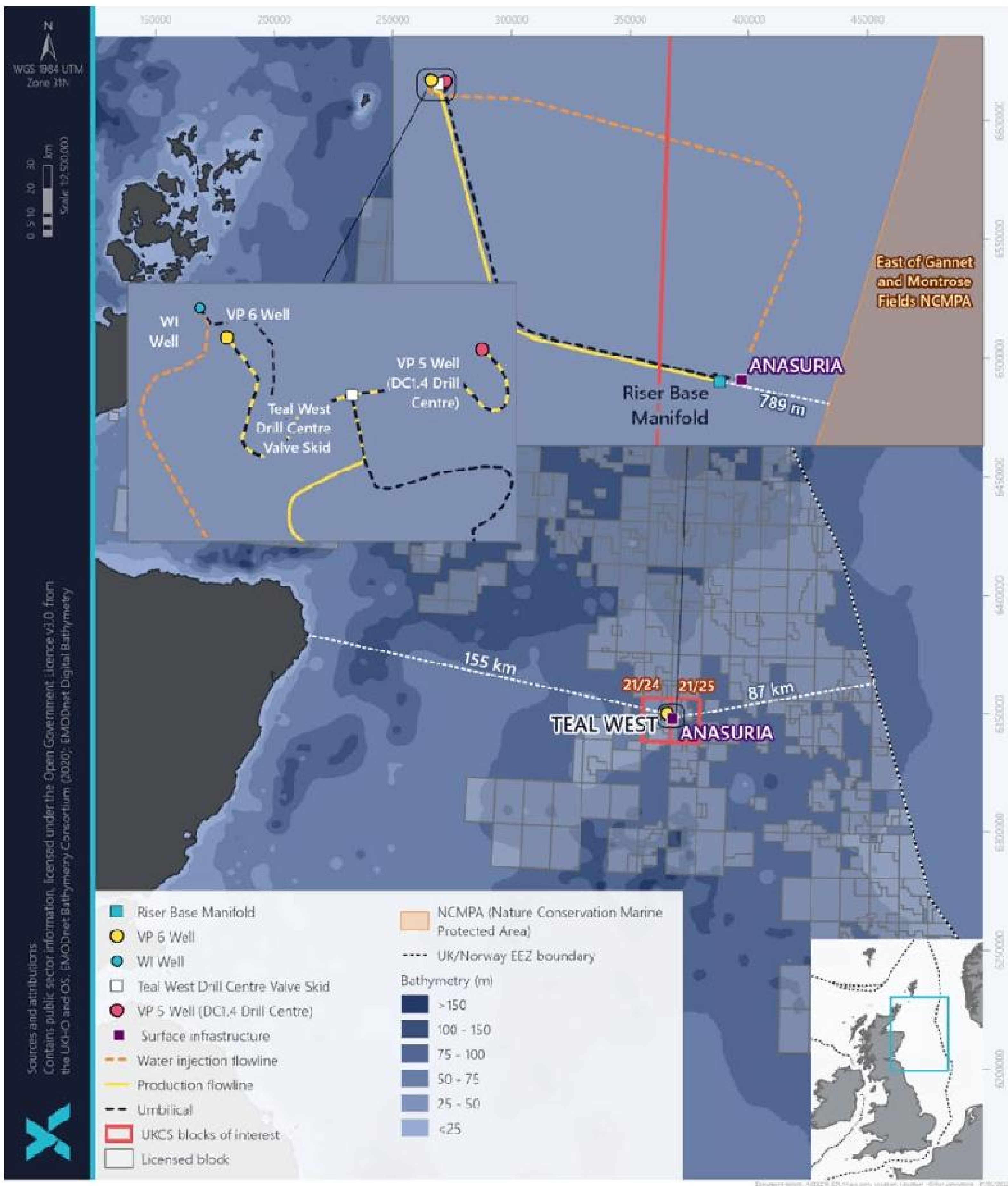
SOSI	Seabird Oil Sensitivity Index
SPAs	Special Protection Areas
SPL	Peak Sound Pressure
SPLrms	Sound Pressure Level
SRES	Special Report Emissions Scenario
SSS	Side Scan Sonar
SSSI	Sites of Special Scientific Interest
TCP	Tubing Conveyed Perforation
Te	Tonnes
THC	Total Hydrocarbon Content
TOM	Total Organic Matter
TOOPEP	Temporary Operations Oil Pollution Emergency Plan
TTS	Temporary Threshold Shift
TSV	Trenching Support Vessel
UHB	Upheaval Buckling
UK	United Kingdom
UKAPP	Air Pollution Prevention Certificate
UKCS	United Kingdom Continental Shelf
UKETS	UK Emissions Trading Scheme
UKOOA	United Kingdom Offshore Operators Association
UNFCCC	United Nations Framework Convention on Climate Change
UTA	Umbilical Termination Assembly
VMS	Vessel Monitoring System
VHF	Very High Frequency
VSP	Vertical Seismic Profiling
XT	Xmas Tree
0-Peak	Zero-to-Peak
2DHR	Two-Dimensional High Resolution Seismic Survey
µPa	Micropascal

NON-TECHNICAL SUMMARY

Introduction

This non-technical summary provides an overview of the Environmental Statement (ES) prepared for the Teal West development.

The Teal West development is a project involving the drilling of subsea wells in the Teal West field to extract oil and gas. The wells will be connected by new flowlines to the existing Anasuria Floating, Production, Storage and Offloading (FPSO) vessel where the oil will be exported to shore via offtake tankers. The gas produced by the wells will be used as fuel offshore and the remaining gas will be exported to shore via the existing Fulmar Gas Line.



Anasuria Hibiscus UK (AHUK) will operate the Teal West Licence. The licenses for the blocks in which the field is located are held by AHUK and Neo Energy.

The Teal West field is located in the Central North Sea (CNS), approximately 155 km north-east of Peterhead and 87 km west of the UK-Norway median line, in water of approximately 90 m depth. It is within United Kingdom Continental Shelf (UKCS) Block 21/24d and the new flowlines will run to the Anasuria FPSO which is located in Block 21/25.

Consideration of Alternatives

The consideration of alternatives is a process where a wide range of options are screened to ensure the final plans are optimal. For the Teal West development, options for elements such as facilities and equipment were considered, based on criteria that included economic viability, safety, environmental impact and carbon footprint.

Key elements of the alternatives consideration included the potential host options for the development , selection of which took into consideration the technical feasibility and the environmental impact. The Anasuria FPSO was selected as the host due to its proximity to the Teal West field, the requirement for only minimal pipeline crossings, a reduced reliance on ageing infrastructure and no pipeline capacity issues.

Project Description

The Teal West Development will be divided into three phases, whereby Phase 1 will consist of the drilling of one production well tied back to the Anasuria FPSO via a new 3.4 km production flexible which will produce oil and gas for approximately 10 years. Depending on the successful results of this Phase 1 well, Phase 2 will involve the drilling of a water injection well. If these both indicate the potential for high oil volumes, a second production well will be drilled and tied back to the Anasuria FPSO in Phase 3. Drilling of the Phase 1 well is scheduled to start in Q3 2023 with an aim for first oil in Q2 2024. If successful, the water injection well and second production well are scheduled for Q3 2025 and Q1 2027, respectively. All three phases comprising the two production wells and a Water injection well are included within the scope of this ES.

Annualised oil production is predicted to peak at 1,333 tonnes/day during 2024 when the well comes online, decreasing to 583 tonnes/day in 2026 and then increasing again to approximately 813 tonnes/day in 2027 when the second production well becomes operational. From here the production rate steadily declines, hence the requirement for the water injection well to maintain the pressure required.

Details of the activities occurring during the development are provided in the table below.

Activity	Description
Drilling	The two production wells and one water injection well will be drilled. Each well will be drilled in five sections of successively smaller diameters. Fluids used during drilling include water-based mud and oil-based mud. When water-based mud is used, drill cuttings will be discharged directly to the seabed. When oil-based mud is used, the cuttings will be transferred onshore for treatment. Cement will be used to secure the steel well casings in place.
Infrastructure Installation	The types of subsea in-field infrastructure include wellheads, flowlines for the transport of oil and gas, manifolds and trees for directing and monitoring flow, foundations and pipelines for the water injection system, and umbilicals (small pipelines for communication cables, hydraulic control fluid and chemicals). Vessels and remotely-operated vehicles will support the installation of this infrastructure and will maintain their position using dynamic positioning.
Production	Prior to production, the integrity of the flowline will be confirmed via testing such as leak detection. The production wells will be produced back to the Anasuria FPSO where hydrocarbons will be processed. Produced water will be discharged to sea via existing facilities on the FPSO. Vessels, helicopters and remotely-operated vehicles will support production and operation throughout the life of the development (approximately 10 years).
Decommissioning	As decommissioning is likely to be far in the future, it is anticipated that technology and regulations may change before it occurs. As a result, activities are subject to change. In general, the pipelines and infrastructure is flushed and cleaned, the well is plugged and sealed with cement. Infrastructure may be removed, depending on environmental, safety and cost factors at the time of decommissioning.

Environmental Baseline

Detailed information about the environment in which the development will take place was required as part of the EIA process. The following table provides a brief summary of the key information collated.

Bathymetry and Metocean Characteristics
The development will occur in the CNS in water depths approximately 90 m. The seabed slopes gently from the south-east and north-east to the north-west. Generally, the area experiences frequent rain, strong winds and

changeable wind direction. The ocean here is characterised by multiple strong non-tidal currents interacting with relatively weak tidal flow.
Sediment Type and Seabed Features
The seabed sediment at the development is characterised as sand or muddy sand, with various physical features including pockmarks, boulders and depressions. Surveys indicated that the sediments was relatively homogenous across the Teal West area.
Plankton
The distribution and abundance of plankton is heavily influenced by water depth, with the majority of the plankton occurring in the photic zone (i.e. the upper 20 m of the sea). Zooplankton can extend to greater depths and many species undergo diurnal vertical migrations, rising to feed before returning to depth
Seabed Habitats and Species
Site specific environmental baseline and habitat assessment surveys found that the epifauna across the site was homogenous and relatively sparse, mainly comprising crabs, starfish, sea pens, anemones and soft corals. The infaunal diversity was assessed to be moderate to high across the Teal West Area and dominated by polychaete species. The biotope "Seapen and Burrowing Megafauna community" is potentially present in the area.
Fish and Shellfish
Fish and shellfish populations may be vulnerable to impacts from offshore installations such as hydrocarbon pollution. The development is in a low or undetermined intensity nursery grounds for anglerfish, blue whiting, cod, European hake, haddock, herring, ling, mackerel, Nephrops, plaice, sandeels, sprat, spurdog and whiting. It is also located within low or undetermined spawning grounds for cod, lemon sole, mackerel and Nephrops as well as high intensity spawning grounds for sandeels and a high concentration spawning area for Norway pout.
Marine Mammals
Species known to be present in the area include harbour porpoise, white-beaked dolphim, minke whale, bottlenose dolphin and Atlantic white-sided dolphin. However, the development area is considered to have a low cetacean density and not significant for feeding, breeding, nursery or migrating cetaceans. Grey and harbour seals are the most likely seal species to be encountered in the area.
Seabirds
In the CNS, the most numerous species present are likely to be northern fulmar, black-legged kittiwake and common guillemot. Species present and densities vary with the time of year. Seabird sensitivity to surface oil in the Teal West area is considered low throughout the year.
Conservation
There are no Special Areas of Conservation within 100 km of the development, but there are several other conservation sites, including the East of Gannet and Montrose Fields Marine Protected Area (NCMPA) which is located immediately adjacent to the development.
Other Sea Users
The area is fished by local and international vessels. Fishing effort is low and both demersal and pelagic fish species are caught in the area. Commercial shipping activity is considered very low and on the shelf most vessels are cargo, tanker and fishing vessels.

EIA Methodology

The EIA process considers impacts and the resulting effects on receptors. This includes the duration, extent and, if necessary, the likelihood of an impact, as well as the sensitivity of a receptor. The consequence of impact on a receptor is then assessed, to identify any potentially significant impacts.

The EIA process began with identification of the sources of potential impact which required further assessment. Identification of these sources was based on the specific proposed activities, relevant environmental sensitivities, a review of past EIA outcomes, and wider stakeholder input. A range of stakeholders were consulted during the EIA process, including the regulator OPRED and the North Sea Transition Authority.

The following issues were selected for assessment in the EIA:

- Discharges to sea;
- Seabed impacts;
- Interaction with other sea users (physical presence);
- Underwater sound;
- Atmospheric emissions and climate; and
- Accidental events.

Discharges to Sea

Activities that result in discharges to the sea will occur within drilling, installation and operation activities of the Teal West development. Discharges include cuttings and fluid from drilling, cement, and water-based fluids used in the infrastructure as well as produced water from the FPSO. The drilling discharges may lead to increased suspended solids in the water column and materials settling on the seabed. This may indirectly cause a change to the physical or chemical nature of the habitat or impairment of benthic organisms feeding or respiratory systems. The volume and content of the cuttings from the drilling activities, and their predicted dispersion through the water column were assessed alongside the sensitivity of species present, such as plankton and fish, and the recovery potential of the environment. In addition the effects on the water column from the operational discharges via produced water was also considered. Impacts to the water column and seabed were found to be not significant.

To help avoid a significant impact, several steps will be taken, including:

- Drilling muds will be recycled as far as practicable to reduce discharges;
- The drilling rig will be audited to ensure it conforms to all relevant guidelines and legislation; and
- Chemical selection will take into account permit conditions and approvals based on an environmental risk assessment.

Seabed Impacts

Activities such as the deployment of the jack up drilling rig, installation of infrastructure and deposition of drill cuttings and rock on the seabed can lead to changes at the seabed and negative impacts including loss of species, loss of habitat, introduction of a new hard substrate and wider indirect disturbance from sediment suspension in the water. The area that will be occupied by the structures and materials (the footprint) of the development, the timeframe and nature of activities and the duration of effects were assessed alongside benthic species sensitivity and tolerance, and features of the seabed. Seabed impacts were found to be not significant.

To help avoid a significant impact, several steps will be taken, including:

- Environmental surveys will be used to allow the gas pipeline route to avoid sensitive locations;
- Installation of subsea facilities will use vessels that do not need anchors; and
- The drilling rig spud cans will be placed to avoid sensitive areas.

Underwater Noise

Noise generated by development activities adds to the background sound in the environment. Noise will be generated by several activities, including drilling, operation of vessels and helicopters, hammer piling and seismic profiling of the subsea wells (using airguns). Some animals may behave differently in response to this noise. The noise may block sounds they use for communication, or it may cause discomfort or injury.

The intensity, frequency and duration of the noise from the seismic airguns and piling (considered the worst-case sources) was assessed with reference to sensitivities and likely presence of specific animals. The risk of disturbance to fish is considered low and habituation is unlikely due to the short period of activity. There is a very low likelihood of injury or non-trivial disturbance to marine mammals.

To help avoid a significant impact, several steps will be taken, including:

- Ensuring a Marine Mammal Observer is present to monitor for the presence of marine mammals before and during the surveys. If animals are present, work is delayed until they have passed; and
- Conducting a soft start for survey work. Activities that generate noise begin at low levels to allow time for animals to move away from the sound before the higher intensity noise begins.

Physical Presence

The presence of infrastructure, facilities and vessels have the potential to obstruct or exclude other sea users. The risk of vessel collision and snagging of fishing gear may be increased, and the use of the area for other purposes may be reduced due to the safety zone established around the activities. The time during which the areas are occupied by vessels or infrastructure, the size of area occupied, and the nature of the vessels and infrastructure or equipment on the seabed were considered in the assessment. Details of fishing and other vessels using the area, types of fishing methods used and the depth of the seabed were also taken into account. Impacts to commercial fisheries and shipping were found to not be significant and the risk of snagging found to be low.

To help avoid a significant impact, several steps will be taken, including:

- The subsea facilities will be designed so that trawling can still occur over them (where the most fishing occurs);
- A dropped object protocol will be developed to reduce the risk of dropped objects from installation vessels;
- The operations centre will remotely monitor vessel traffic around the field; and
- A fishery liaison strategy will be developed and implemented.

Atmospheric Emissions and Climate

Emissions come from the incremental increase in fuel consumption and flaring and venting at the Anasuria FPSO as a result of the Teal West development, the drilling rig, vessels and helicopters, subsea infrastructure installation. Gas emissions may impact air quality, climate change and acid deposition. The types and worst-case volumes of gas emitted, along with the background air quality were assessed. The assessment found that significant impacts on local air quality are not expected. The atmospheric emissions assessment focused on ways to reduce emissions, which include (in addition to those discussed in the consideration of alternatives):

- Developing the subsea installation programme to minimise the number of mobilisations, demobilisations and length of vessel transit;
- Green dynamic positioning or economical speeds when operationally appropriate;
- Use of low carbon products or solutions, and seek supplier engagement to deliver these; and
- Streamlining of activities through planning to reduce the time required for vessels and helicopters.

Accidental Events

By their nature, oil and gas developments come with the risk of an accidental release of hydrocarbons. There are many sources of potential releases, including a failure of a well (known as a well blowout) and spilling of diesel from a vessel involved in the development. The potential impact of an oil spill on the receiving environment has been assessed by considering environmental sensitivities, and factors such as properties of the material and probable direction of its movement. The likelihood of an event happening is also considered in this type of assessment. The assessment found that the worst case scenario well failure has the potential to lead to a major environmental incident. Impacts to individual receptors are considered either major or moderate. The probability of this occurring is very low.

The assessment was based on no steps being taken to stop the spill. In reality, many measures will be put in place to reduce the probability of an accidental release. These measures include:

- Having suitable emergency response procedures in place;
- Installing suitable blowout preventers on the production wells; and
- Employing robust maintenance and inspection programmes;

Environmental Management

AHUK has developed an Environmental Management System (EMS) which is designed to ensure activities are executed in a way that protects people and the environment. The environmental elements of the EMS are aligned with the requirements of ISO 14001:2015 and in compliance with OPRED requirements. AHUK's commitment to environmental safety is reflected in their sustainability fundamentals, within the corporate framework, which are aligned with achievement of UK Net Zero emissions targets. AHUK Oil Spill Response Procedures will be applied during all operations and Emergency Response Bridging Documents are prepared for all offshore activities involving contractor facilities and vessels.

Conclusions

The Teal West development concept minimises the environmental footprint and supports the UK's net zero target, while maintaining a hydrocarbon supply and contributing to the UK's energy security. In assessing the environmental impact of the development, the planned activities and the existing environmental sensitivities were considered. The environmental impacts arising from known and expected activities, were found to be not significant. The potential impact to the environment from an unexpected worst case well failure is considered moderate or major, but the likelihood of it occurring is very low. Mitigation measures are in place to ensure any impacts or risks are reduced as much as possible as the development progresses.

The Teal West team will deliver the mitigation measures identified in this ES and work towards continual improvement in environmental performance beyond these commitments.

1. INTRODUCTION

1.1. Anasuria Hibiscus UK Limited

Anasuria Hibiscus UK Limited ("AHUK") is an indirect, wholly owned subsidiary of Hibiscus Petroleum Berhad ("Hibiscus") which is an independent oil and gas exploration and production company. Hibiscus holds a portfolio of exploration, development and production assets with interests in the United Kingdom (UK), Malaysia and Australia.

AHUK and Zennor Exploration Limited ("Zennor") were awarded the interest in Block 21/24d held under UK Petroleum Licence P2535 on the United Kingdom Continental Shelf (UKCS) during the 32nd Offshore UK Licensing Round. AHUK has a 70% interest and is the appointed operator for the licence block, with Zennor holding the remaining 30% interest. In July 2021, NEO Energy (ZEX) limited ("NEO") completed its acquisition of Zennor and took over its entire interest in Block 21/24d.

AHUK and NEO (the "JV Partners") have carried out further detailed evaluation of the selected development concept for the Teal West field, in order to identify the development plan for the field, the Environmental Impact Assessment (EIA) of the selected option is presented in this document.

1.2. Project Overview

AHUK is seeking to produce the oil reservoirs of the Teal West field, located in Block 21/24d in the central North Sea (CNS), approximately 155 km north-east of Peterhead and 87 km from the UK/Norway median line (Figure 1-1).

The base case plan for Teal West is to drill an oil development well to the south-east of the structure (VP5), followed by a water injector well at the west of the structure, aiming for commencement of water injection about 1.5 years after first oil. In the event of a low oil production outcome, the VP5 well will be produced under depletion mode (with no water injection well drilled) until cessation of production (CoP). In the high oil production scenario, a second oil development well (VP6) may be drilled to the south-west of the structure approximately 3 years after first oil to drain the oil accumulation at the western flank. The production and water injection wells will be developed from a single drill centre (DC), DC1.4, at the coordinates shown in Table 1-1. The tophole locations of the VP5 and VP6 wells will be approximately 350 m apart.

Table 1-1 - Proposed Development Coordinates

Infrastructure	Northing	Easting	Latitude (DMS)	Longitude (DMS)
Drill Centre DC1.4	6 350 397 mN	365 771 mE	57° 16' 31.994" N	00° 46' 25.646" E
Coordinate system: ED50 Zone 31N UTM				

Based on the geological similarities, the reservoir fluids from the Teal West field are expected to be analogous to the fluids at the Teal field approximately 3.5 km to the east, which consist of light oil of 37 to 38°API[1] gravity.

[1] American Petroleum Institute gravity – a measure of how heavy or light a petroleum liquid is compared to water.

Teal West will be a subsea development tied back to the existing Anasuria floating production storage and offloading vessel (FPSO), located approximately 4 km south-east of the proposed Teal West drill centre DC1.4. The Anasuria FPSO was originally designed to process fluids from the currently-producing Teal field, which, as described above, has been identified as a very close analogue for Teal West. Therefore, the Teal West reservoir fluid properties are not expected to require any modifications to the FPSO for processing.

A new 3.4 km, 6" production flowline and a new 3.4 km umbilical will be installed from a new DC Valve Skid at DC1.4 to the Anasuria FPSO via a trench and burial method. In the most likely and high case development a new water injection flowline will be installed between the Teal / Cook Water Injection Riser Base at the Anasuria FPSO and the water injection well at Teal West DC1.4, also via trench and burial. In the high case scenario, the second oil producer will connect to the previously installed flowline at the DC Valve Skid.

In the most likely and high case development, seawater injection is planned to be implemented about 1-1/2 years after the first oil. The injection of seawater is expected to recharge and maintain the reservoir pressure throughout the life of the field.

The Teal West field life is expected to be 10 years, from 2024 to 2034. In this period, production in the High Case (i.e. two oil producers and one water injection well) is estimated to reach a total of 10.4 Million Stock Tank Barrels (MMstb) of oil and 9.8 Billions of standard cubic feet (Bscf) of gas. The highest annual average production would be reached in 2025 with a production rate of 5.9 thousand barrels per day (kbpd) of oil, and 9.8 Million standard cubic feet per day (MMscfd) of gas in the High Case.

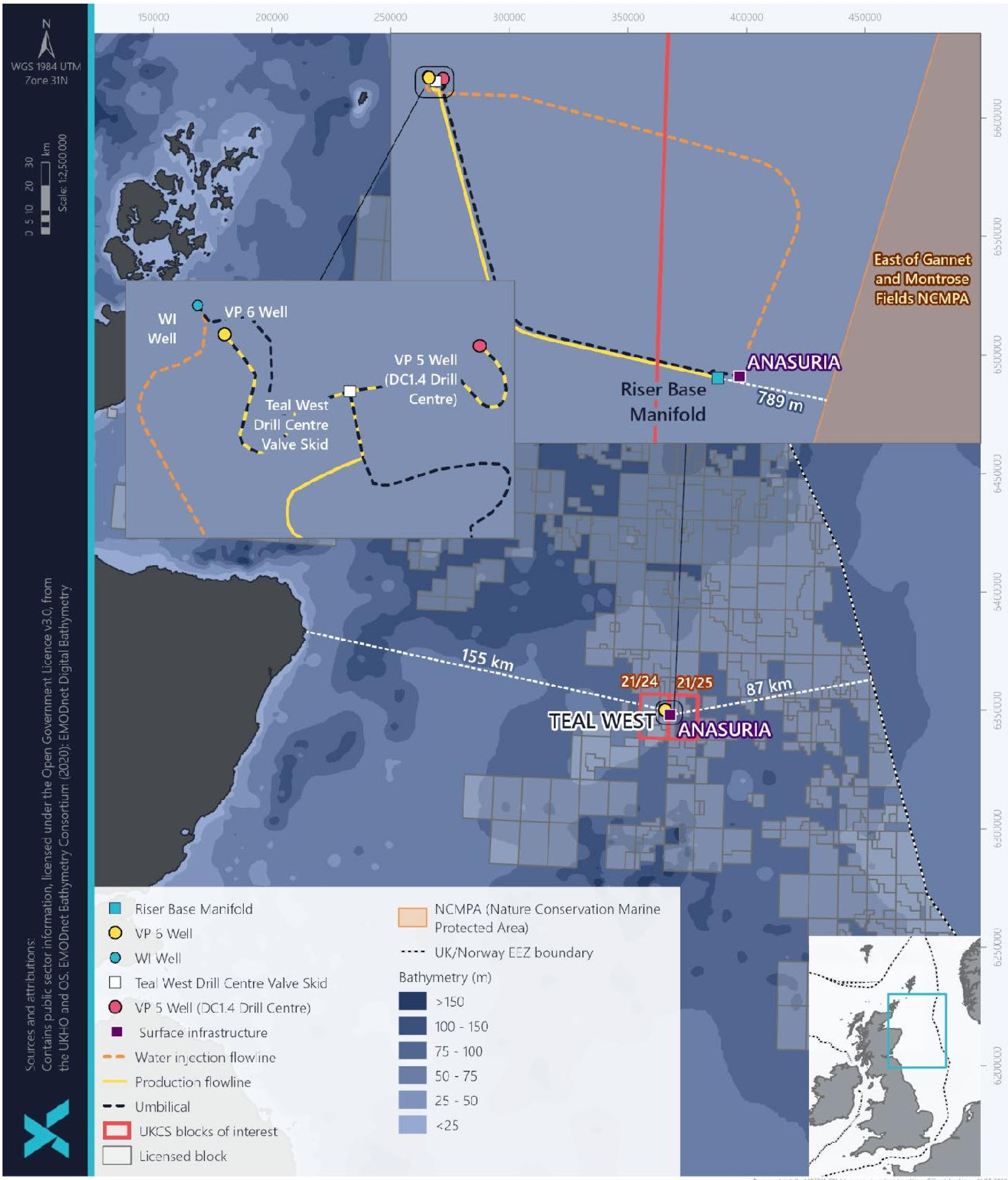


Figure 1-1 - Location of the Teal West Development

1.3. Development Schedule

The Teal West field is planned to be developed on a schedule which takes into account the UKCS regulatory approval timelines and with consideration of weather limitations in the Teal West Development area. A high-level schedule for each of the key milestones has been developed, as shown in Table 1-2.

Table 1-2 - High-level Teal West Development Schedule

Activity	2021	2022				2023				2024				2025				2026				2027			
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Concept Select Report submission to the Oil and Gas Authority (OGA)	■																								
Field Development Planning (FDP) submission to the OGA				■																					
EIA submission to Offshore Petroleum Regulator for Environment and Decommissioning (OPRED)				■																					
Drilling of first oil production well								■																	
Subsea installation											■														
First oil											♦														
Drilling of water injection well																■									
Subsea installation																■									
First water injection																	♦								
Drilling of second oil production well																						■	■		
Subsea installation																							■		
First oil from second producer																								♦	

1.4. Scope of Environmental Impact Assessment

The overall aim of the EIA is to assess the potential environmental impacts (both routine and accidental), that may arise from the Development and to identify the measures that will be put in place to reduce these potential impacts.

The EIA process is integral to the Development, assessing potential environmental impacts and concept alternatives, and identifying design and operational elements to minimise the potential impacts of the Development as far as reasonably practicable. The process also incorporates stakeholder engagement, so issues can be identified and addressed as appropriate at an early stage. This ensures that all planned activities comply with legislative requirements and with AHUK's environmental policy.

The EIA scope includes installation, commissioning, operational and decommissioning activities of the Teal West Development over which AHUK has operational control. These include:

- Drilling of up to two development wells and one water injection well;
- Installation, commissioning, operation and maintenance of subsea infrastructure including production and water injection flowlines, control umbilical, wellheads, Drill Centre Valve Skid (DCVS), xmas tree (XT) and protection and stabilisation materials; and
- Decommissioning of the Teal West Development.

In addition, embodied carbon in the new infrastructure and incremental environmental impacts from the Anasuria FPSO as a result of the Teal West Development, for example potential additional operational emissions, are considered within the scope.

This Environmental Statement (ES) summarises the EIA process and the results of the assessment. The scope of the EIA was developed in conjunction with stakeholders; the method applied during the EIA process is described in Chapter 5. This ES is submitted to the Offshore Petroleum Regulator for Environment and Decommissioning (OPRED) to inform the decision on whether the Development may proceed, based on the residual levels of potential impact, and is subject to formal public consultation.

1.5. Legislation and Policy

1.5.1. Offshore Environmental Legislation

The EIA summarised in this ES has been undertaken in accordance with the requirements of the Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020. These Regulations require the undertaking of an EIA and the production of an ES for certain types of offshore oil and gas developments likely to have a significant impact on the environment.

An EIA is mandatory for any offshore oil and gas development that is expected to produce more than 500 tonnes (Te) of oil per day or more than 500,000 m^3 gas per day. The Teal West Development triggers the requirement for an EIA on the grounds of oil production.

Approval of the ES by OPRED is required before approval can be granted to the Field Development Plan (FDP) by the Oil and Gas Authority (OGA) under the Petroleum Act 1998.

The EIA has been completed in accordance with the latest OPRED Guidance, issued July 2021 (Rev 03).

The EIA Regulations require that the EIA considers the likely significant impacts of a project on the environment. The potential impacts that have been considered in the EIA were selected following formal scoping with the Regulator, environmental issues identification (ENVID) and consultation with a number of stakeholders. Following this, the decision process related to defining whether a project may potentially significantly impact on the environment is the core principle of the EIA process. The EIA Regulations themselves do not provide a specific definition of significance, but they indicate that the methods used for identifying and assessing potential impacts should be transparent and verifiable. Despite this being inherently a subjective process, a defined methodology has been developed to make the assessment as objective as possible.

Distinct from, but closely related to, the EIA Regulations are the requirements under international and national legislation to consider impacts to certain protected sites. The Conservation of Offshore Marine Habitats and Species Regulations 2017 (as amended) implements the provisions of the EU Directive 2009/147 on the conservation of wild birds and of the European Union (EU) Directive 92/43 on the conservation of natural habitats and of wild fauna and flora. This regulation provides protection to sites known as Special Areas of Conservation (SACs), and Directive 2009/147/EC (the Birds Directive), which protects sites important for wild bird populations known as Special Protection Areas (SPAs) are applicable to the Development.

For offshore areas oil and gas projects the requirements of the Habitats and Birds Directives are transposed into national law through the Offshore Petroleum Activities (Conservation of Habitats) Regulations (2001) as amended. In accordance with these Regulations, the impacts of a project on the integrity of a European protected site are assessed and evaluated as part of the Habitat Regulations Assessment (HRA) process.

In an analogous process, the Marine and Coastal Access Act 2009 requires the potential for significant risk to the conservation objectives of Marine Conservation Zones (MCZs) being achieved to be assessed.

Relevant technical information required by OPRED as part of the consideration of impact on protected sites and species is provided within Sections 6 to 11 of this ES.

1.5.2. UK Government's Net Zero Strategy and Energy Transition Context

As widespread concern has increased about the impact of climate change, so has the acknowledgement that timely action is required to address the global rise in temperature. The Paris Agreement (adopted in 2015; in force 2016) under the United Nations Framework Convention on Climate Change (UNFCCC) relating to greenhouse gas (GHG) emissions mitigation, adaptation and finance provides for all signatories to keep the increase in global average temperature to well below 2°C above pre-industrial levels, and to pursue efforts to limit the temperature increase to 1.5°C (UNFCCC, 2016). In line with Article 4 of the Paris Agreement, the UK has submitted a Nationally Determined Contribution (NDC) which commits the UK to reducing economy-wide greenhouse gas emissions by at least 68% by 2030, compared to 1990 levels.

To facilitate achievement of the NDC commitments, target dates were set when the UK including Scotland would be a net balance of zero emissions (the net zero targets). The UK government set a legally binding target for the UK to reduce its greenhouse gas emissions from 1990 levels by 100 % by 2050 (The Climate Change Act 2008 (2050 Target Amendment) Order 2019). In Scotland the target year was set as 2045 via the Climate Change (Emissions Reduction Targets) (Scotland) Act 2019. The net zero targets are supported by a system of legally binding five-year 'carbon budgets' and an independent body to monitor progress, the Climate Change Committee (CCC) . The UK carbon budgets restrict the amount of GHG emissions the UK can legally emit in a defined five-year period. In 2020, the 6th carbon budget was published by the CCC for consideration by Government and is the first budget to reflect the amended trajectory to 2050.

The UK Net Zero Strategy: Build Back Greener (October 2021) outlines policies and proposals for decarbonising all sectors of the UK economy to meet our carbon budgets and net zero emissions target by 2050 (and 2045 in Scotland) as follows:

- Sets out the government's vision for a prosperous, low carbon UK industrial sector in 2050; and
- Provides industry with the long-term certainty it needs to invest in decarbonisation.

The Energy White Paper Powering our Net Zero Future and the UK 10 Point Plan for a Green Industrial Revolution embeds the UK Net Zero emissions strategy by describing how the transition to clean energy can be achieved by 2050. To support the Energy White Paper and the Industrial Decarbonisation Strategy requirement, the OGA revised the oil and gas sector specific Maximising Economic Recovery Strategy in February 2021 to include the following central obligation with underpinning requirements:

"Relevant persons must, in the exercise of their relevant activities, take the steps necessary to:
a. secure that the maximum value of economically recoverable petroleum is recovered from the strata beneath relevant UK waters; and, in doing so,
b. take appropriate steps to assist the Secretary of State in meeting the net zero target, including by reducing as far as reasonable in the circumstances greenhouse gas emissions from sources such as flaring and venting and power generation, and supporting carbon capture and storage projects."

The revised OGA Strategy, which came into force on 11th February 2021, reflects the ongoing energy transition and features a range of net zero obligations for the oil and gas industry, including increasing efforts to reduce production emissions, support carbon capture and storage (CCS) projects and unlock clean hydrogen production. The revised guidance on the development of fields demonstrates where the Net Zero requirements are embedded in the OGA assessment and approvals process. In addition, the OGA expects the following requirements in relation to emissions from flare and vent sources:

- *"flaring and venting and associated emissions should be at the lowest possible levels in the circumstances;*
- *zero routine flaring and venting for all by 2030; and*
- *all new developments should be planned and developed on the basis of zero routine flaring and venting".*

The North Sea Transition Deal (BEIS, March 2021) introduced a sector deal between the UK government and the offshore oil and gas industry. The sector deal supports and anchors the expert supply chain that has built up around oil and gas in the UK, to both safeguard and create new high-quality jobs. The Deal will transform the sector in preparation for a net zero emissions future and catalyse growth throughout the UK economy ensuring a just transition of the energy sector.

The oil and gas industry through the OEUK (Offshore Energies UK, previously Oil and Gas UK) has developed the Roadmap 2035: A Blueprint for Net Zero (https://roadmap2035.co.uk/) in which the industry outlines the role the sector can play in decarbonisation.

1.5.3. Scotland's Marine National Plan

Scotland's National Marine Plan (Scottish Government, 2015) provides an overarching framework for marine activity in Scottish waters out to 200 nautical miles (nm), with the aim of enabling sustainable development and the use of the marine area in a way that protects and enhances the marine environment whilst promoting both existing and emerging industries. This is underpinned by a core set of general policies which apply across existing and future development and use of the marine environment. Policies of relevance to the Development include:

- General planning principle: There is a presumption in favour of sustainable development and use of the marine environment when consistent with the policies and objectives of the Plan;
- Economic benefit: Sustainable development and use which provides economic benefit to Scottish communities is encouraged when consistent with the objectives and policies of this Plan;
- Natural heritage: Development and use of the marine environment must:
    - Comply with legal requirements for protected areas and protected species;
    - Not result in significant impact on the national status of Priority Marine Features (PMFs); and
    - Protect, and where appropriate enhance the health of the marine area.
- Noise: Development and use in the marine environment should avoid significant adverse effects of man-made noise and vibration, especially on species sensitive to such effects;
- Air quality: Development and use of the marine environment should not result in the deterioration of air quality and should not breach any statutory air quality limits;
- Engagement: Early and effective engagement should be undertaken with the general public and interested stakeholders to facilitate planning and consenting processes; and
- Cumulative impacts: Cumulative impacts affecting the ecosystem of the Marine Plan area should be addressed in decision-making and Plan implementation.
- Sectoral policies are also outlined in the Plan where a particular industry brings with it issues beyond those set out in the general policies. Policies and objectives relating to the oil and gas sector are detailed in Table 1-3 -, along with comment on the degree to which the Development is aligned with these.

Table 1-3 - Alignment between the Development and the oil and gas objectives and policies of the Scottish National Marine Plan

Objective/ policy	Teal West Development details
Maximise the recovery of reserves through a focus on industry-led innovation, enhancing the skills base and supply chain growth.	New oil and gas source making use of up to date and innovative technology, providing jobs and training.
An industry which delivers high-level risk management across all its operations and that it is especially vigilant in more testing current and future environments.	Extensive mitigation measures and response strategies developed for identified risks.
Continued technical development of enhanced oil recovery and exploration, according to the principles of Best Available Technique (BAT) and Best Environmental Practice (BEP).	Use of up to date and innovative technology in the development of a North Sea oil reserve, aligned with the principles of BAT and BEP. Use of real time information gathering during operations and multi-skilled offshore engineers reduces the number of personnel exposed to potential risks offshore.
Where possible, to work with emerging sectors to transfer the experience, skills and knowledge built up in the oil and gas industry to allow other sectors to benefit and reduce their environmental impact.	The Teal West Development will draw on experienced engineers, environmental specialists and other groups that are not necessarily limited to the oil and gas sector throughout the Development lifetime, thereby contributing to the transfer of experience.
The Scottish Government will work with the Department for Business, Energy & Industrial Strategy (BEIS), the OGA and the industry to maximise and prolong oil and gas exploration and production whilst ensuring that the level of environmental risks associated with these activities are regulated. Activity should be carried out using the principles of BAT and BEP. Consideration will be given to key environmental	BAT has been used as a key tool in developing the Teal West Development design. The potentially significant environmental impacts from drilling, installation, flaring activities, accidental release and habitat change have been considered within the EIA.

Objective/ policy	Teal West Development details
risks including the impacts of releases to atmosphere, oil and chemical contamination and habitat change.	
Where re-use of oil and gas infrastructure is not practicable, either as part of oil and gas activity or by other sectors such as carbon capture and storage, decommissioning must take place in line with standard practice, and as allowed by international obligations. Re-use or removal of decommissioned assets from the seabed will be fully supported where practicable and adhering to relevant regulatory process.	The production facilities to be installed will be specified as far as possible to reuse existing non used/spare and / or decommissioned infrastructure components such as the manifold and topsides communications equipment, XTs and wellheads that are being procured as well as to be easily removeable and decommissioned to the required standard. The surplus equipment's will be refurbished with relevant inspections, testing and certifications done prior to installation offshore. AHUK will also review decommissioning best practice closer to the point at which the Teal West Development area will be decommissioned. Full consideration will be given to available decommissioning options, including reuse and removal.
All oil and gas platforms will be subject to 9 NM consultation zones in line with Civil Aviation Authority guidance.	AHUK will engage as necessary with any relevant future developments that may be proposed within 9 NM of the Teal West Development area to ensure all helicopter flight routes remain free of obstacles.
Consenting and licensing authorities should have regard to the potential risks, both now and under future climates, to oil and gas operations in Scottish waters, and be satisfied that installations are appropriately sited and designed to take account of current and future conditions.	The Teal West Development area has been developed in a way that there will not be a significant impact on the physical, biological and socio-economic environment. This demonstrates an appropriate siting within North Sea.
Consenting and licensing authorities should be satisfied that adequate risk reduction measures are in place, and that operators should have sufficient emergency response and contingency strategies in place that are compatible with the National Contingency Plan (NCP) and the Offshore Safety Directive.	Potential environmental impacts have been reviewed as part of this EIA and relevant mitigation measures developed. The AHUK response strategy to accidental hydrocarbon release has been developed with due reference to the NCP.

1.6. Stakeholder Consultation

Consultation with statutory bodies and other interested parties is an important part of assessing the environmental impacts of a proposed project. The aim of the Development consultation process has been to ensure that the views of key stakeholders are identified early on in the EIA process, and that communication is maintained as necessary throughout the EIA process. Further information on consultation undertaken for the Development is provided in Section 5.3.

1.7. Environmental Statement Structure

Key elements of this ES include the following:

- A non-technical summary;
- Introduction including background, scope of the EIA, legislation and policy context (this Chapter);
- Consideration of alternatives (Chapter 2);
- Project description (Chapter 3);

- Environmental baseline and identification of the key environmental sensitivities which may be impacted by the Teal West Development (Chapter 4);
- EIA methodology, describing the method used to identify and evaluate the potential environmental impacts (Chapter 5);
- Detailed assessment of potential impacts, including cumulative and transboundary impacts (Chapters 6 to 11);
- Description of AHUK's environmental management system (EMS) including delivery of Net Zero requirements (Chapter 12);
- Conclusions (Chapter 13); and
- References (Chapter 14).

2. CONSIDERATION OF ALTERNATIVES

2.1. Concept Select Screening

The following factors were considered in the selection of the development concept for the Teal West reservoir:

- Technical feasibility;
- Environmental impact;
- Safety considerations;
- Commercial considerations;
- Maximising economic recovery (MER) considerations - additional capacity for development of other discoveries in the area;
- Reuse of existing infrastructure; and
- Joint developments with other operators in the locality.

Preliminary screening of the concept options identified that the estimated recoverable reserves and production rates from the field were relatively low therefore a new surface facility would not be economical. A subsea development tied back to a host facility was considered the primary concept for the development of Teal West.

The concept select process then focussed on the screening of potential host installations. Existing host facility options were identified based on a notional maximum tie-back distance of 30 km. The following four host installations were within the 30 km radius and were subject to technical feasibility and environmental impact screening:

- Anasuria FPSO 4 km;
- Kittiwake Platform 26 km;
- Triton FPSO 24 km; and
- Gannet Platform 18 km.

A wide range of environmental issues/receptors were considered and narrowed down to those that could provide a differentiator. The options were then assessed against the following issues to give a high-level comparative assessment between the options based on publicly available information:

- Net Zero and CO2 emissions – e.g., available power generation, flaring, potential for electrification and host company commitment to Net Zero
- Produced water management
- Physical environmental considerations such as seabed area (length[2]) and conservation sites potential for changed habitat i.e., crossings
- Future marine climate considering both susceptibility and resilience.

The ICES fisheries catch data and the low spawning activity in the area meant that fisheries would not present a potential differentiator for the host selection.

[2] It should be noted that in general the longer the pipeline length the higher the energy requirement to obtain the MER from the field.

2.1.1. Not to Develop Teal West Field (do nothing option)

It is recognised that not developing the field further would reduce the environmental impacts to those associated with the Plug and Abandonment of the existing Anasuria infrastructure and the removal of the trees, spools and manifold. However, the do-nothing option for the development of the Teal West field was discounted due to the continued need for secure energy supply during the UK energy transition and the replacement of imports with national hydrocarbon supply. High level review of environmental impact of the tie-back option assessed the environmental impact from developing the field and determined that the project was unlikely to have any significant effects on the environment.

Whilst the country transitions to new low carbon feedstocks, production of crude oil will need to continue. This has been further exacerbated by the current geo-political climate, which has caused a wave of uncertainty surrounding the supply of hydrocarbons both within the UK and abroad. The key issues for the UK are how to produce or import these hydrocarbons with the least environmental impact (e.g., low carbon intensity and high levels of sustainability in the supply chain) whilst maintaining a diversified supply network which ensures security of supply. The Digest of UK Energy statistics for 2020 (DUKES) indicates that production of primary oil by the UK totalled 49,362 kt, with a further 39,309 kt imported. The UK exported 39,857 kt of oil (net exports 547 kt crude oil) with the net oil production used by the petrochemical industry as raw material. UK refinery throughput was 48,233 Kt of crude oil with the UK being a net importer of oil products of 5,332 kt. These statistics highlight the continued need for national oil production to reduce reliance on imports. Furthermore, the recent British Energy Security Strategy (2022) highlights the need to "fully utilise our great North Sea reserve" in order to reduce the UK´s reliance on imported fossil fuels. The strategy also seeks to drive rapid industry investment in electrifying offshore production, meaning that the UK will be in a position to use and export lower carbon oil and gas than other countries.

In 2015, the UK refined 95% of the crude it produced in just six refineries which produced a combined average of 0.78 Mbbl/d, placing the UK in 23rd position out of 66 countries refining oil based on production volume (Jing *et al.*, 2020). UK Domestic processing, terminals and refining provides a national oil supply which minimizes tanker transport emissions and produces the required raw material with a carbon intensity in the bottom third of international production and refinery emissions. National production avoids carbon leakage and maintains domestic regulatory control of emissions and energy use, in line with the UK transition to Net Zero emissions, the UK Nationally Determined Contributions and The Energy White Paper.

The production from the Teal West field will contribute to the continued national need for hydrocarbon production in the short-term. AHUK commits to producing this field in alignment with the North Sea Transition Authority (NSTA) Net Zero Stewardship Expectation 11 (NSTA 2021) where relevant to the Teal West situation, which is designed to give operators and licensees clarity on expected behaviours and good practices. Expectation 11 focuses on the following areas:

- Creating a culture of GHG emissions reduction within the UKCS;
- Ensuring that GHG emissions reduction is considered throughout the entire oil and gas lifecycle; and
- Collaboration between all relevant parties to support and progress potential energy integration developments (such as electrification).

Chapter 10 quantifies the emissions anticipated as a result the Development across the entire oil and gas lifecycle and assessessment of the potential impacts of CO_2e and climate change, (as well as other atmospheric pollutants) are also presented in Chapter 10.

2.1.2. *Screening of Alternatives*

The results of the technical and environmental screening are summarised in Table 2-1.

Table 2-1 - Technical and environmental screening of the potential hosts for Teal West production.

Differentiator	Anasuria FPSO	Kittiwake Platform	Gannet Platform	Triton FPSO
Technical Feasibility	FPSO has sufficient processing ullage (subject to Anasuria Operating Company (AOC) compressor and water injection upgrade projects), remaining life and available tie-ins.	• Platform has sufficient ullage; Remaining life unknown.	• Insufficient ullage; • No water injection system; and • Remaining life unknown.	• Insufficient processing ullage; and • Remaining life unknown.
Environmental Impact	• Ongoing CO_2 emissions from flare and fuel use, lowest EUETS emissions of the potential hosts, Net Zero commitments in a policy, no indication of electrification plans; • Produced water overboard; • Short pipeline and seabed area take and few crossings; and • FPSO may be less vulnerable to future changes.	• Ongoing CO_2 emissions from flare (high current routine) and fuel use, second lowest EUETS emissions of the potential hosts, Net Zero emissions commitment in a policy, no indication of electrification plans; • Produced water overboard; • Long pipeline and seabed take and infrastructure crossings likely to be required; and • Platform will be required to withstand extreme weather events with greater frequency.	• Ongoing CO_2 emissions from flare and fuel use, second highest EUETS emissions of the potential hosts, commitment to NZ by 2050, no indication of electrification plans[3]; • Produced water overboard • Medium pipeline length and seabed area take but crosses the East of Gannet and Montrose NCMPA. Infrastructure crossings likely to be required; and • Platform will be required to withstand extreme weather events with greater frequency.	• Ongoing CO_2 emissions from flare and fuel use, highest EUETS emissions of the potential hosts, no Net Zero policy and no indication of electrification plans; • Produced water overboard; • Medium pipeline and seabed area take and few crossings; and • FPSO may be less vulnerable to future changes.
Overview	**Carried forward**	**Carried forward**	**Not considered further on technical and seabed environmental grounds.**	**Not considered further on technical and environmental grounds.**

[3] At time of the concept selection process

It was noted that the Gannet Alpha platform, has recently (May 2022) been included in the future Central North Sea Electrification (CNSe) Project. The CSNe project is currently in the Concept Select phase with a Final Investment Decision in 2024 and (if approved) start-up in 2027. As water injection is a fundamental requirement for MER from the Teal West reservoir which is not available at Gannet Alpha platform and not economical to install, then this host option is excluded from further consideration.

The Triton host option was also excluded from further consideration on both technical and environmental grounds. The Kittiwake platform and the Anasuria FPSO were carried forward to a more in-depth comparison. As power generation will be the major source of emissions for the Teal West Development, the impact of the processing of Teal West production on both the incremental power demand of both potential host facilities was compared and is provided in Table 2-2.

Table 2-2 -Comparison of the incremental Teal West power demand for the Anasuria FPSO and Kittiwake Platform

Incremental Power Demand from Teal West	Anasuria FPSO (4km)	Kittiwake Platform (25.6km)	Comparison
Associated gas compression	Compression of Teal West produced gas from arrival pressure to SEGAL gas pipeline pressure for export	Compression of Teal West produced gas from arrival pressure to SEGAL gas pipeline pressure for export	No difference in power required
Water injection pumps	Pumping water from ambient pressure to Teal West injection pressure	Increasing pressure of water from ambient pressure to Teal West injection pressure	Kittiwake power demand slightly higher due to the requirement for higher injection pressure as a result of higher frictional pressure drop over the longer pipeline length than to Anasuria
Crude Export	Pumping crude a short distance during infrequent cargo offloads to shuttle tankers	Continuously pumping crude 33km to the Unity Platform and onto Kinneil Oil Terminal	Assumed to be no difference as this is a small demand.
Artificial Lift	None required due to short tieback distance the fluids require to travel to the FPSO.	Long tieback distance and estimated pressure drop / 100m indicates reservoir pressure will be insufficient to deliver required flow rate (until water injection takes effect in Most Likely	Kittiwake requires an additional incremental 0.7MW of power for artificial lift.

Incremental Power Demand from Teal West	Anasuria FPSO (4km)	Kittiwake Platform (25.6km)	Comparison
		Case and High Case). Estimated power demand based on typical electrical submersible pump or gas lift requirement is 0.7MW.	

Based on the comparison of incremental power demand for the two host options it is established that the incremental power demand for Teal West with Anasuria as the host facility is lower than the incremental power demand for Kittiwake as the host facility. The Anasuria FPSO tieback concept has the lowest incremental emissions of the technically feasible hosts.

There are a few opportunities for the re-use of infrastructure and reduction of area of seabed take when tying back to the Anasuria FPSO. A summary of the technical screening findings for these options is provided in Table 2-3.

Table 2-3 - Screening of the tie-back locations to Anasuria FPSO

	Direct to FPSO	Teal	Teal South	Cook	Guillemot
Pipeline Distance	3.6 km	4.5 km	6.8 km	9.4 km	13.6 km
Crossings on route	1	Minimum 2	Minimum 2	Minimum 1	Minim um 1
Pipeline ullage	No restrictions, dedicated flowline from Teal West to the FPSO	Limited ullage available	No ullage available	Limited ullage available	No ullage available
Age of infrastructure[4]	N/A	1997 start of production Reliant on ageing infrastructure.	1992 start of production Reliant on ageing infrastructure.	1983 start of production Reliant on ageing infrastructure.	1978 start of production Reliant on ageing infrastructure.
Other		Design pressure restrictions.	Reliant on ageing infrastructure. Design pressure restrictions.		Design pressure restrictions.
Screening opinion	**Selected option**	**Screened out**	**Screened out**	**Screened out**	**Screened out**

Based on the results of the screening, the concept selected was to tieback directly to the FPSO via a new flexible production flowline / riser and static / dynamic control umbilical. The selected option offers the shortest pipeline distance with only one crossing, together with reduced reliance on ageing infrastructure and no pipeline capacity issues.

[4] Dates of the start of production obtained from the NSTA Offshore interactive map (https://www.nstauthority.co.uk/data-centre/interactive-maps-and-tools/)

2.2. Water Injection Flowline Route Selection

The development will require a water Injection flowline, trenched and buried, to be installed from the Water Injection XT located at the Teal West drill centre to the subsea tie in point adjacent to the Teal Water Injection riser base. Reconfiguration of the existing spools at the Riser Base will be required to create a suitable tie-in point.

There was initially up to 3 different options considered for the water injection route, one of these was via the existing Teal Umbilical Termination Assembly (UTA), while the other two options were direct to the FPSO. Of the direct route options, one of these looped round to the east of the FPSO, extending into the Nature Conservation Marine Protected Areas (NCMPA) and involved a number of pipeline crossings, which was the least preferred potential option. The options that were under consideration for Water injection are listed in Table 2-4 - and Figure 2-1.

Table 2-4 - Water Injection route options

	Length	Max No of Crossings	Comments
Water Injector Option 1 (Route C)	4.0 km	6	Selected option – proven to be most technically feasible and incurs fewest pipeline crossings.
Water Injector Option 2 (Route D)	5.5 km	8	Back up option. Ruled out due to proven feasibility of Route C. Route also extended into East of Gannet and Montrose Field NCMPA.
Water Injector Option 3 (Route F)	3.2 km	4	Shortest route but not selected due to technical restrictions of subsea tie-in point and also had more pipeline crossings than Route C.

The selected route for the WI flowline was dictated by the availability of the subsea tie-in point The selected option for the Water injection route is to connect into the Teal Water Injection Riser Base to the north of the FPSO as shown in Figure 3-4. This option offered the best technical option while also limiting the number of crossings to two and thus reducing the amount of protection material required. It is also shorter than the alternative and avoids extending into the East of Gannet and Montrose Field NCMPA, in the case of option 3. This tie-in point enables injection water to be supplied via the existing Teal water injection riser, rather than installing an additional Water Injection riser. Details of the tie-in point shown in Figure 3-5.

At the Teal West end of the line, the Water Injection flowline will be connected directly to water injection tree and will therefore by-pass the DC Valve Skid.

The 4 km water injection flowline will be flexible in design and trenched and buried in a 3 m corridor along its entire length. The trench will be up to 3 m width and 1 m depth , with mattress protection provided at the crossings and trench transitions.

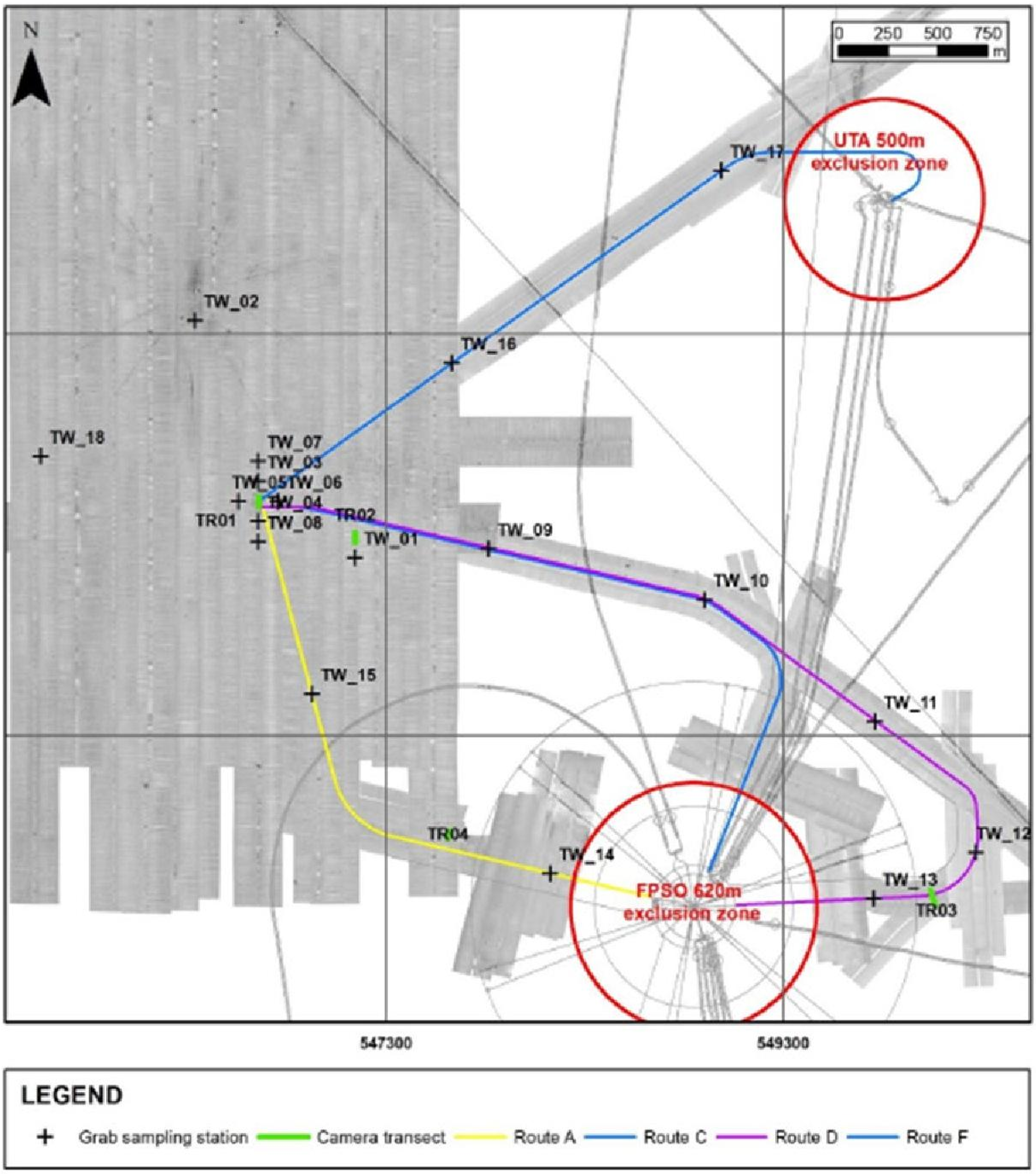


Figure 2-1 Optional water injection tie back routes (C = Direct to FPSO, D =alternative direct to FPSO, F = subsea tie-back option).

3. PROJECT DESCRIPTION

3.1. Summary

This section includes a description of the proposed field development and assumes a high case development scenario with two development wells and one water injection well which would be developed in three phases as follows:

- **Phase 1** - Phase 1 of the Teal West project will consist of one production well tied back to the Anasuria FPSO and is planned to last approximately 10 years from first oil.
- **Phase 2** - Depending on successful production results and flow behaviour from the Phase 1 well, a water injection well will be drilled, completed, and tied back to the Teal Water Injection Riser Base.
- **Phase 3** - In the event that the results of Phase 1 and Phase 2 indicate the potential to achieve High Case oil volumes, a second oil production well shall be drilled, completed and tied back to the Anasuria FPSO using the subsea valve skid and flowline installed for Phase 1.

3.2. Drilling

3.2.1. Nature of the reservoir

Teal West discovery is a Fulmar sandstone interpod feature, similar to the prolific Fulmar sandstones which are the main producing reservoir in the neighbouring Anasuria Cluster fields (Teal, Teal South, Guillemot-A, and Cook), Clapham, and Kittiwake fields. The Teal West reservoir fluid is a light oil of 37 to 38 °API and, based on the reservoir's properties, is assumed to be highly analogous to Teal field oil (~3.5km away). As Teal West is shallower and at a lower temperature and lower pressure than the Teal Field, it is assumed that the saturation pressure, oil formation volume factor, API and Gas to oil ratio will also be slightly lower. This trend can be seen across the Western Central Shelf through the Kittiwake fields and at Teal West.

3.2.2. Drilling Strategy

The full field development will consist of two subsea production wells and one water injection well. As explained in Section 3.1, the wells are planned to be developed in separate phases. Phase 1 will be the initial development of the Teal West field through the mobilisation of a jack-up rig and the drilling and hook up of a single production well (VP5). A water injection well (Phase 2) is expected to be drilled 18 months after first oil production, followed by a second production well (VP6) (Phase 3) to be drilled about 3 years after first oil. The production and water injection wells will be developed from a single drill centre, DC1.4, as shown in Figure 3-1. The base case is for the drilling and completion activities to be undertaken prior to the subsea installation activities in preparation to tie in to the FPSO.

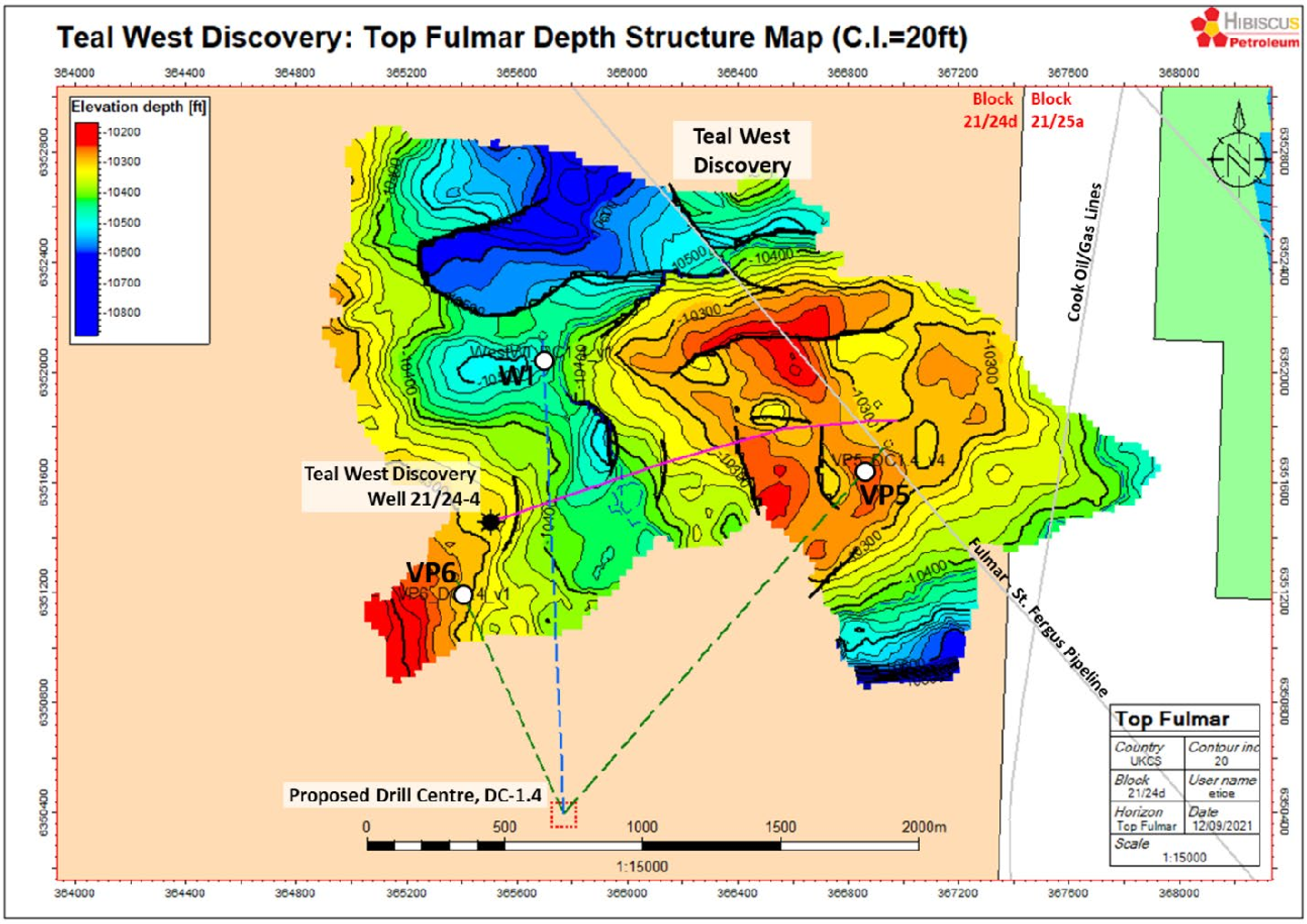


Figure 3-1 - Teal West Subsurface Development Plan

The VP5 and VP6 wells will be completed as directional wells with a cemented and perforated 7" outer diameter (OD) liner in the reservoir. The VP5 well is targeting to produce initially up to 10,000 bbls per day. The design life of the well is 15 years.

The tophole sections (42"/36" and 26") of the wells will be drilled riserless with WBM cuttings discharged to the seabed. A High-Pressure Riser system and Blow-out Preventer (BOP) will then be installed and the 17½", 12¼" and 8½" hole will be drilled with Synthetic Oil Based Mud (SOBM) with the cuttings collected and returned to shore to be processed in a licenced facility. The well design and mud systems are discussed in more detail in Sections 3.2.4 and 3.2.5. A remote operated vehicle (ROV) will be used throughout the drilling operation to provide visual monitoring of activities. A skip and ship system will be used for SOBM" cuttings.

The potential for use of a jack up type rig (instead of the semi-submersible type rigs previously used in the area) was confirmed after the site survey in Q4, 2021 and this is expected to reduce fuel utilisation and carbon emissions to the environment. Real time/remote monitoring is being considered to reduce the personnel on board the rig, which will reduce exposure to offshore hazards and the carbon footprint associated with logistics.

The predicted duration of drilling activities is up to 100 days per well on average with 6 days for rig mobilisation and demobilisation from Invergordon. As each well will be drilled separately, it is assumed that in total there will be approximately 300 operational rig days and approximately 18 days for rig mobilisation/de-mobilisation.

3.2.3. Drilling Rig

The subsea wells are proposed to be drilled by a Jack-up rig, which is assumed to be a Super Gorilla class (Figure 3-2) which has been used to provide an approximation for the purposes of the risk assessment, although no drilling rig has been contracted at the time of writing. A site-specific survey of the seabed morphology and shallow sediment geology present at the drilling site has been undertaken to confirm the seabed suitability for the jack up drilling rig. Each spud can will have a base area of up to 244 m^2 which will penetrate the seabed up to 19 m. As there are three wells drilled at different times, the worst case assessment has taken into account three separate deployments (i.e. total of nine spud can footprints). However, AHUK will look to minimise the footprint by re-using the existing spud can depressions wherever possible (this will be dependent on the availability of the same rig for the latter phased wells).

The rig will be positioned using a global positioning system (GPS) system to assist well coordinate assessment with dynamic positioning (DP)/GPS system with a 500m radius safety zone in place around the drilling rig during drilling operations.

To maintain a closed system circulation path during drilling operations using SOBM system, a High-Pressure Riser system will be installed on the subsea wellhead for fluids to be circulated back to the rig.

The drilling rig mobilised for the Development will be fitted with a BOP. The function of the BOP is to prevent uncontrolled flow from the well by closing in the well at the surface if required. The BOP is made up of a series of hydraulically operated rams that can be closed in an emergency from the drill floor and from a safe location elsewhere on the drill rig.

It is not anticipated that any simultaneous operations (SIMOPS) will be undertaken in the area while drilling is ongoing. However, should any be required such as any other vessel activities, risk assessment and SIMOPS documents will be in place to ensure all risks are assessed and mitigated for the operation to be done safely.

Figure 3-2 - Example of heavy duty jack up drilling rig class

3.2.4. *Well Design*

The Teal West reservoir is expected to be uniform in nature and all three wells will therefore be of a similar design. Each well will be drilled to a total measured depth of up to approximately 3,813 m (12,880 ft). The wells will be drilled in six sections of successively smaller diameters (i.e., 42”, 36”, 26”, 17½”, 12¼” and 8½”). Each well will be drilled vertically until the 20” casing is set and then drilled directionally to the target depth. Table 3-1 - provides the section diameters and proposed well lengths and **Figure 3-3** shows a typical well design of the type that will be used at Teal West. Details on the drilling muds to be used on each section are provided in Section 3.2.5.

Table 3-1 - Expected well dimensions

Section	Length (m)		
	VP5 Well	VP6 Well	WI Well
42”	24.4	24.4	24.4
36"	41.9	41.8	41.8
26"	582.0	579.0	579.0
17 ½ "	1124.7	1127.8	1127.8
12 ¼"	1676.4	1280.2	1676.4
8.5”	363.9	302.7	359.7
Total	3813.3	3355.8	3809.1

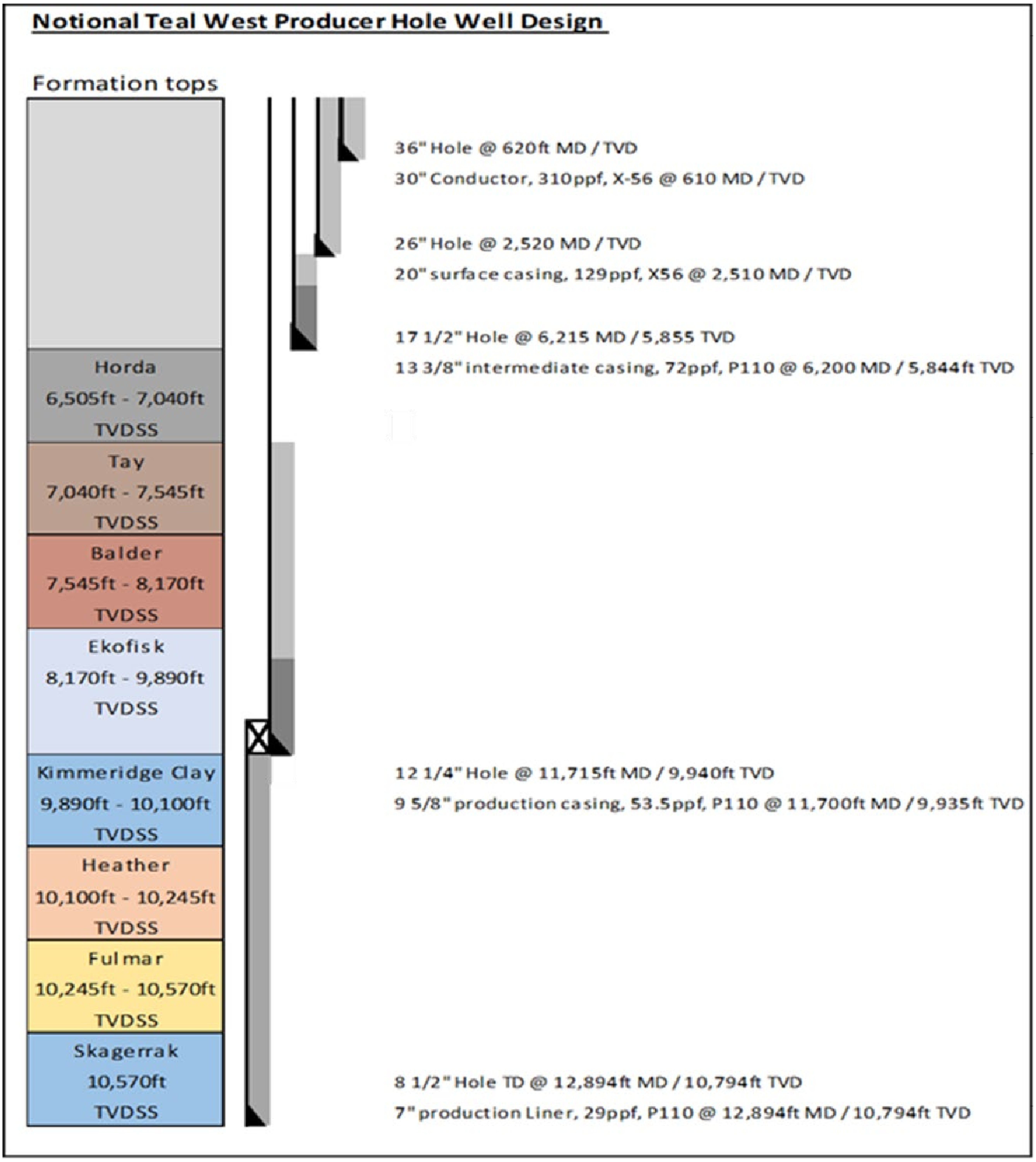


Figure 3-3 - Indicative Teal West Well Design

It should be noted that for the Teal West wells, a conventional conductor is proposed to be cemented in position and a 42" x 36" top hole section will be drilled. AHUK had considered emerging technologies such as 'Canductors' which can potentially reduce the quantity of discharges at the seabed. However, "Canductors", as a relatively new technology, have never been used in conjunction with a jack-up type rig and represent a hazard on the seabed insofar as placing the jack-up legs and spud cans on the seabed. In addition, for this particular project, there were scheduling and commercial limitations associated with using this technology. As such, the use of 'Canductor' technology was not considered further.

3.2.5. Mud System and Cuttings Discharge

The drilling fluids, or muds, used to drill the various sections of a well have a number of functions, including:

- Maintenance of downhole pressure to avoid formation fluids flowing into the wellbore (also called "a kick");
- Removal of drill cuttings from the drill bit to permit further drilling and transporting cuttings to the surface cuttings handling equipment;
- Lubrication and cooling of the drill bit, bottom hole assembly and drilling string; and
- Deposition of an impermeable "mudcake" on the walls of the well bore, which seals and stabilises the open hole formations.

Drilling fluids can consist of various materials including weighting agents and other chemicals to achieve the required weight, viscosity, gel strength, fluid loss control and other characteristics to meet the technical requirements of drilling and completing the well. Generally, drilling fluids can be divided into two categories based on their base fluid types:

- Water-based mud (WBM) where the base fluid is water; and
- SOBM where the base fluid is a low-toxicity oil.

Various chemicals may also be added to either type of drilling fluid to achieve specific functions, which are mainly driven by formation pore pressures and fracture gradients, downhole temperatures, geological characteristics etc. Different types of mud are planned to be used for the different well sections.

For the top hole sections (42"/36" and 26"), the wells will be drilled riserless with seawater and regular bentonite sweeps and displaced to 10ppg (WBM) mud, to stabilise the hole, prior to running casing. The WBM will be pumped downhole to provide enough weight and viscosity to turn the drill bit, remove the cuttings and keep the hole clean. Cuttings from these top-hole sections will be discharged directly from the wellbore at the seabed. ROV monitoring will be available to monitor cuttings discharges back to mudline as the well is being drilled.

For the deeper sections (17.5", 12.25" and 8.5"), a High-Pressure marine riser will be situated between the well and the drilling deck so that cuttings and drilling fluid are circulated back up to the rig for treatment. The mixture of cuttings and used SOBM circulated back up to the rig will be separated over the shale shakers. A skip and ship system will be used for SOBM cuttings. These will be returned to shore and disposed of in licenced premises. A cuttings dryer system may be employed offshore (space allowing) located between the shale shakers and the skip. This will reduce the oil on cuttings before disposal of the cuttings into the skips and the oil will be returned to the drilling mud. The use of a jack up type rig instead of a semi-submersible rig is expected to reduce fuel utilisation and associated carbon emissions to the environment. Real time/remote monitoring is being considered to reduce personnel on board the rig, which will reduce their exposure to offshore hazards and the carbon footprint associated with logistics.

During drilling, 36"/30" conductor will be initially installed. Following drilling the 26" hole section an 18-3/4" high pressure wellhead housing will be installed. High Pressure riser and BOP will be installed for 17.1/2" , 12-1/4" and 8-1/2" hole phases. Once each well is completed, a Xmas tree will be installed together with a Fishing Friendly Structure (FFS).

A slops water treatment system on board the rig will be used to reduce slops handling onshore.

The recovered SOBM at the rig will be treated and recycled back into the SOBM system. Table 32 - details the proposed drilling mud requirements for each of the three wells. The quantities are approximate worst-case estimates that will vary depending on final drilling fluids design and well trajectories but are representative for the planned wells.

Table 3-2 - Cuttings generation and discharge volumes for each well

Section	Drilling Fluid	Disposal route	Mass of cuttings generated (Te)			Mass of WBM generated (Te)		
			VP5	VP6	WI	VP5	VP6	WI
42"	Seawater & Bentonite sweeps	Seabed	54.4	54.4	54.4	64.6	64.6	64.6
36"	Seawater & Bentonite sweeps	Seabed	68.4	68.4	68.4	92.8	92.8	92.8
26"	Seawater & Bentonite sweeps	Seabed	497.5	494.9	494.9	964.7	959.7	959.7
17 ½ "	SOBM	Skip and Ship	435.5	436.6	436.6	0	0	0
12 ¼"	SOBM	Skip and Ship	318.0	242.9	318.0	0	0	0
8 ½"	SOBM	Skip and Ship	33.2	27.6	32.8	0	0	0

3.2.6. Cement and Other Chemicals

Steel casings will be installed in the wells to provide structural strength to support the wellheads and XTs, isolate unstable formations and separate formations which have different pressures and fluids. Each steel casing will be cemented into place to provide a structural bond and an effective seal between the casing and formation. Up to 200% excess cement may be required in the two upper well sections to ensure well casing integrity. As a worst case, this could result in up to approximately 67 Tonnes of cement discharged around the top hole of each well, forming a potential 'cement patio' on the seabed. To limit the quantity of a cement batch mixed, it is anticipated that all cement will be mixed as required and typically only 10% of the total cement slurry will be discharged to sea due to the clean-out of mixing pits following cementing operations.

All chemicals to be used within the cement will be selected based on their technical specifications and environmental performance. Chemicals with sub warnings will be avoided where technically possible. The cementing chemicals to be used have not yet been determined but will be selected following AHUK's chemical management and selection policy.

3.2.7. Well Logging and Vertical Seismic Profiling (VSP)

The rig will be using GPS positional system to assist well coordinate assessment with DP/GPS system on the vessel for positioning. No coring is planned for the wells. The relatively low inclinations planned allows the options of running wireline logs, if required. This will include the taking of reservoir pressures and samples.

There may also be the potential to take VSP seismic logs. It is estimated that this will take up to 16 hours. Deployment will be carried out by mounting an airgun on a rig crane and placed in the water close to the rig. There are two airgun array options being considered at the time of writing for undertaking the VSP survey:

- Option 1 – Triaxial geophone array with 3 x 150 in^3 Sercel G-Gun air gun cluster; and
- Option 2 – Hdvs/DAS fibre optics with 3 x 250 in^3 Sercel G-Gun air gun cluster.

The 'worst-case' array in terms of overall maximum disturbance will be taken into account as part of the noise assessment.

3.2.8. Well testing, Completion and Clean-up

The production wells will be cleaned up with a clean-up package rigged up on the drilling rig. The wells will be flowed to the drilling rig for planned 24 hrs with rates +/- 3000 bbls/day at controlled choke sizes to separators and burners. A surge tank will be rigged up to ensure zero spill overboard with a flare system to burn flowed oil and gas at surface. A filtration system will also be rigged up to ensure fluid is filtered to required levels prior to discharge. The initial flow from the well will be conducted during daylight hours to minimise the potential for an unseen leak to remain undetected for a period of time.

Each production well will be completed as a directional well with a cemented and perforated 7" OD liner in the reservoir.

Prior to production, each well will be cleaned up to remove any waste and debris remaining, to prevent damage to the pipeline and topsides production facilities. During well completion operations, completion brine will be discharged to sea. It is anticipated that the maximum discharge volume of this brine will be up to approximately 400 bbls per well based on the predicted annular volume.

As the bottom hole section of each well will be drilled using SOBM, there is a potential for the discharged completion brine to contain residual quantities of SOBM and/or reservoir hydrocarbons. This will be closely monitored during well completion and measured for any contamination (e.g. via infracal). Efforts will be made to reduce the quantity of contaminated brine being discharged. Any residual SOBM/ hydrocarbon discharged during clean-up activities will be compliant with the applicable environmental permits. Any discharges will be kept to As Low as Reasonably Practical (ALARP) and will be appropriately permitted prior to undertaken drilling.

A cased and perforated completion strategy is the preferred choice for the Fulmar sandstone. Based on the offset well analysis, sand production is not expected to be a concern at these reservoir depths so sand control is not required. The preferred method of perforation is to install Tubing Conveyed Perforation (TCP) guns as an independent run prior to installation of the completion assembly. The well will be perforated prior to the well clean up phase. Barriers to ease such operations will need to be in place including performing inflow tests, displacing with completion brine, pressure tests, etc.

The design life of the well completions will be 15 years. Minimal well completion accessories are to be installed, thus minimizing potential leak paths.

The likely sequence of events for well testing and clean-up will be as follows:

- The well will be opened. Initially the well will produce only completion brine which will be discharged to sea via the drilling rig;
- The water/ hydrocarbon interface fluids will be separated and tested:
    - If oil in water concentration is equal to or below 30 mg/l then the fluids will be discharged overboard in accordance with permits;
    - If the oil in water concentration is above 30 mg/l the water will be treated until it is below 30 mg/l, or as low as reasonably practical, for overboard discharge; or
    - Oil and gas will be flared via high combustion efficiency burners with water injection.
- Clean-up will be monitored to capture data regarding the amount of water and suspended solids in the produced fluids (called the basic sediment and water (BS&W) specification);
- After the well has been cleaned up, it may be flowed for a test period of approximately 24 hours, during which time approximately 477 m^3/day (3000 bbls/day) of oil may be produced. A surge tank will be

rigged up to ensure zero discharges overboard with a high combustion efficiency flare system to burn flowed oil and gas at surface. A filtration system will also be rigged up to ensure fluid is filtered to required levels prior to discharge;

- Necessary fluid samples will be taken during the flow period;
- No extended well test will be conducted; and
- Well will be closed in, ready for production.

3.2.9. Well Suspension

Once drilling and testing activities have been completed, the VP5 well will be suspended in line with Offshore Energies UK (OEUK) guidelines for approximately nine months, to allow valve skid, pipeline, umbilical and riser installation in Q2, 2024. Once the subsea pipelines and umbilical are installed, the wells will be connected and production from the well will commence. The subsequent water injection and VP6 production wells will also be suspended prior to connection but the period of suspension will be significantly less.

3.2.10. Well Intervention

The well completions will be designed with an aim that no workovers are required over the life of the field with the exception of scale squeezing on the production wells which will be undertaken approximately every 18 months (total of 19 interventions) for the two wells over the life of the field. As a contingency, three well interventions (once every three years) have been assumed on the water and production injection wells to account for unplanned well failures.

The expected tubing/completion design will have sufficient chrome content to resist corrosion throughout the production life cycle of the wells, currently based at approximately 15 years. The completion will be designed such that the well bore will be accessible by a light-weight intervention vessel should such a need arise or, in the case of a more substantial intervention, accessible by a Mobile Offshore Drilling Unit (MODU).

3.2.11. Relief Wells

At the time of writing, relief well planning is in an early phase. This work will be completed as part of Detailed Design study. A suitable drilling rig may be required to conduct the relief well operations, should circumstances arise that one is needed.

In this scenario, it is estimated that, assuming co-operation from other UKCS Licence holders, drilling rig contractors and Government agencies (BEIS and Health and Safety Executive (HSE)), drilling of a relief well could be started within 28 days of a blowout commencing. It is then estimated that it will take approximately 60 days to drill the relief well to a point where the problem well can be brought under control.

To facilitate the spud of a relief well, AHUK will require the support of BEIS and the HSE to process and urgently expedite permitting and consent applications.

3.2.12. Well Abandonment

Wells will be abandoned as per OEUK Wells Abandonment Guidelines (2015). Cap rock seal will be established at the reservoir cap rock level to ensure sufficient barriers are in place to contain hydrocarbon in the well. This will include cement placement and evaluation both inside and outside of production casing. A subsequent casing section will be cut and retrieved as per the requirements and cement barriers put in place. All barriers will be tagged, pressure tested and inflow tested as per requirements. The conductor stub will be cut 1-2 m below the seabed with a suspension cement plug placed to mudline level.

3.3. Subsea Infrastructure

3.3.1. Overview of Field Layout and Subsea Infrastructure

Anasuria FPSO is selected as the host facility for the Teal West subsea tie-back. The development will consist of up to two production wells and one water injection well, drilled over three different campaigns.

The production flexible flowline and umbilical will be initially surface laid due to the requirement to cross existing flow lines along the route. The unrestricted sections will be trenched and buried either side of crossings with concrete mattresses provided for protection at crossing points. The selected route ensured that the pipeline length was minimised as much as practicable and also reduces the quantity of crossings, therefore also minimising the associated seabed impact.

Installing both lines in a single trench was considered as this would incur a lower overall environmental footprint. However, the EIA has assumed the worst case which is that the production flowline will be installed in a separate trench from the static umbilical with approximately 30 m spacing. The main reason for keeping this option of separate trenches is that the installation vessel may be unable to carry and install the flowline and umbilical in a single vessel campaign. Therefore, one of the flowline or the umbilical would be laid followed by a trip back to shore to collect the other product prior to installation and subsequent burial of both lines.

The size of the burial machines dictates 30m separation to avoid the potential for damage to the first product as the second product is trenched. However, this 30m will be dictated by installation contractor and availability of suitable equipment for the installation campaign.

The water injection flowline will be installed at a later time in a similar manner.

Table 3-3 - Summary of subsea infrastructure to be installed

Infrastructure	No.	Dimensions	Installation method
6" inner diameter (ID) Production Flowline (Valve Skid to Riser Based manifold)	1	3.6 km length, 250 mm OD	Surface laid then trenched and buried. Assumed 3 m width at seabed surface/ 1m (depth) trench as worst case in assessment
Electrohydraulic Umbilical (Valve Skid to Riser Base manifold)	1	3.6 km length, 180 mm OD	Assumed 3 m width at seabed surface/ 1m (depth) trench as worst case in assessment
6 " (ID) Water Injection line (Valve Skid to Cook tie in spools)	1	4.0 km length, 250 mm OD	Assumed 3 m width at seabed surface/ 1m (depth) trench as worst case in assessment
8 " (ID) Production Dynamic Riser	1	300m length, 75 m on seabed; 225 in water column.	50m from dynamic/ static transition point
Umbilical riser	1	300 m length, 75 m on seabed; 225 in water column..	50m from dynamic/ static transition point
Teal West DCVS	1	5m (w) x 7 m (l) x 3.75 (h)	Lowered via crane from DP2 vessel. Requires piling to resist trawl board interaction (4 x 610mm dia, 23 m long piles)

Infrastructure	No.	Dimensions	Installation method
Teal West Riser Base Manifold (RBM)	1	6.5m (w) x 8 m (l) x 5 m (h)	Lowered via crane from DP2 vessel. Gravity based with additional ballast to maintain stability
Clump weights for risers (10 tonnes)	2 (one for each riser)	6m (w) x 6 m (l) x 2 m (h)	Lowered via crane from DP2 vessel
Wellheads/Horizontal trees (including protection structure	3 (3 campaigns)	3.5 (w) x 4 m (l) x 2.42 (h)	To be installed from drilling rig & supported by Drilling Support Vessel (DSV)
Water Injection Spools (from Water injection line to Cook tie in point)	4 (including contingency)	Approximately 100 m (including contingency) Approx. 221 mm OD	Installation via DP Vessel/DSV (note – existing cook spools at tie-in point will be removed and replaced)
6" Production (flexible pipe) Jumper Drill Centre Valve Skid to XT	2 (Two production wells)	150m length, 250 mm OD	Surface laid, mattress protected
Electrical flying leads (DC to XTs)	6 (Two for each x 3 XTs)	150m length, 55 mm OD	Surface laid, mattress protected
Hydraulic flying lead or Control Jumper	3 (For 3 XTs)	(on Valve Skid) 10 m (bundle), 180mm OD (From Valve Skid to XTs) 150m, 127 mm OD	Installation via DP2 Vessel
Sandbags	100 (3 campaigns)	1 m x 1 m (1 tonne) sacks each containing 40 x 25 kg sand bags)	Installation via DSV
Mattresses	300 (3 campaigns)	6 m (l)x 3 m (w) x 0.15(t)	Installation via DSV
Rock placement	4500	Tonnes	Rock placement vessel. Protection of crossings and contingency for Upheaval buckling mitigation. Detail TBC – worst case contingency is a 2m wide berm along the production line.

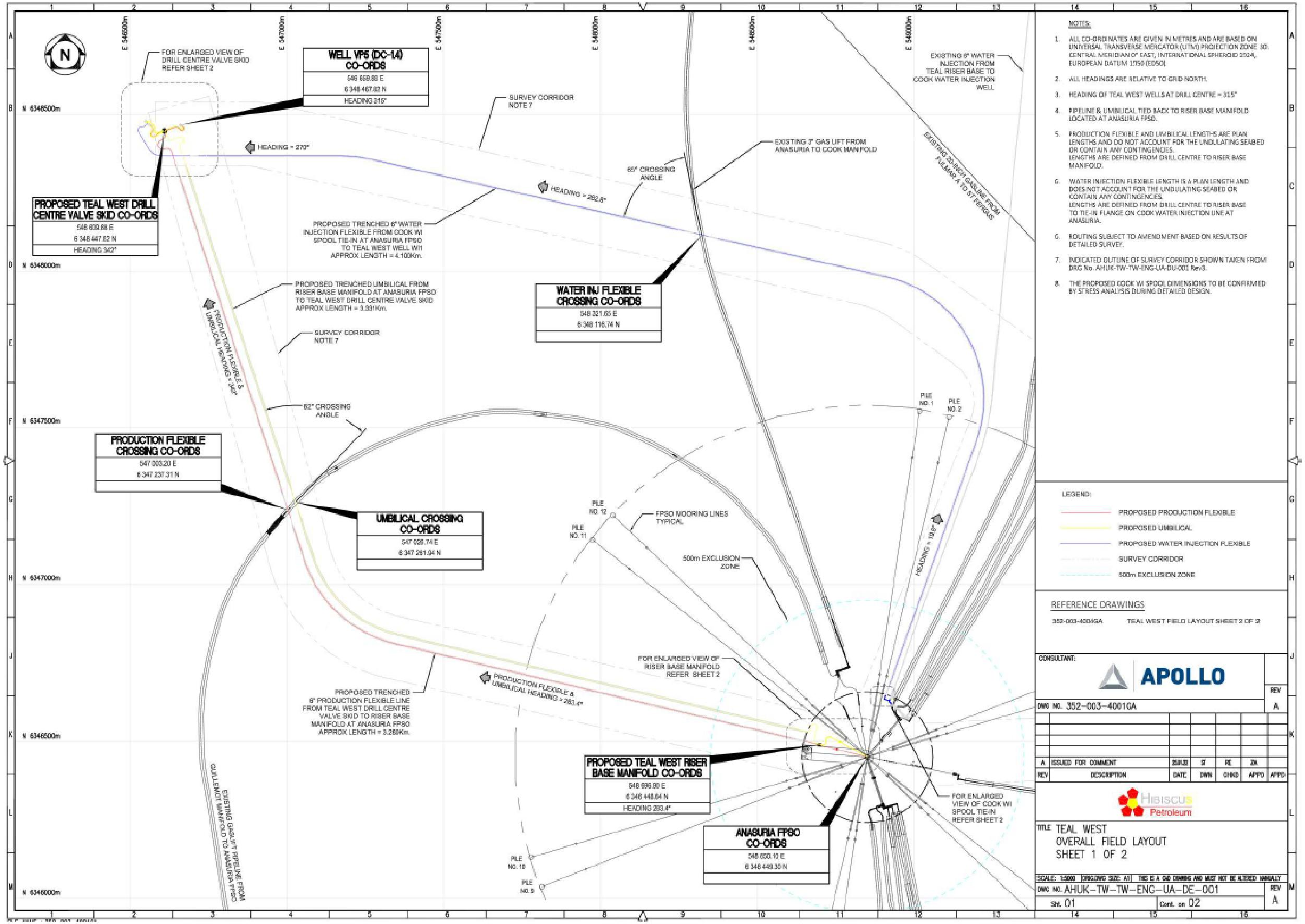


Figure 3-4 - Summary of Teal West Subsea layout

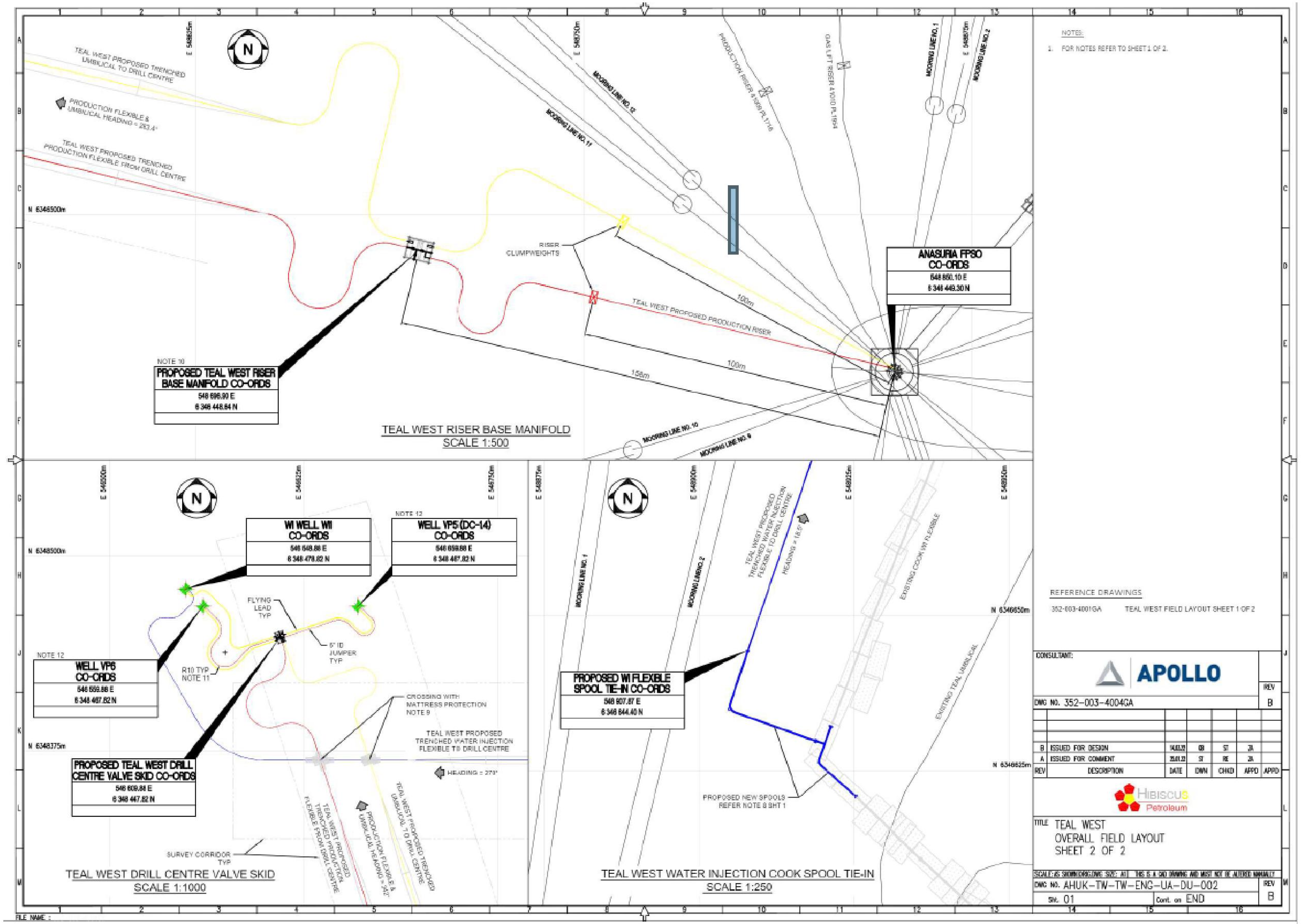


Figure 3-5 - Teal West Field layout showing detail of tie-in points

3.3.2. Wellheads and Subsea Trees

In offshore oil and gas infrastructure, XTs connect to the wellhead after drilling is completed and the well is ready to begin producing, and are used to control the flow produced by a well The current plan for the Teal West project is to use Horizontal XTs. These offer a simplified operation over Vertical XTs, and due to its popularity in the North Sea, intervention tooling would be readily available if required. It also provides ease of intervention if required. Horizontal XTs allow intervention or replacement of completion equipment without the need to remove the tree.

Once the wells are completed, trees will be installed which will each have designated 500 m safety zones and will be fitted with an integrated protection structure, designed to be fishing friendly and so offer protection from both fishing gear and minor dropped objects. It is the intention that infrastructure will be surface laid. Any crossings between jumpers used to connect between the pipelines, manifolds and trees shall be mechanically protected with the use of concrete mattresses.

3.3.3. Teal West Drill Centre Valve Skid

The proposed valve skid will be placed approximately 100 meters from the wells, depending on the final top hole location of the wells. It will measure 5 m (L)x 7 m (W) x 3.75 m (H). The DC Valve skid will require 4 x 610 mm diameter piles each 22.5 m long to maintain stability on the seabed. Trawl board interaction dictates this requirement. The use of piling has been included in the worst-case noise assessment.

3.3.4. Production Flowline

The 6" ID production flexible will be up to 3,600 m in length and will be installed directly from the Teal West drill centre to the Anasuria FPSO. The base case (as worst-case environmental footprint) is that this flowline will be trenched and backfilled along the entire length, with the exception of a single pipeline crossing (See Section 3.3.10). The details of the installation methodology is still to be determined at the time of writing but the basis will be a 3 m wide trench (1 m deep) which will be backfilled.

This flowline will accommodate production from both production wells in the high case scenario. Based on best available technology, a flexible pipeline is selected rather than rigid pipe construction which means that there is a lower risk of upheaval buckling (UHB). Under certain circumstances the pipeline will be relatively hot (especially in late life). The UHB analysis makes certain assumptions as to the (un)evenness of the cut trench and the potential for UHB trigger points. This will be revisited post installation to determine if the assumptions made remain valid. Absolute minimum rock placement will be used to mitigate the UHB.

3.3.5. Riser Base Manifold

An RBM, measuring 6.5 m x 8 m x 5m high will be situated within or adjacent to the swing circle of the FPSO.

The RBM is required to:

- Facilitate the connection of the flexible riser (6" ID) to the flowline (6" ID);
- Provide manual isolation in the event of future disconnection of either riser or flowline;
- Facilitate potential future connection of production from Guillemot into the Teal West riser
- Facilitate subsea pigging of the flowline (but not the riser) if required;
- Accommodate the Dynamic Umbilical Termination Assembly (DUTA) – This requirement depends on the turret slots allocated for the production riser and the umbilical; and

- Provide a structure to protect the pipework and valves and foundation to support.

3.3.6. Dynamic Production Riser

The production riser will be a 6" ID flexible pipe. The slot in the FPSO turret which has been allocated for the production riser is slot 9, subject to riser analysis and verification during detailed engineering by the manufacturing vendor and independent verification body. The riser will depart the turret heading West by Northwest.

The flexible riser shall be configured such that it satisfies all of the functional requirements. In order to demonstrate this a dynamic analysis of the riser will be carried out in line with current design codes. The analysis shall demonstrate amongst other things that the new riser does not clash with the existing risers or mooring lines.

3.3.7. Static and Dynamic Umbilical

Power, communications, chemicals, and hydraulic functions are required to operate the Teal West subsea XTs. An electrohydraulic umbilical will travel from Slot 11, (subject to riser analysis and verification during detailed engineering by manufacturing vendor and independent verification body) of the Anasuria FPSO Turret system to the Teal West drill centre carrying the services required for each XT and with spare cores.

The static umbilical will travel 3.6 km from the FPSO to the drill centre. At the drill centre, the umbilical will terminate in a UTA located in the valve skid and distribute the Electrical, Hydraulic, Chemical functions to the XTs. The drill centre UTA may house the Subsea Distribution Unit and Electrical Distribution Unit or it may be a separate unit, subject to detail design.

It is proposed that the dynamic umbilical will be pulled into the Anasuria FPSO I-tube and connected to the existing topsides based subsea control system via a new Topsides Umbilical Termination Unit which will connect to the existing Hydraulic Power Unit, Master Control System and Electrical Power Unit. On the seabed the dynamic umbilical will transition to the static umbilical with identical cores. The dynamic umbilical will be a weighted lazy wave type with buoyancy units and will have additional tethers to hold it in place.

3.3.8. Water Injection Flowline

For Phase 2 of the development, a water Injection flowline, trenched and buried, will be installed from the Water Injection XT located at the Teal West drill centre to the subsea tie in point adjacent to the Teal Water Injection riser base. Reconfiguration of the existing spools at the Riser Base will be required to create a suitable tie-in point.

As discussed in Section 2.2, there were initially three different options considered for the water injection route. The selected route for the WI flowline is to connect into the north of the FPSO as it offers the best technical option while also limiting the number of crossings to two. The intention is to use the existing Teal water injection riser, rather than install an additional Water Injection riser.

The 4 km water injection flowline will be flexible in design and trenched and buried in a 3 m corridor along its entire length. The trench will be up to 3 m width and 1 m depth, with mattress protection provided at the crossings and trench transitions.

3.3.9. Water Injection Tie-in Spools

The water injection tie-in at the Teal RBM will require removal of one existing spool which will be replaced with a similar spool incorporating a branch line. Depending on the final tie-in point, the Water Injection flowline will cross up to two umbilicals and the Cook Water Injection pipeline in close proximity to the FPSO. Installation vessel workability (close to the FPSO) will dictate the number of spools required to connect the flowline to the Teal system. The maximum length of the spools will be 100 m. The indicative base case tie-in drawing of the Water injection spools into the Cook line is shown in Figure 3-5.

3.3.10. Pipeline Crossings, Upheaval Buckling and Protection

The production flowline, umbilical and water injection line will be trenched and buried with surface breaking crossings over existing pipelines/cables (Figure 3-5). Crossings will be designed to protect the existing pipelines/cables and Teal West lines. The crossings associated with the Development are shown in Table 3-4.

Table 3-4 – Crossings along the Teal West Flowlines and Umbilical

Teal West Pipeline Route	Crossed line		Operator	PL No.	Size	Service	Crossed line Status
	From	To					
Teal West Production flowline	Anasuria FPSO	Guillemot A	Anasuria Operating Company	PL1954	4.5”	Guillemot A Gas Lift	Active
Teal West Control Umbilical	Anasuria FPSO	Guillemot A	Anasuria Operating Company	PL1954	4.5”	Guillemot A Gas Lift	Active
Teal West Water Injection flowline	Cook Manifold	Anasuria FPSO	Ithaca	PL1716	8”	Cook Oil	Active
	Anasuria FPSO	Cook Manifold	Ithaca	PL1719	3”	Cook Gas Lift	Active
	Teal West	Anasuria FPSO	AHUK	TBA	6”	Teal West oil production	Future
	Anasuria FPSO	Teal West	AHUK	TBA	6”	Teal West Umbilical	Future
	Anasuria FPSO	Cook WI Trees	Ithaca	PL4603	8”	Cook Water Injection	Active (Alternative water injection connection point)
	Anasuria FPSO	Teal	AOC	PLU264 8	3”	Teal Umbilical	Active (Alternative connection point)
	Anasuria FPSO	Teal	AOC	PL1237	5”	Teal Umbilical	Active (Alternative connection point)

There will be one crossing each along the production pipeline and umbilical routes of the 4.5” Gas lift line from Anasuria FPSO to Guillemot A. In addition, there will be a maximum of six along the water injection pipeline route including the Cook to Anasuria production line (including piggybacked gas lift line) plus crossing over the new Teal West Production flowline and Umbilical. The Teal West water injection spools (connecting the flowline to the Teal RBM) may also cross spools in the Cook water injection flowline and two Teal umbilicals.

These will be protected by mattresses. In total, it is estimated that up to 300 mattresses measuring 6m x 3m x 0.15m will be deployed along with up to 4000 x 25 kg sandbags.

There is currently no plan to use rock as protection for infrastructure although a contingency of up to 4500 tonnes has been included, which would include any requirement to mitigate against UHB. As mentioned previously, the flexible design of the production flowline and trench and backfill installation strategy is expected to minimise the associated UHB risk.

3.3.11. Pipeline Pre-commissioning and Commissioning

The production and water injection flowlines will be pressure/leak tested after initial installation and then again after being tied-in. Natural dye (colour) will be used for the hydrotest. The production flowline will be designed to be de-watered by pigging if this is necessary but this is not expected to be required. No detailed pre-commissioning plan is available at the time of writing.

There is no intention to discharge control fluids during tie-ins or commissioning. The umbilical will be a closed-loop system and a dedicated return core used to ensure fluids go back to the FPSO for clean-up / disposal. Couplers will be fully rated (connection under pressure) and poppet sealed. During connection of couplers there is a potential negligible discharge (less than 1cc / ml). During commissioning all used fluids are returned to the FPSO as in normal operations.

3.4. Teal West Production

3.4.1. Overview of Host Facility - Anasuria FPSO

The Anasuria FPSO (Figure 3-6) is a purpose built FPSO which was built in 1995 in Nagasaki, Japan, and installed and commissioned in 1996 as part of the development of the Guillemot A, Teal and Teal South Fields. The Cook Field was subsequently developed as a subsea satellite tie-back to the Anasuria FPSO in 2000. No other third party's fields are currently tied-back to the Anasuria FPSO.

Figure 3-6 - The Anasuria FPSO

The primary functions of the Anasuria FPSO are:

- To produce dead crude for export via offtake tankers;
- To treat associated gas and export it into the Fulmar Gas Line;
- To provide gas lift to the subsea wells;
- To treat produced water prior to overboard discharge (at or below the permitted level of cleanliness);
- To treat and inject seawater for water injection; and
- To provide controls and chemicals to the subsea wells.

The Anasuria FPSO is comprised of a permanently moored bow-integrated Bottom Mounted Internal Turret and rotating barge on which the topsides processing facilities are installed. The installation is moored on station by twelve anchor lines, each 1km long, which are attached to seabed piles. The anchors attach to a chain table just below the vessel keel, above which a main turret bearing transfers the mooring loads into the vessel structure.

Flexible risers and umbilicals connect the subsea infrastructure to the FPSO via 'I' tubes (I.e., riser slots) which pass through a moon pool up to the turret structure. Within the turret the various fluids pass through a swivel stack arrangement which, along with the main bearing, permits the vessel to weathervane freely around the mooring.

3.4.2. Modifications required for Teal West

The Teal West fluids will be processed within existing ullage available within the Anasuria FPSO systems, therefore there are very limited modifications required. The scope of modifications for Teal West is:

- Install the pipework, valving and instrumentation to connect the production riser to an existing topsides production manifold; and
- Install a new wax inhibitor chemical injection package.
- Minor modifications and upgrades to the existing subsea control system for Teal West

This scope of modifications results in limited additional power demand. The overall power demand is within the available power from two out of the three power generation gas turbines. Therefore, no modifications to the power generation system are planned for Teal West.

3.4.3. Teal West Production Profiles

The high case Teal West 10-year production forecast with both producer wells online with 100% uptime is provided in Table 35 and Figure 37 below.

A high case oil production from the field is achieved if both the VP5 and VP6 wells meet their maximum expected potential. Oil Production from VP5 is expected to exceed 1000 tonnes/day initially and remain above 500 Tonnes/day for the first three years production. As production from VP5 drops off, bringing on the second producer maintains a field production of over 100 tonnes/day until 2030, when the production starts to significantly drop. The produced water increases significantly in year three in the high case as water injection takes effect.

The processing facilities on the Anasuria FPSO are designed for 11,000 m^3/d (c. 70,000 bbls/d) gross well fluids, which is separated into oil, gas and produced water.

Gas production profile follows a similar pattern to oil with gas production being maintained for the first four years of production > 100,000 m^3/day This gas will be used as fuel with the excess exported via the Fulmar gas line. Gas compression capacity (for gas export and gas lift) on the Anasuria FPSO is currently restricted to 708,250 m^3/day (25MM SCF/D) due to it being in 'Low Pressure' operating mode. This situation results in the high case gas production rate temporarily exceeding the available capacity by a very small amount due to an overlap of a peak in the Anasuria gas rate (gas lift plus gas production) and the Teal West gas production at first oil. The exceedance occurs for around a four-month period and will be managed during operations by optimising gas production and gas lift across all fields tied back to the Anasuria to within the available gas compression capacity.

Table 3-5 - Teal West Field High Case Production Forecast

Year	Oil Rate (Te/day)	Gas Rate (Mm3/day)	Water Rate (m^3/day)
2024	1333	239	1
2025	936	302	1
2026	583	133	245
2027	813	117	1017
2028	439	63	1862
2029	238	33	2102
2030	155	21	2200
2031	115	15	2248
2032	87	11	2281
2033	68	9	2304
2034	56	8	2318

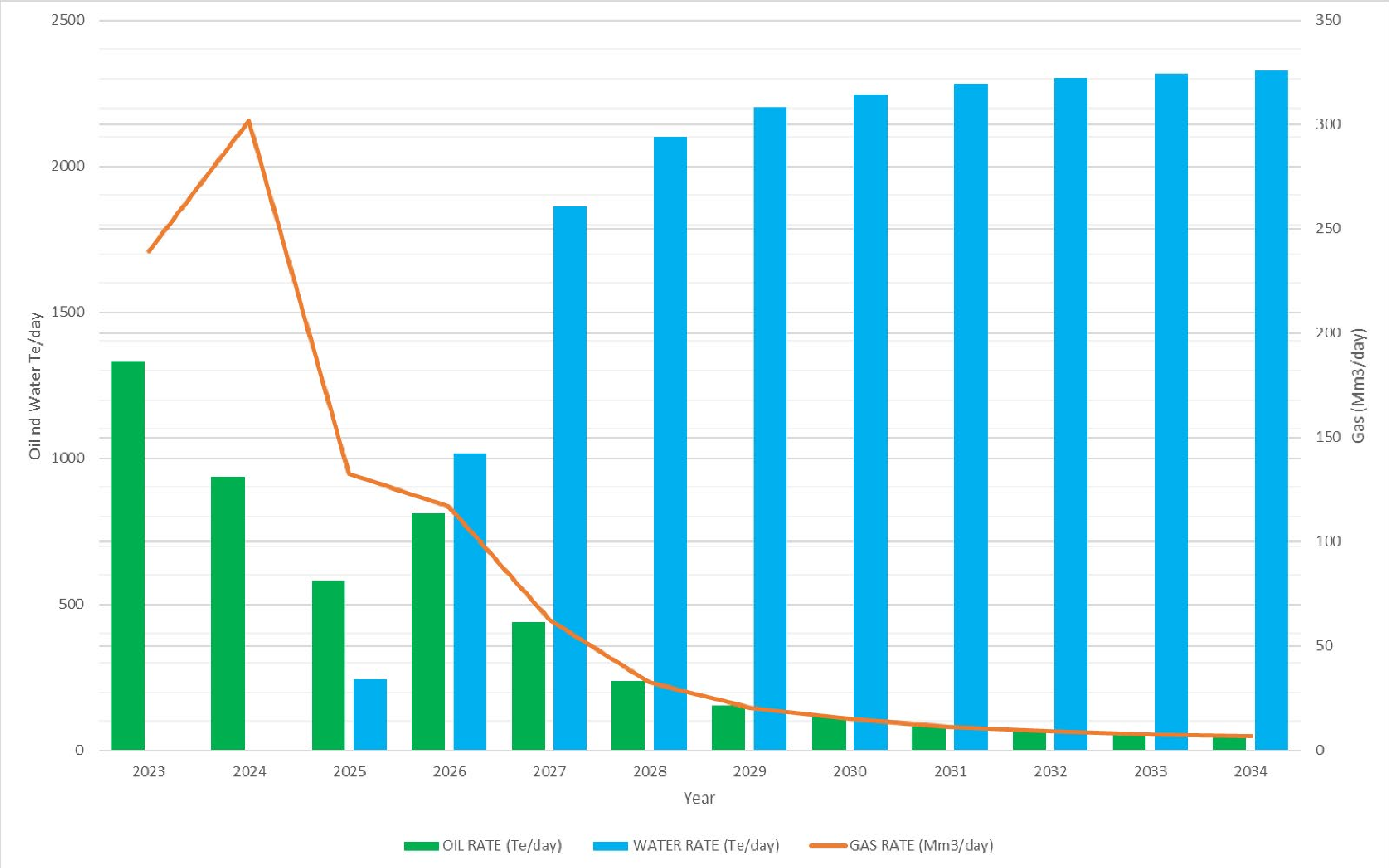


Figure 3-7 - Maximum case P10 Production at Teal West

3.4.4. Produced Water

Produced water will be commingled with existing Anasuria Cluster produced water in the First Stage Separator. Produced water will be treated and discharged overboard in compliance with the Anasuria's OPPC Permit. As shown in Figure **3-7**, produced water volumes rise significantly in year five of production (in response to water injection) to >1800 te/day. The FPSO production permit will be updated to include Teal West's produced water volumes and chemistry. There is not expected to be any significant impact on the existing facility produced water process as a result of Teal west production. Furthermore, the incremental produced water volume generated through the Anasuria as a result of Teal west is well within the installed handling capacity, with no modifications required.

3.4.5. Sand Production

Minimal sand production is expected, and sand loading is assumed to be less than 10 lb/1000 bbl, based on the analogous Teal field.

3.4.6. Water Injection Requirements

The profiles outlined Section 3.4.2 include the additional water production as a result of water injection. The water injection uses seawater lifted from the sea and treated via filtration and oxygen removal. Produced water will continue to be discharged overboard.

3.4.7. Chemical Storage, Injection and Discharges

The included chemical injection requirements are based on data for the analogous Teal field (Table 3-6). Analysis of the Teal fluids has indicated a wax appearance temperature of 36°C which has been used as the basis for Teal West.

On this basis wax deposition is only an issue in the low case production profile where water injection is not implemented and at low flowrates when the arrival temperatures at the FPSO are below the predicted wax appearance temperature. Provision for the injection of wax inhibitor chemical will be provided at the subsea tree to mitigate this risk.

The properties of the Teal West fluids will be confirmed via analysis of samples obtained during the drilling of the first production well.

Per the existing Anasuria chemical treatment philosophy demulsifier will be injected topsides to assist oil / water separation, scale inhibitor will be injected topsides to protect against scale formation in equipment and methanol will be injected at the x-mas tree and topsides during start-up to prevent hydrate formation.

Table 3-6 - Chemical injection requirements

Chemical Function	Chemical	Maximum (worst case) Injection Rate (ppm)	Phase basis	Injection location	Injection Pressure (bara)
Wax Inhibitor	To be determined once the actual sample is available after the drilling of the well	300ppm	Oil	Subsea XT	28 to 320*
Hydrate Inhibitor	Existing Anasuria Methanol supply	Up to 1.5m3/hr (Batch)	N/A	Subsea XT	34 to 361*

Chemical Function	Chemical	Maximum (worst case) Injection Rate (ppm)	Phase basis	Injection location	Injection Pressure (bara)
Hydrate Inhibitor	Existing Anasuria Methanol supply	Up to 1.5m3/hr (Batch)	N/A	Topsides Production Flowline	0 to 70
Demulsifier	Assume existing Anasuria FPSO supply, TBC by testing	15ppm	Total Liquids	Topsides Production Flowline	10 to 20
Scale Inhibitor	Assume existing Anasuria FPSO supply, TBC by testing	15ppm	Produced water	Topsides Production Flowline	10 to 20

3.4.8. Power Generation

Electrical power is supplied by 3 x 50% 8.7 MW (limited by the power management system) dual fuel (gas and diesel) aero derivative power generation turbines. Two out of the three turbines are fitted with waste heat recovery units (2 x 100%) to supply heat to the process and utility systems. As explained in Section 3.4.1, there is sufficient capacity in the existing system for producing the Teal West Field without any modifications to power generation. Based on historical data the forecasted overall production efficiency of the Anasuria FPSO for Teal West production is 92% excluding planned shutdowns.

3.4.9. Flaring and Venting

Currently all flare purge gas and other sources of low-pressure gas on the Anasuria FPSO (e.g., compressor dry gas seal vents, glycol regeneration column vapour outlet) are flared. AOC have a study ongoing into the installation of a flare gas recovery system, utilising an eductor or similar technology, to eliminate continuous flaring. There is expected to be no additional flaring as a result of the tieback of Teal West to the FPSO. There will be additional venting from the cargo oil tanks as a result of the additional oil production from Teal West.

3.4.10. Maintenance

The assumed annual subsea surveillance inspection will consist of general visual inspection, taking cathodic protection readings of the structures, recording anomalies and anode wastage. For the flowline and riser there will be a visual inspection of the subsea route, crossings, touch down points and ancillaries. The riser will be subject to periodic annulus integrity testing. The inspection vessel (a modified platform support vessel or lightweight construction vessel) will be fitted with a lightweight ROV with a camera. The inspection duration is expected to be about 5 days (excluding weather downtime) and no intervention is accounted for.

If any anomalies are recorded during the planned inspection that require remedial work, a separate subsea intervention will be carried out.

3.5. Vessel and Helicopter Requirements

An overview of the vessel and helicopter requirements for drilling, subsea installation and operation of the Teal West field development is provided in Table 3-7.

At the time of writing, it is assumed that subsea installation vessels shall operate within the parameters of DP2. No moored or anchored vessels shall be utilised on the scope.

Table 3-7 - Summary of vessel and helicopter requirements

Vessel Type	Duration (Days)	Operations to be undertaken
Surveys		
Survey vessel	50	Site surveys and installation preparation
Drilling Activities		
Drill rig (on site)	300	100 days drilling x 3 wells
Drill Rig (Transit)	36	12 days transit (return trip) x 3 mobilisations
Rig Tow Vessel	126	14 days for each tow vessel. 3 required per rig mobilisation (3 rig mobilisations).
Supply vessel	300	Supply vessel to rig
Helicopters during drilling	300	Transfer of personnel. Up to 7 trips per week during drilling.
Emergency Response and Rescue Vessel (ERRV)	300	ERRV on site for duration of drilling up to 3 wells, with the possibility of using the existing on-site ERRV with minimal impact.
Subsea Installation		
Reel Lay Vessel	45	Pipeline installation Vessel
Trenching Support Vessel (TSV)	45	Trenching
Construction Support Vessel (CSV)/ DSV	45	Installation of RBM, DCVS, spools, jumpers and mattresses.
Rock Placement Vessel	10	Contingency rock placement
Operations		
DSV	660	19 Well workover (Scale Squeezes) on production wells each for 30 days each). 3 Workovers (1 every 3 years on water injector well)
Export of Oil	22	Additional offloads of oil as a result of Teal West Production
Helicopters		No additional helicopter flights will be required for Teal West operations
Transfer of supplies		Chemicals will be delivered via the FPSO's routine supply vessels
Inspection and maintenance	75	5 days per year for visual inspection activities.

3.6. Decommissioning

The decommissioning philosophy and planning will be in line with relevant legislation at the time of decommissioning. At present this is controlled through the Petroleum Act 1998, as amended by the Energy Act 2008.

Any structures and installations that are on or above the seabed in line with OSPAR Decision 98/3 will be fully removed in accordance with OSPAR decision 98/3.

The plugging and abandonment of all wells will be under the provision of the licence terms and the OEUK Well Decommissioning Guidelines (2015) at the time of well abandonment.

The cap rock seal will be established at the reservoir cap rock level to ensure sufficient barriers are in place to contain hydrocarbons in the well. This will include cement placement and evaluation of the barriers, both inside and outside of production casing. Subsequent casing sections will be cut and retrieved as per requirements and cement barriers put in place. All barriers will be tagged, pressure tested, and inflow tested as per requirements. The conductor stub will be cut to approximately 3 m below the seabed with suspension cement plug placed to mudline level.

4. ENVIRONMENTAL BASELINE

4.1. Introduction

As part of the EIA process it is important that the main physical, biological and socio-economic sensitivities of the receiving environment are well understood. This section describes the main characteristics of the offshore environment in the vicinity of the Teal West Development (hereafter referred to as 'the Development') (UKCS Blocks 21/24 and 21/25), with particular attention being given to those aspects that may be sensitive to, or affected by, the proposed operations. This section draws on a number of data sources including published papers on scientific research in the area, industry wide surveys (e.g. the Offshore SEA3 programme) and site-specific investigations commissioned.

The following publicly available data sources were utilised to inform the baseline section:

- UK Offshore Energy Strategic Environmental Assessment 3 (DECC, 2016);
- UK SeaMap, 2018 (JNCC, 2019a); and
- National Marine Plan Interactive (NMPi) (NMPi, 2022).

Site-specific surveys carried out at the Development are summarised below, and the sampling locations are illustrated on Figure 4-1.

- **Fugro (2022a, b, c) Teal West Environmental Site and Route Surveys** – These surveys were undertaken in two phases across 2021 and 2022, with a delay in survey operations due to poor weather conditions. Phase 1 was carried out between 12th and 26th November 2021 and involved the partial completion of the geophysical survey operations. Phase 2 was carried out between 31st December 2021 and 15th January 2022 and involved the completion of the geophysical survey and environmental survey operations. The survey covered the proposed well locations and four pipeline route options (including the two proposed pipeline routes – 'option A' and 'option C'). The geophysical survey covered 1.15 x 1.8 km grid over the well locations and the pipeline route options and included the use of multibeam echosounders (MBES), side scan sonar (SSS), magnetometer, sub-bottom profiler (SBP) and two-dimensional high resolution seismic survey (2DHR). The environmental survey involved four camera transects and 18 grab sampling stations (using a 0.1 m^2 dual van Veen grab), with drop-down video. Sampling stations were located at the proposed well and pipeline locations (Figure 4-2). One reference station, approximately 1 km north of the DC 1.4 well was also investigated.

The following data from nearby fields was also reviewed:

- Guillemot Environmental Desktop Study: a desktop study review of existing geophysical data from the area surrounding the proposed Guillemot P5 well location in UKCS Block 21/25, located approximately 10 km south of the Anasuria FPSO) (Fugro, 2013); and
- UK Benthos Database including seabed survey data recorded at the Teal Field (located approximately 2.5 km north-east of the proposed Teal West drill centre) in 2006 (OGUK, 2021).

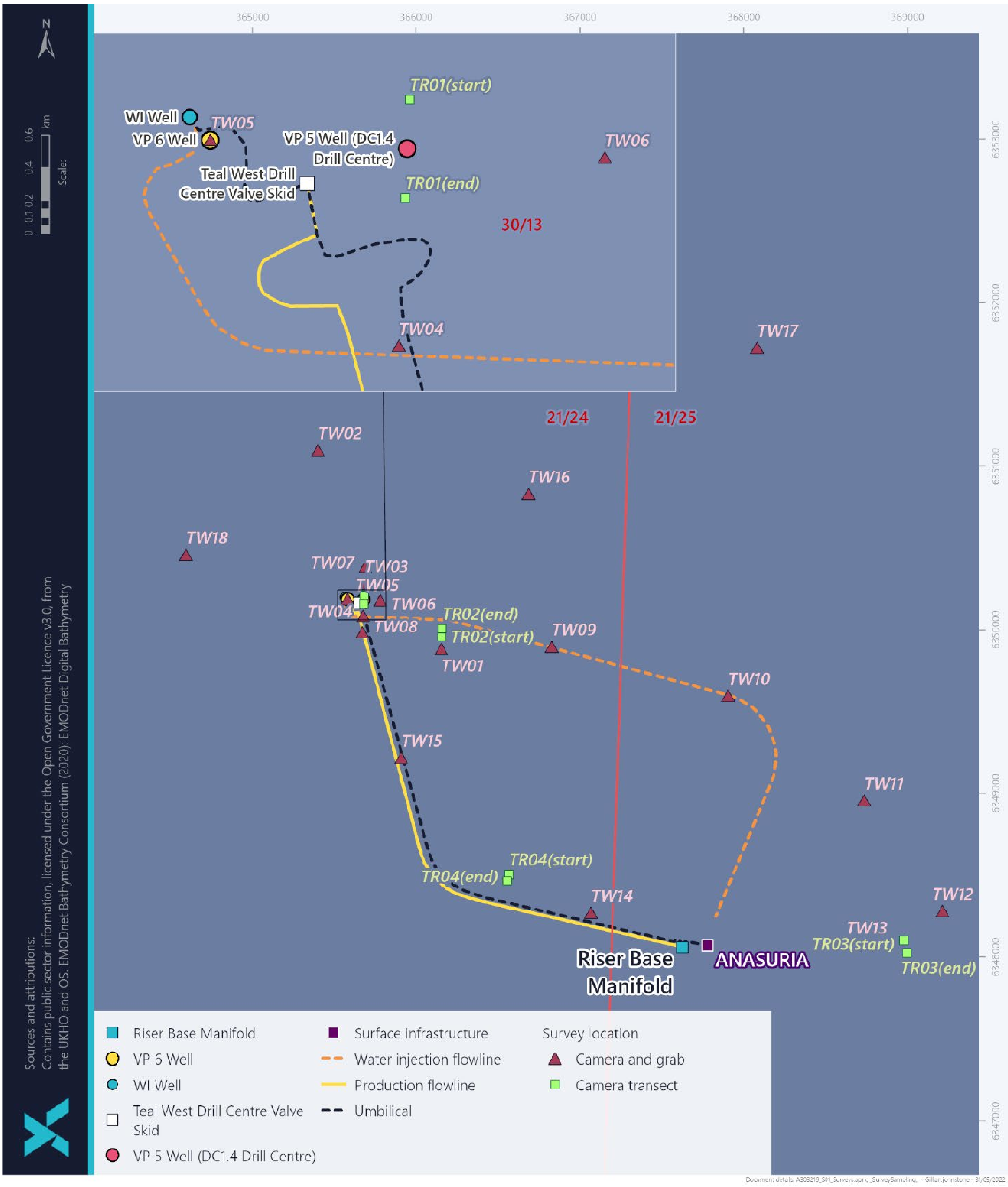


Figure 4-1 – Location of the site-specific sampling locations at the Development

4.2. Physical Environment

4.2.1. Weather and Sea Conditions

Currents in the North Sea circulate in an anti-clockwise direction, driven by inflows from the Atlantic via the Fair Isle Channel and around the north of Shetland and outflow northwards along the Norwegian coast (DECC, 2016). Against this background of tidal flow, the direction of residual water movement in the CNS is generally to the south-east (DTI, 2001; DECC, 2016). Offshore tidal current velocities in the region of the Development are between 0.26-0.5 m/s during mean spring tides. The mean spring tidal range is approximately 1.1 – 2.0 m, which is considered to be low. In this region of the North Sea, the water column is seasonally stratified (Summer and Autumn), and the strength of the thermocline is determined by solar, tidal and wind forces (DECC, 2016).

The prevailing winds in the CNS are from the south-west and north-north-east. Wind strengths in winter are typically in the range of Beaufort scale force 4-6 (6-11 m/s) with higher winds of force 8-12 (17-32 m/s) being much less frequent. Winds of force 5 (8 m/s) and greater are recorded 60-65% of the time in winter and 22-27% of the time during the summer months. In April and July, winds in the open, CNS to Northern North Sea (NNS), are highly variable and there is a greater incidence of north-westerly winds (DECC, 2016). The average wind speed at the Development area over a 30-year long-term period is approximately 10 – 11 m/s (DECC, 2016).

The annual mean wave height in the CNS region follows a gradient decreasing from the northern area of the Fladen/Witch Ground to the southern area of the Dogger Bank. The wave height at the Development ranges from 2.1 – 2.4 m and the annual mean wave power ranges from 24.1 – 30 Kw/m, which is typical of the wider area (ABPmer, 2008). McBreen *et al.,* (2011) shows that wave energy at the seabed ranges between 'low' (less than 0.21 N/m2) and 'high' (more than 1.2 N/m^2) in the CNS region.

Sea surface temperature and salinity are largely influenced by tidal flow. Data on salinity and temperature from the years 1971 – 2000 indicates that near-bed and surface temperature at the Development is approximately 7 – 8°C and 9-10°C, respectively, and that surface and near-bed salinity is approximately 35 parts per thousand (ppt) (Berx and Hughes, 2009).

4.2.2. Bathymetry and Seabed Features

The North Sea is a large shallow sea with a surface area of around 750,000 km^2. Water depths in the CNS gradually deepen from south to north from approximately 40 m at the Dogger Bank to approximately 100 m at the Fladen/Witch Ground (DTI, 2001; DECC, 2016). The main topographic features in the CNS are the Dogger Bank, a large sublittoral sandbank submerged through sea-level rise, located in the south-west corner of the region, marking a division between the Southern North Sea (SNS) and CNS, and the Fladen/Witch Ground, a large muddy depression generally considered to define the northern extent of the CNS (DTI, 2001; DECC, 2016). No major seabed topographic features are in the vicinity of the Development, although there are several shelf troughs within the North Sea east of Scotland (DECC, 2016).

The water depths identified within the Teal West survey area ranged from 87.1 to 91.5 m below lowest Astronomical Tide (LAT). The seabed slopes gently from the south-east and north-east towards the north-west. Across the survey area, a total of 30 boulders, 10 debris, 23 linear debris and 55 depressions were identified (Fugro, 2022a). Areas of suspected Methane Derive Authigenic Carbonate (MDAC) were observed in the northeast of the Survey area, approximately 2 km to the north of the drill centre which is a sufficient distance that it will not be impacted by the Teal West operations. Pockmarks were also observed along the flowline, umbilical route and the water injection pipeline route (Fugro, 2022b).

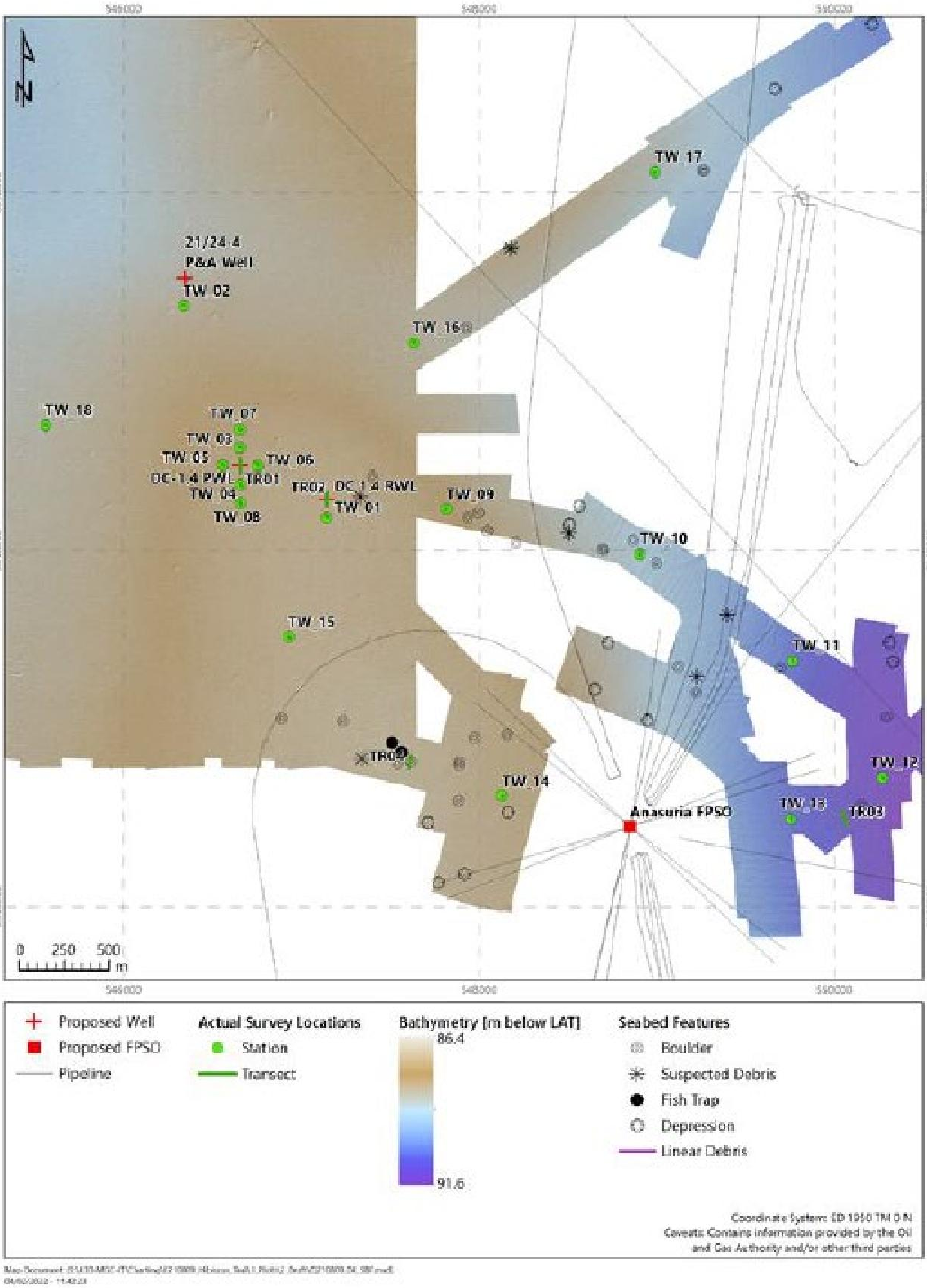


Figure 4-2 - Seabed features observed in the Teal West survey area (Fugro, 2022a)

4.2.3. *Sediment Type*

The UKSeaMap online resource provides broad-scale habitat classification of the seabed in UK waters and uses the European Union Nature Information System (EUNIS) classification systems (JNCC, 2019a). The seabed at the Development was classified as 'deep circalittoral sand', EUNIS habitat code A5.27. EUNIS habitat A5.27 is described by the European Environment Agency (EEA) (2021) as 'offshore (deep) circalittoral habitats with fine sands or non-cohesive muddy sands'. EUNIS habitat A5.15 is described as 'offshore (deep) circalittoral habitats with coarse sands and gravel or shell' (EEA, 2021).

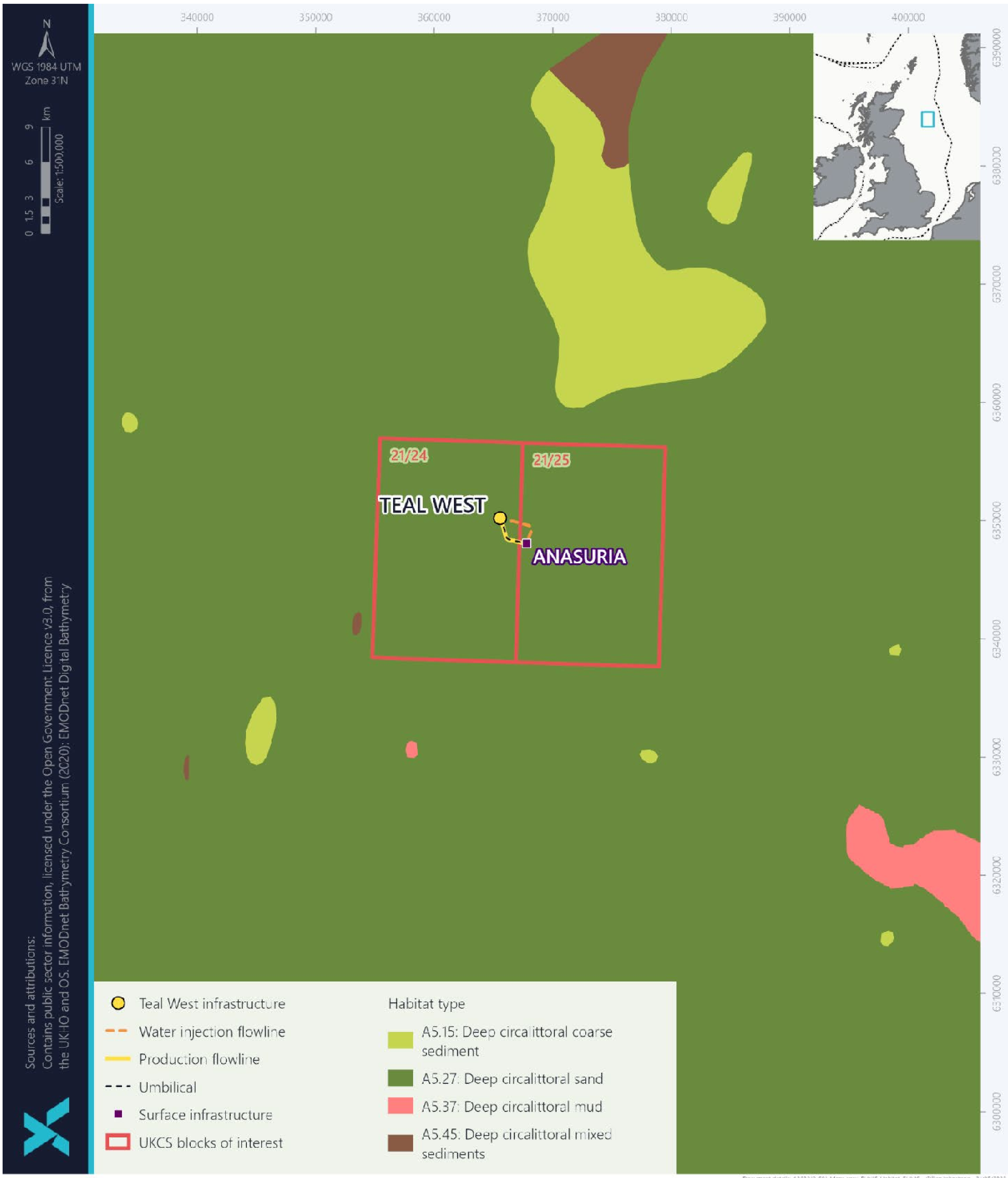


Figure 4-3 - Seabed habitats in the vicinity of the Development (JNCC, 2019a)

Examples of the sediments observed in the survey area are displayed in Figure 4-4. The main sediment type observed at the Development was muddy sand with shell fragments, and this was also interpreted as EUNIS habitat A5.27, which is consistent with the UKSeaMap prediction described above (Fugro, 2022c). The surveys indicated that the sediments were relatively homogenous across the Teal West survey area (‘the survey area’) with a low variability in sand and fines content (Fugro, 2022b).

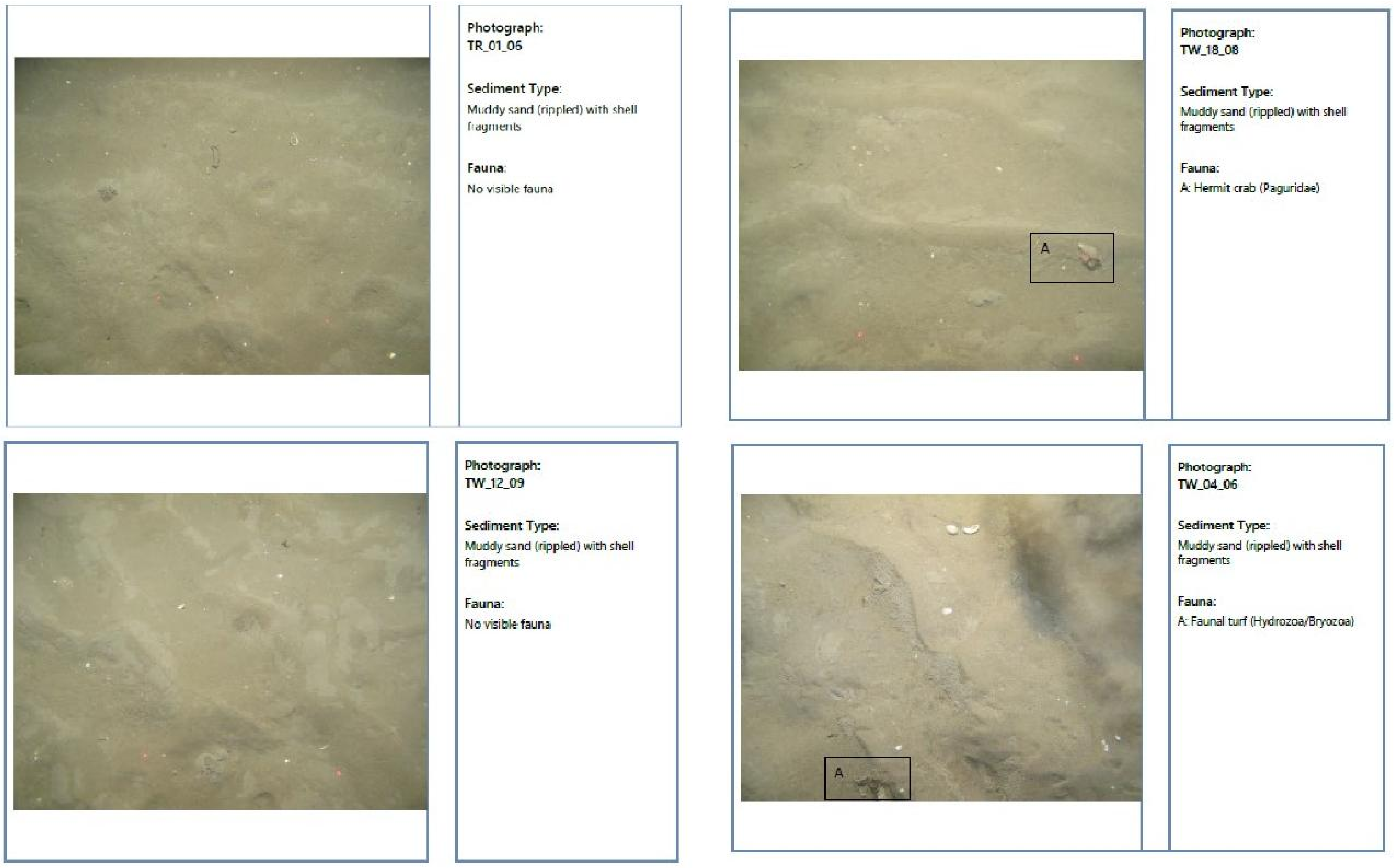


Figure 4-4 - Examples of sediments observed during the Teal West survey campaign (Fugro, 2022c)

The seabed sediment at the Development can be further described from the Particle Size Analysis (PSA) conducted on sediment grab samples during the 2021 / 2022 survey. Mean particle diameter ranged from 163 µm to 187 µm. Sand was dominant at all survey stations, accounting for 88 – 93% of the sediment, the fines content ranged from 7 – 12% and particles > 2 mm (classified as gravel) accounted for 0 – 0.77%. Total organic matter (TOM) ranged from 0.72% - 1.2% and Total Organic Carbon (TOC) ranged from 0.2% - 0.28%. The TOM and TOC concentrations had a low variability across the survey stations. TOM concentrations were below the United Kingdom Offshore Operators Association (UKOOA) (2001) CNS mean background value (1.63%), indicating that both TOM and TOC are unlikely to influence macrofaunal distribution in the survey area (Fugro, 2022c).

Overall, the sediment at the survey area are classified as sand or muddy sand under the Folk classification system (Fugro, 2022c). The geophysical survey data at proposed well locations in the survey area indicates that loose to dense slightly clayey and slightly fine sand to medium sand with shell fragments is present to a depth of 0.6 m below the seabed. Between 0.6 m and 1.8 m, the sediments are predicted to comprise medium dense to very dense fine sand with occasional shells and shell fragments (Fugro, 2022b).

The sediment type at the survey area was consistent with the reference station, approximately 1 km from the Development (Fugro, 2022c). The sediment is also considered to be generally consistent with the surveys at Guillemot which comprised EUNIS biotope ‘circalittoral fine sand’ (Fugro, 2013). The 2006 surveys at Teal also comprised sediment with a fines content of approximately 5% and Teal 7– 15.5%, which is similar to that which was observed at the Development (OGUK, 2021).

4.2.4. Sediment Contaminants

Hydrocarbons

Total Hydrocarbon Content (THC) values in sediments collected during the 2021 / 2022 Teal West surveys ranged from 2.6 µg/g to 25.3 µg/g. All stations were below the UKOOA (2001) mean of 9.5 µg/g with the exception of TW_02, which is located 150 m south of a plugged and abandoned well and contains sediment with enhanced mineral oil-based fluid input.

N-alkane concentrations ranged from 0.14 µg/g to 1.52 µg/g, which were all below the UKOOA (2001) mean of 0.4 µg/g with the exception of TW_02, which was above the UKOOA (2001) 95th percentile value of 1.18 µg/g. Polycyclic Aromatic Hydrocarbon (PAH) concentrations were below their respective Effects Range Low concentrations, indicating that adverse effects on macrofauna from PAHs is unlikely (Fugro, 2022c). PAHs normalised to 2.5% TOC were also below OSPAR (2014) BAC values.

There was a low variability of hydrocarbon concentrations across the survey area and no spatial trends were observed, with the exception of station TW_02. Station TW_02 contained a lower pristane / phytane ratio indicating a higher proportion of phytane from petrogenic sources, consistent with this station containing enhanced mineral oil-based fluid input. Analysis of the proportions and distribution of individual PAHs also indicated that the sediment at TW_02 contained a mix of petrogenic and pyrolytic sources, whereas the analysis at all other stations indicated a predominantly pyrolytic source of PAHs (Fugro, 2022c).

The THC and n-alkane concentrations present at the survey area are considered to be comparable to those recorded at the reference site and the range from the 2006 Teal survey (THC: 0.6 to 4.6 µg/g, N-alkane: 0.067 – 0.18 µg/g). PAH concentrations values were comparable to the reference station.

Heavy metals

Sediments sampled in the 2021 / 2022 surveys were analysed to determine heavy metal concentrations (Table 4-1 -).

Several metals were present at concentrations which exceeded CNS background concentrations for areas over 5 km from the nearest platform and almost all stations exceeded the background concentrations for chromium and iron, as shown in Table 4-1 -. The heavy metals showed a low to high variability with the highest variability recorded for barium. Total Barium concentrations ranged from 200 µg/g to 2,200 µg/g at station TW_02 and this is likely related to this station's proximity to the plugged and abandoned 21/24-4 well, as cuttings material from the drilling of this well may influence nearby sediment. This elevated total barium concentration at station TW_02 was the only instance in which a heavy metal concentration exceeded the UKOOA (2001) 95th percentile value. Station TW_02 also contained higher concentrations of other metals associated with barite, including copper, mercury, nickel, lead and zinc, suggesting the presence of cuttings material (Fugro, 2022c).

All concentrations were comparable (with the exception of barium) to the reference station and below their respective ERLs, and therefore, unlikely to adversely affect macrofauna. Considering the existing oil and gas developments in the area, the concentrations are considered to be consistent with areas associated with oil and gas activities and with the wider CNS (Fugro, 2022c).

The heavy metal concentrations at the survey area were considered to be consistent with those observed in the 2006 Teal surveys (Fugro, 2022c). The UKBenthos results from the 2006 Teal Field survey show that total barium concentrations (typically used as a marker of drilling muds) ranged from 240 µg/g to 620 µg/g (UKOOA, 2001). The majority of samples were below the UKOOA (2001) background concentration for the CNS at 348 µg/g, with the exception of one sample at 620 µg/g. However, all samples were below the UKOOA (2001) 95th percentile and all other heavy metal concentrations were below the relevant CNS background concentration (OGUK, 2021).

Table 4-1 - Summary of heavy metal concentrations in the Teal West survey (Fugro, 2022c)

Heavy Metal	Range of Values at the Teal West Survey Area (2021 / 2022) (µg/g)			CNS Background Concentration (µg/g)	Background Reference
	Min	Max	Mean		
Arsenic	2.6	5.0	3.7	2.8	ERT, 2003
Aluminium	2,640	3,890	3,080	N/A	N/A
Total barium	200	2,200	435	348 (mean), 720 (95th percentile)	UKOOA, 2001
Cadmium	<0.01	0.05	0.02	0.03 (mean), 0.12 (95th percentile)	UKOOA, 2001
Chromium	9.6	17.8	13.1	9.13 (mean), 31.0 (95th percentile)	UKOOA, 2001
Copper	0.8	3.4	1.2	2.41 (mean), 6 (95th percentile)	UKOOA, 2001
Iron	4,660	5,610	5,030	4,725 (mean) 11,160 (95th percentile)	UKOOA, 2001
Lithium	2.7	6.0	3.9	N/A	N/A
Nickel	2.9	5.1	3.7	7.3 (mean), 19 (95th percentile)	UKOOA, 2001
Lead	4.2	10.2	5.4	6.75 (mean), 16.7 (95th percentile)	UKOOA, 2001
Vanadium	9.7	14.0	11.4	19	ERT, 2003
Zinc	8.1	21.3	11.1	13.5 (mean), 32.6 (95th percentile)	UKOOA, 2001
Mercury	<LOD	0.03	N/A	0.03 (mean), 0.12 (95th percentile)	UKOOA, 2001
Cells in green correspond to concentrations above the SEA2 Area 2 mean (ERT, 2003)					
Cells in purple correspond to concentrations above the UKOOA (2001) mean value.					
Cells in orange correspond to mean concentrations above the UKOOA (2001) 95th percentile value.					

4.3. Biological Environment

4.3.1. Plankton

Planktonic assemblages exist in large water bodies and are transported simultaneously with tides and currents as they flow around the North Sea. Plankton forms the basis of marine ecosystem food webs and therefore directly influences the movement and distribution of other marine species.

The distribution and abundance of plankton is heavily influenced by water depth, tidal mixing and thermal stratification within the water column (Edwards *et al*., 2010). The majority of the plankton occurs in the photic zone, i.e. the upper 20 m or so of the sea in temperate latitudes, which receives enough light for photosynthesis (Johns and Reid, 2001). However, zooplankton can extend to greater depths and many species undergo diurnal vertical migrations, rising to feed before returning to depth. Natural seasonality and high small-scale variability, both in species composition and abundance, is an important feature of planktonic communities. Many species of larger animals such as fish, birds and cetaceans, are dependent upon plankton for food. The distribution of plankton, therefore, directly influences the movement and distribution of other marine species.

In both the northern and central areas of the North Sea, the phytoplankton community is dominated by dinoflagellates of the genus *Tripos* (*T. fusus, furcam, lineatum*) and diatoms such as *Thalassiosira spp*. And *Chaetoceros spp*. In recent years the dinoflagellate *Alexandrium tamarense* and the diatom *Pseudo-nitzschia* (known to cause amnesic shellfish poisoning) have been observed in the CNS (DECC, 2016). Densities of phytoplankton fluctuate throughout the year, with sunlight intensity and nutrient availability driving its abundance and productivity together with water column stratification (Johns and Reid, 2001; DECC, 2016). Plankton production generally shows two peaks in the year. The first occurs in spring when increased sunlight allows exploitation of the nutrient rich water generated over winter, and the second occurs in autumn, when the onset of mixing delivers additional nutrients while there is still sufficient energy from sunlight to power photosynthesis (DECC, 2016).

Zooplankton species richness is greater in the northern and central areas of the North Sea, than in the south and displays greater seasonality. Zooplankton communities in this area are dominated in terms of biomass and productivity by copepods, particularly *Calanus* species such as *C. finmarchicus* and *C. helgolandicus*. Other important taxa include *Acartia*, *Temora*, and *Oithona spp*. Larger zooplankton species such as euphausiids and decapod larvae are also important to the zooplankton community in this region (DECC, 2016).

C. finmarchicus has historically dominated the zooplankton of the North Sea and is used as an indication of zooplankton abundance. Overall abundance of *C. finmarchicus* has declined dramatically over the last 60 years, which has been attributed to changes in seawater temperature and salinity (Beare *et al.,* 2002; FRS, 2004). *C. finmarchicus* has largely been replaced by boreal and temperate Atlantic and neritic (coastal water) species in particular, and a relative increase in the populations of *C. helgolandicus* has occurred (DECC, 2009; Edwards *et al.,* 2010; Baxter *et al*., 2011).

4.3.2. Benthos

The biota living near, on, or in the seabed, are collectively termed benthos. The diversity and biomass of the benthos is dependent on a number of factors including substrata (e.g. sediment, rock), water depth, salinity, the local hydrodynamics and degree of organic enrichment (DECC, 2016). The species composition and diversity of the benthos or macrofauna found within sediments is commonly used as a biological indicator of sediment disturbance or contamination.

The CNS and NNS predominantly consist of deep circalittoral sand with areas of finer sediments to the north. Generally, the benthic communities in the NNS are more diverse compared to the south (DECC, 2016).

The faunal community associated with the EUNIS habitat A5.27 is associated with a diverse community of polychaetes, amphipods, bivalves and echinoderms. Site surveys at the Development from 2021 / 2022 found that the epifaunal community was homogenous and relatively sparse. The most frequently observed benthic fauna in the survey area included crabs (e.g. Paguridae), starfish (*Asterias rubens*), sea pens (*Pennatula phosphorea*), anemones (e.g. Actiniaria) and soft corals (e.g. Alcyonacea) (Fugro, 2022a).

The macrofaunal analysis on sediments collected during the 2021 / 2022 Teal west survey recorded 163 Taxa and 3,050 individuals across the survey area. Annelids dominated in terms of taxa, accounting for

49.6% of taxa, followed by molluscs, arthropods, and echinoderms which accounted for 20.2%, 16.8%, and 4.2% of recorded taxa, respectively. Annelids accounted for 63.9% of individuals with the remaining individuals being associated with molluscs (20.5%), arthropods (7.9%), echinoderms (2.5%) and other (5.3%). Commonly recorded species included *Paramphinome jeffreysii*, *Scalolplos armiger*, *Spiophanes bombyx, Thyasira flyxuosa*, *Cylichna cylindracea*, and *Galathowenia 72nergy72*, and these species were recorded at every station (Fugro, 2022c).

Diversity was assessed to be moderate to high across the survey area and the analysis indicated that the survey area could be classed as a single community. There was no obvious influence of the higher THC and total barium concentrations in TW_02 on the macrofaunal community (Fugro, 2022c).

The macrofaunal community was used to further refine the biotope classification at the survey area, which was interpreted as 'Deep circalittoral sand' based on sediment data only. When considering the macrofaunal community, the biotope complex was interpreted as *Paramphinome jeffreysii*, *Thyasira spp*. And *Amphiura filiformis* in offshore circalittoral sandy mud' (A5.376). However, the sediments at the survey area did not match this biotope, which requires mud or sandy mud not influenced by tidal streams. Rippled sand was observed at the survey area, indicating that tidal currents are influencing the seabed, and it was therefore concluded that the physical environment differs from the biological community (Fugro, 2022c).

The biotope "Seapen and Burrowing Megafauna", listed as PMF in Scottish waters on the OSPAR List of Threatened and/or Declining Habitats and Species, was identified as potentially being present at the survey area (as described further in Section 4.5.2). Other species or habitats of conservation importance identified during the surveys included the habitat 'offshore subtidal sands and gravels', listed as a PMF and ocean quahog, listed as a PMF and on the OSPAR list of threatened and/or declining species (Fugro, 2022a,c). Further detail on these features is provided in Section 4.5.

The site survey undertaken in 2006 at the Teal Field reported five taxonomic groups including polychaetes, crustaceans, molluscs, echinoderms and other minor phyla. The top three most abundant species recorded were all polychaete worms of the *Myriochele sp*. The next most numerous species recorded was *Echinocardium cordatum* (sea potato) which is a species of sea urchin (OGUK, 2021). This was considered to be generally consistent with the macrofaunal community observed in the 2021 / 2022 Teal West surveys (Fugro, 2022a,c).

4.3.3. Fish and Shellfish

A number of commercially important fish and shellfish species can be found in the vicinity of the Development. Fish and shellfish populations may be vulnerable to impacts from offshore installations such as hydrocarbon pollution and exposure to aqueous effluents, especially during the egg and juvenile stages of their lifecycles (Bakke *et al.*, 2013). The North Sea is historically important for its fish stocks, with fishing occurring throughout the year.

The Development is located within the International Council for the Exploration of the Sea (ICES) rectangle 43F0, in an area of spawning and nursery grounds for several commercially important species, as shown in Table 4-2. The Development falls within low or undetermined intensity nursery grounds for anglerfish (*Lophius piscatorius*), blue whiting (*Micromesistius poutassou*), cod (*Gadus morhua*), European hake (*Merluccius merluccius*), haddock (*Melanogrammus aeglefinus*), herring (*Clupea harengus*), ling (*Molva molva*), mackerel (*Scomber scombrus*), *Nephrops* (*Nephrops norvegicus*), plaice (*Pleuronectes platessa*), sandeels (*Ammodytes marinus*), sprat (*Sprattus sprattus*), spurdog (*Squalus acanthias*) and whiting (*Merlangius merlangus*) (Ellis *et al.*, 2012; Coull *et al.*, 1998).

The Development is located within low or undetermined spawning grounds for cod, lemon sole (*Microstomus kitt*), mackerel and *Nephrops* as well as high intensity spawning grounds for sandeels (*Ammodytes marinus*) and a high concentration spawning area for Norway pout (*Trisopterus esmarkii)*(Ellis *et al*., 2012; Coull *et al*., 1998).

Table 4-2 - Fisheries sensitivities within ICES rectangle 43F0 (Coull *et al*., 1998; Ellis *et al*., 2012)

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Anglerfish	N	N	N	N	N	N	N	N	N	N	N	N
Blue Whiting	N	N	N	N	N	N	N	N	N	N	N	N
Cod	SN	S*N	S*N	SN	N	N	N	N	N	N	N	N
European hake	N	N	N	N	N	N	N	N	N	N	N	N
Haddock	N	N	N	N	N	N	N	N	N	N	N	N
Herring	N	N	N	N	N	N	N	N	N	N	N	N
Lemon Sole				S	S	S	S	S	S			
Ling	N	N	N	N	N	N	N	N	N	N	N	N
Mackerel	N	N	N	N	S*N	S*N	S*N	SN	N	N	N	N
Nephrops	SN	SN	SN	S*N	S*N	S*N	SN	SN	SN	SN	SN	SN
Norway Pout	SN	S*N	S*N	SN	N	N	N	N	N	N	N	N
Plaice	N	N	N	N	N	N	N	N	N	N	N	N
Sandeels	SN	SN	N	N	N	N	N	N	N	N	SN	SN
Sprat	N	N	N	N	N	N	N	N	N	N	N	N
Spurdog	N	N	N	N	N	N	N	N	N	N	N	N
Whiting	N	N	N	N	N	N	N	N	N	N	N	N
S = Spawning, N = Nursery, S/N = Spawning and Nursery; * = peak spawning; Shading = high concentration spawning as per Coull et al., (1998), Shading = High intensity spawning as per Ellis *et al*., (2012)												

The probability of 0-group fish (i.e. fish within the first year of their lives) is low for all species, with the exception of Norway pout, haddock and anglerfish which have a moderate probability of 0-group fish (Aires *et al*., 2014). There is also a low probability of the presence of buried sandeel[5] (Marine Scotland, 2021a).

Some commercially important fish species potentially present at the Development are listed as Scottish PMFs, including anglerfish, herring, mackerel, blue whiting, cod, sandeel, spurdog, ling, Norway pout and whiting. Cod is also listed on the OSPAR List of Threatened and/or Declining Species and Habitats.

[5] *Depth biases in the statistical model mean that sandeel habitat suitability predictions in water depths > 70 m are less accurate*

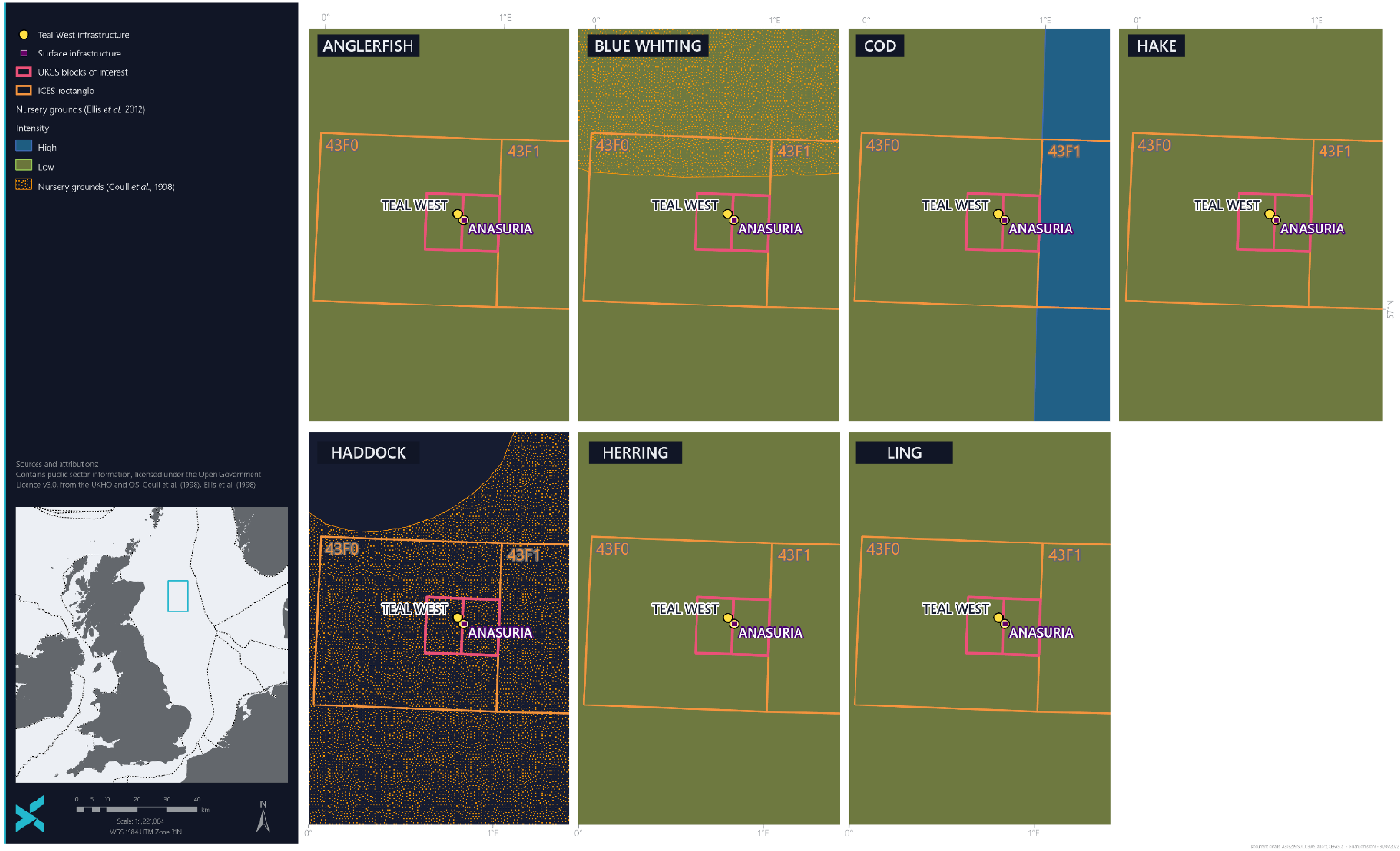


Figure 4-5 - Potential fish nursery grounds around the Development (Coull *et al.*, 1998; Ellis *et al.*, 2012) (1)

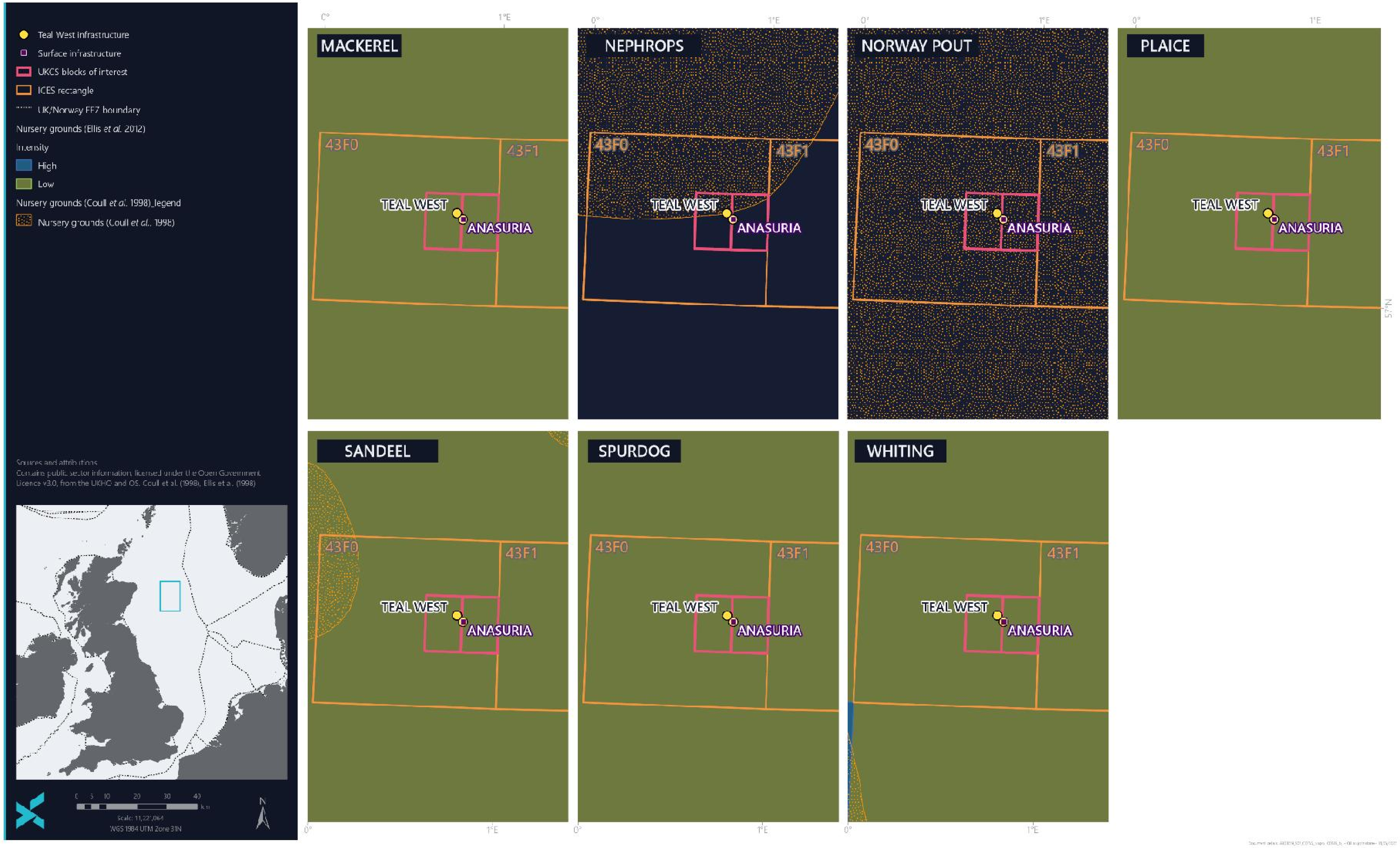


Figure 4-6 - Potential fish nursery grounds around the Development (Coull *et al.*, 1998; Ellis *et al.*, 2012) (2)

Figure 4-7 - Areas of potential fish spawning around the Development (Coull *et al.*, 1998; Ellis *et al.*, 2012)

4.3.4. Seabirds

Much of the North Sea and its surrounding coastline is an internationally important breeding and feeding habitat for seabirds. In the CNS and NNS, the most numerous species present are likely to be northern fulmar (*Fulmarus glacialis*), black-legged kittiwake (*Rissa tridactyla)* and common guillemot (*Uria aalge)* (DECC, 2009; DECC, 2016). Seabirds are not normally affected by routine offshore oil and gas operations. In the unlikely event of an oil release, however, birds are vulnerable to oiling from surface pollution, which could cause direct toxicity through ingestion, and hypothermia as a result the birds' inability to waterproof their feathers. Birds are most vulnerable in the moulting season when they become flightless and spend a large amount of time on the water surface.

After the breeding season ends in June, large numbers of moulting auks (common guillemot, razorbill (*Alca torda)* and Atlantic puffin (*Fratercula arctica)*) disperse from their coastal colonies and into the offshore waters from July onwards. At this time these high numbers of birds are particularly vulnerable to oil pollution. In addition to auks, black-legged kittiwake, northern gannet (*Morus bassanus)*, and northern fulmar, are present in sizable numbers during the post breeding season.

According to the density maps provided in Kober *et al.,* (2010), the following species have been recorded within UKCS Blocks 21/24 and 21/25, which the Development area lies within; northern fulmar, sooty shearwater (*Ardenna grisea*), manx shearwaters (*Puffinus puffinus*), European storm petrel (*Hydrobates pelagicus*), northern gannet, Artic skua (*Stercorarius parasiticus*), great skua (*Stercorarius skua*), black-legged kittiwake, great black-backed gull (*Larus marinus*), common gull (*Larus canus*), lesser black-backed gull (*Larus fuscus*), herring gull (*Larus argentatus*), arctic tern (*Sterna paradisaea*), common guillemot, razorbill, little auk (*Alle alle*) and Atlantic puffin.

The Joint Nature Conservation Committee (JNCC) has released the latest analysed trends in abundance, productivity, demographic parameters and diet of breeding seabirds, from the Seabird Monitoring Programme (JNCC, 2021a). This data provides at-a-glance UK population trends as a % of change in breeding numbers from complete censuses. From the years 2000 – 2019, the following population trends for species known to use the field area have been recorded: northern fulmars (-33%), northern gannet (+34%), arctic skua (-70%), razorbill (+37%), black legged kittiwakes (-29%) and common guillemots (+60%). Generally, breeding seabird numbers of some species have shown a long-term decline, most probably as a result of a shortage of key prey species such as sandeels associated with changes in oceanographic conditions (Baxter *et al*., 2011: DECC, 2016).

The Seabird Oil Sensitivity Index (SOSI) identifies sea areas where seabirds are likely to be most sensitive to oil pollution. It is an updated version of the Oil Vulnerability Index (JNCC, 1999) as it uses survey data collected between 1995 and 2015 and includes an improved method to calculate a single measure of seabird sensitivity to oil pollution (Webb *et al*., 2016). The survey area covers the UKCS and beyond. Seabird data was collected using boat-based, visual aerial, and digital video aerial survey techniques. This data was combined with individual species sensitivity index values and summed at each location to create a single measure of seabird sensitivity to oil pollution. Block/month combinations that were not provided with data have been populated using the indirect assessment method provided by Webb *et al.* (2016). Maximum sensitivity values were used in this assessment to provide a worst-case scenario assessment.

As shown in Table 4-3 -, Seabird sensitivity to oil pollution in Blocks 21/24 and 21/25 is considered to be low throughout the year, although there is no data available for November. Seabird densities in adjacent Blocks range from low to extremely high in Block 21/23 in April and May. The Development's offshore location is remote from sensitive seabird breeding areas along the coast.

Table 4-3 - Seabird oil sensitivity index for Blocks 21/24 and 21/25 and around surrounding vicinity (Webb *et al*., 2016)

Block	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
21/18	5	5	5	1*	1	5	5	5	5	5*	N	5*
21/19	5	5	5	5*	5*	5	5	5	5	5*	N	5*
21/20	5	5	5	5*	5*	5	5	5	5	5*	N	5*
21/23	5	4	5	1*	1	5	5	5	5	5*	N	5*
21/24	5	5*	5	5*	5*	5	5	5	5	5*	N	5*
21/25	5	5	5	5*	5*	5	5	5	5	5*	N	5*
21/28	5	4	5	5*	5*	5	5	5	5	5*	N	5*
21/29	5	5	5	5*	5*	5	5	5	5	5*	N	5*
21/30	5	5	5	5*	5*	5	5	5	5	5*	N	5*
22/16	5	5	5	5*	5*	5	5	5	5	5*	N	5*
22/21	5	5*	5	5*	5*	5	5	5	5	5*	N	5*
22/26	5	5*	5	5*	5*	5	5	5	5	5*	N	5*
Key	1 = Extremely High		2 = Very High		3 = High		4 = Medium		5 = Low		N = No data	
* in light of coverage gaps, an indirect assessment of SOSI has been made												

4.3.5. *Marine Mammals*

Cetaceans

The CNS and NNS have a moderate to high diversity and density of cetaceans, with a general trend of increasing diversity and abundance with increasing latitude (DECC, 2016). Twenty-eight cetaceans have been recorded in UK waters, with eleven being considered as regular visitors and the remaining species being infrequently encountered (DECC, 2016). The regular visitors to UK waters include harbour porpoise (*Phocoena phocoena*), bottlenose dolphin (*Tursiops 78nergy78ed*), white-beaked dolphin (*Lagenorhyncus albirostris*), minke whale (*Balaenoptera acutorostrata*), fin whale (*Balaenoptera physalus*), Atlantic white-sided dolphin (*Lagenorhyncus acutus*), short-beaked common dolphin (*Delphinus delphi*), Risso's dolphin (*Grampus griseus*), killer whale (*Orcinus orca*), long-finned pilot whale (*Globicephala melas*) and sperm whale (*Physeter macrocephalus*) (DECC, 2016).

A description of occurrence for cetaceans expected to occur at the Development is provided in Table 4-4 and is based on Hammond *et al.,* (2021), Reid *et al.,* (2003) and Hague *et al.*, 2020.

Surveys undertaken for the "Small Cetaceans in the European Atlantic and North Sea" (SCANS-III) provide abundance and density estimates for commonly sighted cetacean species across different regions (survey blocks) in the UKCS (Hammond *et al.*, 2021). The approximate density of a particular cetacean species in the vicinity of a Development can be estimated using the densities for the survey Block within which a development is located (Hammond *et al.*, 2021). The Development is located within Block R of the SCANS-III survey (Hammond *et al.*, 2021). Within Block R, harbour porpoise, white-beaked dolphin, minke whale, bottlenose dolphin, and Atlantic white-sided dolphin were encountered in the SCANS-III survey and therefore, density estimates for the area are available for these species, as shown in Table 4-4.

Table 4-4 - Cetacean occurrence in the Development area (Hammond *et al.*, 2021; Reid *et al.*, 2003; Hague *et al.*, 2020)

Species	Abundance of Individuals in Survey Block R	Density (Animals / km^2) Within Scans-III Survey Block R	Description of Occurrence
Harbour porpoise	38,646	0.599	Harbour porpoise are the smallest cetacean in UK waters and are seen throughout the UKCS, though the greatest numbers are found in the SNS. They usually occur in shallow waters (less than 50 m) in groups of up to three individuals, although they have been sighted in larger groups and in deeper waters (up to 200 m). Harbour porpoise movements are variable, and they do not undertake seasonal migrations, although densities are highest in the summer months (May – August).
White-beaked dolphin	15,694	0.243	White-beaked dolphin are the second most abundant cetacean in the North and CNS and are often found in groups of up to 10 individuals. The densities of white-beaked dolphin are highest in the west and central section of the North Sea; however, sightings do occur around the Development area and even extend further north. Peak abundance in the Development area occurs between July and September.
Minke whale	2,498	0.0387	Minke whales usually occur on the continental shelf in water depths up to 200 m. They are mostly seasonal visitors in the North Sea and are usually sighted alone or in pairs; however, groups of up to 15 individuals may aggregate during feeding events. Data suggest that animals return to the same seasonal feeding grounds each year. They are mostly found singly, or in small groups and are rarely sighted outside of the May – September months.
Bottlenose dolphin	1,924	0.0298	There are two different ecotypes of bottlenose dolphin, coastal and offshore. Those present within the Development area are likely to be the offshore ecotype, for which there is less information available when compared to the coastal ecotype. Overall, the densities of this species offshore is considered to be lower than in coastal waters. The species is mostly sighted in groups and are present in Scottish waters year-round.
Atlantic white-sided dolphin	644	0.01	Atlantic white-sided dolphins have a limited distribution but are found in both temperate and cold waters of the north Atlantic Ocean, usually over deep-slope continental shelves and canyon waters. They tend to prefer deeper water and are not seen close to shore that often. They feed in groups, usually found in pods of anything between 2 and 50 individuals. It is not uncommon to see much larger pods (hundreds or even thousands of dolphins) where they have found dense concentrations of food. Densities in the region surrounding the Development are highest between May and September.

Harbour porpoise, killer whale, long-finned pilot whale, white-beaked dolphin, bottlenose dolphin and minke whale are listed as PMFs in Scottish waters and all cetaceans are European Protected Species (EPS) (Tyler-Walters *et al.*, 2016). The harbour porpoise is also protected under Annex II of the EU Habitats Directive (92/43/EEC as amended by 97/62/EC).

Based on the available information, Blocks 21/24 and 21/25 have a low cetacean density and are not considered to be significant for feeding, breeding, nursery or migrating cetaceans. The species that are most likely to occur in the Development area include harbour porpoise and white-beaked dolphin. The mobile nature of cetaceans means that any potentially significant collision risk impacts to marine mammals from the Development are unlikely as vessels will be slow moving. Nonetheless, potential impacts to marine mammals from underwater noise emitted from the Development activities are assessed in detail within Chapter 8 of this ES.

Pinnipeds

Five species of pinnipeds have been identified in the North Sea: grey seal (*Halichoerus grypus)*, harbour seal (*Phoca vitulina),* harp seal (*Phoca groenlandica)*, hooded seal (*Cystophora cristata)* and ringed seal (*Pusa hispida)* (Jones *et al.*, 2016). However, only two of these species live and breed in the UK, namely the grey and harbour seal. Both grey and harbour seals are listed under Annex II of the EU Habitats Directive and as PMFs. The bearded, ringed, harp and hooded seals are Arctic species, and have generally only been sighted on an occasional basis in UK waters.

Grey and harbour seals feed in inshore and offshore waters depending on the distribution of their prey, which changes both seasonally and yearly. Both species tend to be concentrated close to shore, particularly during the pupping and moulting season. Seal tracking studies have indicated that the foraging movements of harbour seals are generally restricted to within a 40 – 50 km range of their haul-outs (Special Committee on Seals (SCOS), 2020). The movements of grey seals can involve larger distances than those of the harbour seal, and trips of several hundred kilometres from one haul-out to another have been recorded (Sea Mammal Research Unit (SMRU), 2011). However, the majority of foraging trips are expected to be within 100 km of a haul out (SCOS, 2020).

Approximately 36% of the world's grey seals breed in the UK and most (81% of UK seals) breed in Scottish colonies. Approximately 32% of European harbour seals are found in the UK. This proportion has declined by from 40% since 2002 (SCOS, 2020).

The Development is approximately 155 km offshore of the nearest coastline. As such, although pinnipeds may be encountered in the vicinity of the Development from time to time, it is not likely that they use the area with any regularity or in great numbers. This is confirmed by the latest grey and harbour seal at-sea distribution maps. These maps predict that the density of grey and harbour seals in the vicinity of the Development are low, representing approximately 0 – 5 individuals and 0 – 0.001% of the respective UK populations, per 25 km^2 (Russel *et al.*, 2017; Carter *et al.*, 2020), as illustrated in Figure 4-8. No interactions with seal haul-out or breeding sites are expected given the intervening distance between the Development and the coastline.

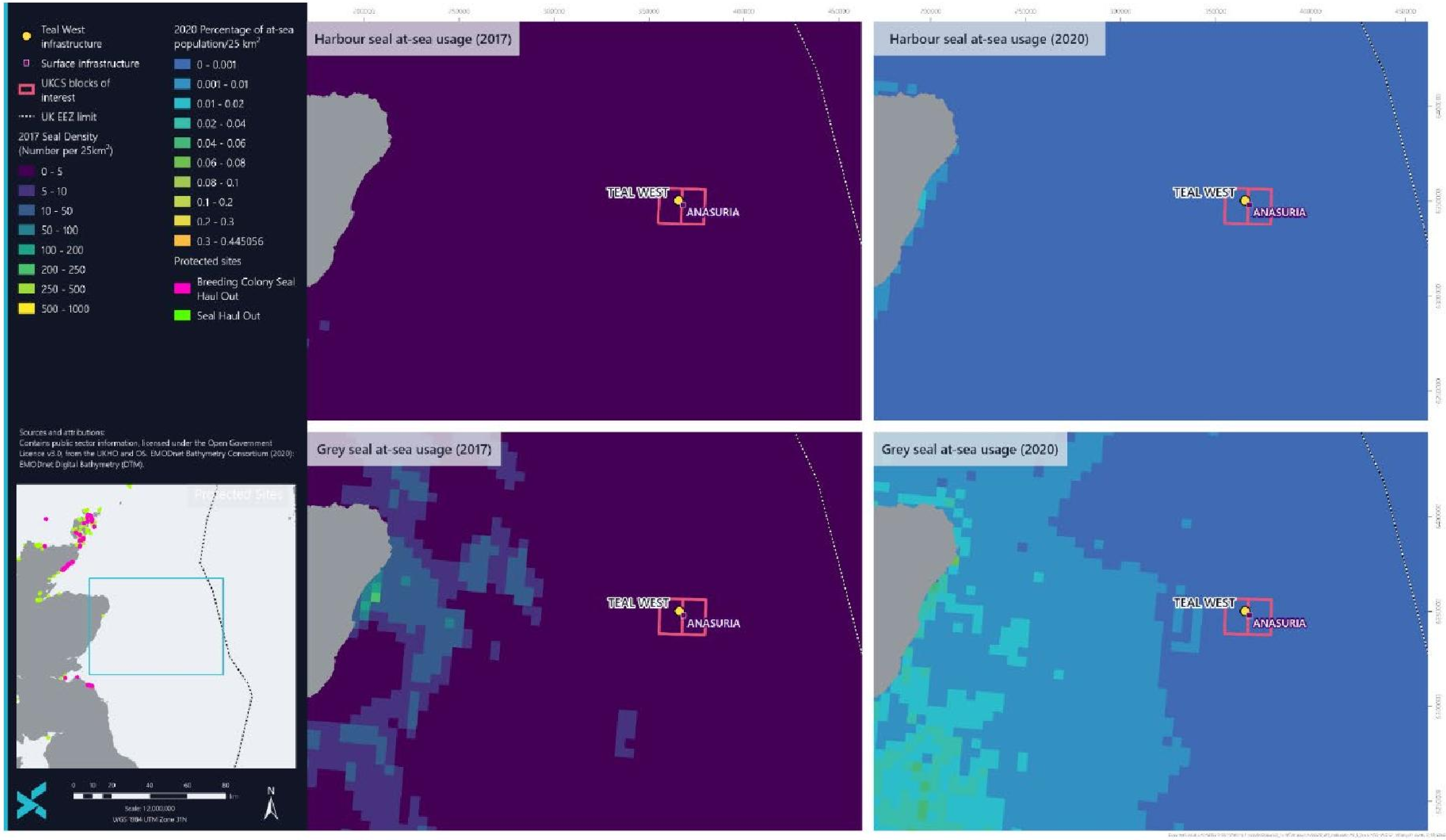


Figure 4-8 - Estimated number of individuals and % of UK harbour and grey seal at-sea population per 25 km² within the vicinity of the Development area (Russel *et al.*, 2017; Carter *et al.*, 2020)

4.4. Coastal Conservation

The Development is located approximately 155 km from the northeast coast of Scotland. Due to this distance, no impacts to onshore conservation sites (including SPAs, as designated under the EU Birds Directive (2009/147/EC)) are expected from anticipated Development activities and routine operations for the Development.

4.5. Offshore Conservation

4.5.1. Designated sites

The closest site of conservation interest is the East of Gannet and Montrose Fields NCMPA, immediately adjacent to the Development (0.7 km from the riser base manifold) (Figure 4-9). Most of the seabed within the NCMPA is dominated by sands and gravel which are the preferred habitat of the ocean quahog (*Arctica islandica*). The species is a long-lived bivalve mollusc which can live over 100 years. Both ocean quahog and their supporting habitat are protected features of this NCMPA. The NCMPA also includes a band of offshore deep-sea mud which supports many types of worm and mollusc which in turn support a number of species of fish. This offshore deep-sea mud is also a protected feature of the NCMPA.

The conservation objectives for the NCMPA are to maintain each feature in favourable condition or those that are not already in a favourable condition should be brought and maintained at this condition (JNCC, 2018a). According to conservation advice produced in 2020, the designated features of this site are in an unfavourable condition (JNCC, 2020). Further details on the conservation objectives for the protected features of the NCMPA are provided in Table 4-5.

Table 4-5 - Conservation objectives for the East of Gannet and Montrose Fields NCMPA (JNCC, 2018a)

Feature	Conservation Objective
Offshore deep-sea muds	• "Extent is stable or increasing; and • Structures and functions, quality, and the composition of characteristic biological communities (which includes a reference to the diversity and abundance of species forming part of or living within the habitat) are such as to ensure that they remain in a condition which is healthy and not deteriorating; Any temporary deterioration in condition is to be disregarded if the habitat is sufficiently healthy and resilient to enable its recovery from such deterioration. Any alteration to that feature brought about entirely by natural processes is to be disregarded."
Ocean quahog aggregations	"The quality and quantity of its habitat and the composition of its population in terms of number, age and sex ratio are such as to ensure that the population is maintained in numbers which enable it to thrive. Any temporary reduction of numbers is to be disregarded if the population is sufficiently thriving and resilient to enable its recovery. Any alteration to that feature brought about entirely by natural processes is to be disregarded."

Although muddy sand was recorded during the 2021 / 2022 Teal West surveys, this was not considered to represent 'mud' as the silt and clay portion of the sediment was less than 15%. Ocean quahog were recorded at seven of the survey stations in the survey area, ranging from 1 to 7 individuals per station (Fugro, 2022c).

The closest SAC to the Development is the Scanner Pockmark, located 110 km to the north-east which is designated for the Annex I habitat 'submarine structures made by leaking gases'. The closest SPA is Buchan Ness to Collieston Coast, approximately 152 northwest of the Development (Figure 4-9).

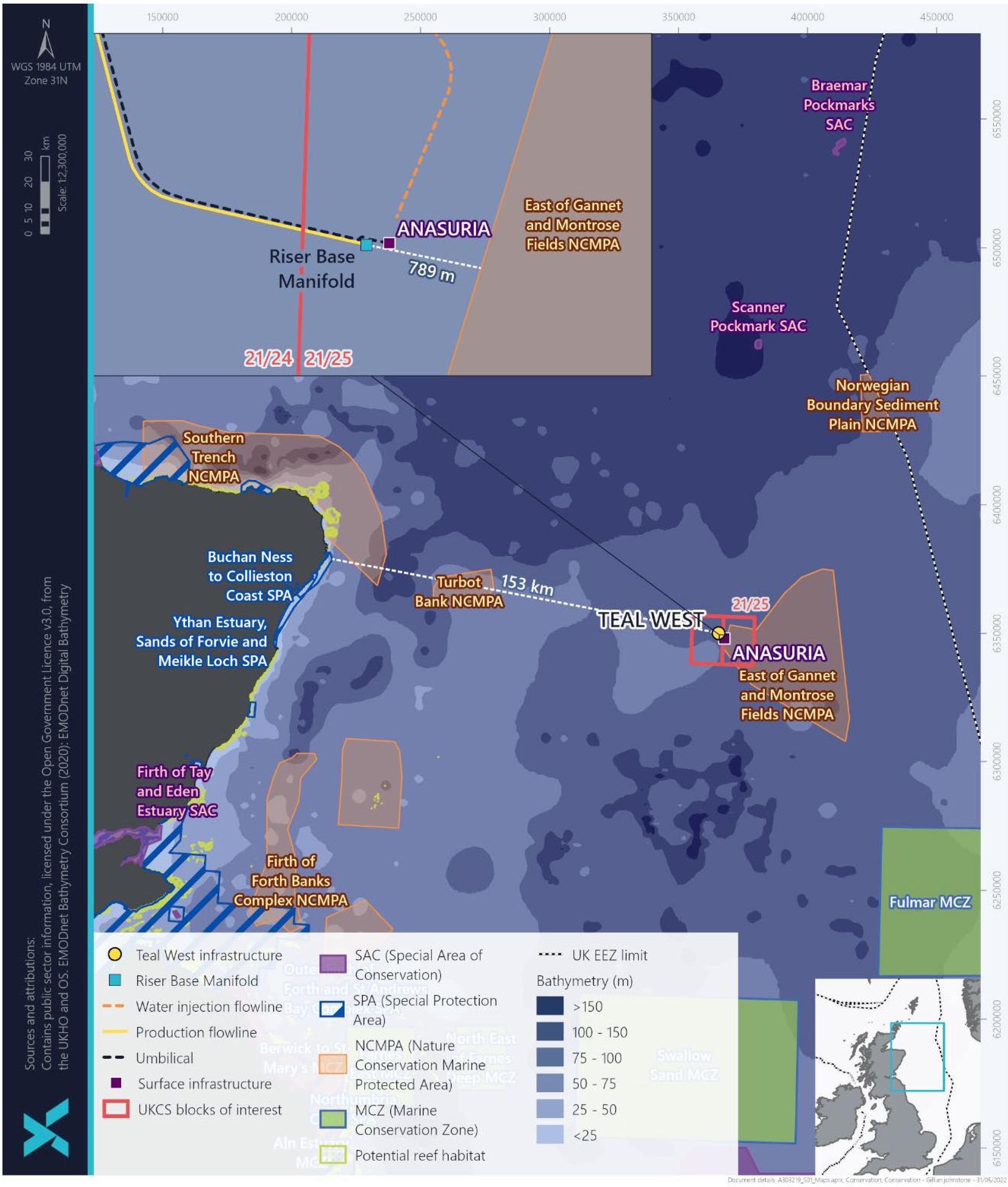


Figure 4-9 - Sites of conservation importance in the vicinity of the Development

4.5.2. Seapens and burrowing megafauna

The "seapens and burrowing megafauna communities" biotope can be broadly defined as areas of "fine mud, at water depths ranging from 15–200 m or more", which are heavily bioturbated by burrowing megafauna; burrows and mounds may form a prominent feature of the sediment surface with conspicuous populations of sea pens, typically *Virgularia mirabilis* and *Pennatula phosphore*a. The burrowing crustaceans present may include *Nephrops norvegicus*, *Calocaris macandreae* or *Callianassa subterranea* (OSPAR, 2010). This habitat type is listed as a PMF and is on the OSPAR (2008) List of Threatened and/or Declining Habitats. There are no public records of seapens and burrowing megafauna within the vicinity of the Development, with the closest public record being > 10 km from the Development.

During the 2021 / 2022 Teal West surveys, sea pens were recorded at most survey stations, ranging from occasional (1 – 9 per 100 m^2) to common (1 – 9 per m^2) on the Super abundant, Abundant, Common, Frequent, Occasional, Rare (SACFOR) scale. Faunal burrows were also recorded at almost half of the stations and transects, ranging from occasional to frequent (1 – 9 per 10 m^2) on the SACFOR scale. Based on JNCC guidance, burrows must be frequent in order for the habitat to qualify as seapens and burrowing megafauna, which did occur at seven stations and one transect in the survey area (Fugro, 2022a). However, only one species of sea pen (*Pennatula phosphorea*) was observed in the survey area and other characterising fauna, such as *Nephrops norvegicus* and signs of cryptic bioturbation (e.g. mounds) were absent from all stations. The abundance of burrows was also on the lower end of the 'frequent' SACFOR abundance scale. Therefore, although this habitat is may be present at the Development, it is unlikely to be considered of particular importance of value from a conservation perspective.

4.5.3. Ocean quahog

The infaunal bivalve *Arctica islandica* (also known as ocean quahog) is listed under the OSPAR list of threatened and/or declining species (OSPAR, 2008). The reason for inclusion on the OSPAR list was due to significant recorded changes in the populations of this species during the last century. This long-lived bivalve is also classified as a PMF.

Artica islandica can be found from shallow low-level waters to depths of about 500 m. They live buried in sand and muddy sand, often with their shells entirely hidden and just a small tube extending up to the surface of the seabed. The tube is a siphon that keeps water flowing across the animal, so that it can breathe, capture food, and expel waste (JNCC, 2019b). They are an important food source for several fish species, such as cod, and show exceptional longevity (studies have shown that it can live up to 400 years) and feature a sporadic juvenile recruitment. They are of particular risk to bottom fishing gear, and, like other slow-growing animals, once their numbers have been reduced, the population can take a long time to recover (JNCC, 2019b).

As displayed on Figure 4-10, there are ocean quahog records in the vicinity of the Development, mainly to the east, within the East Gannet and Montrose Fields NCMPA and also to the west. There are no records directly overlapping with the Development, although this does not necessarily mean that ocean quahog are absent from the area. As noted in Section 4.5.1, ocean quahog were recorded at seven of the survey stations, at a density ranging from 1 to 7 individuals per station (Fugro, 2022a).

4.5.4. *Offshore subtidal sands and gravels*

As described in Section 4.2.2, the seabed at the Development comprises EUNIS habitat A5.27, which is associated with the PMF habitat "offshore sands and gravels". This habitat is widespread across the North Sea.

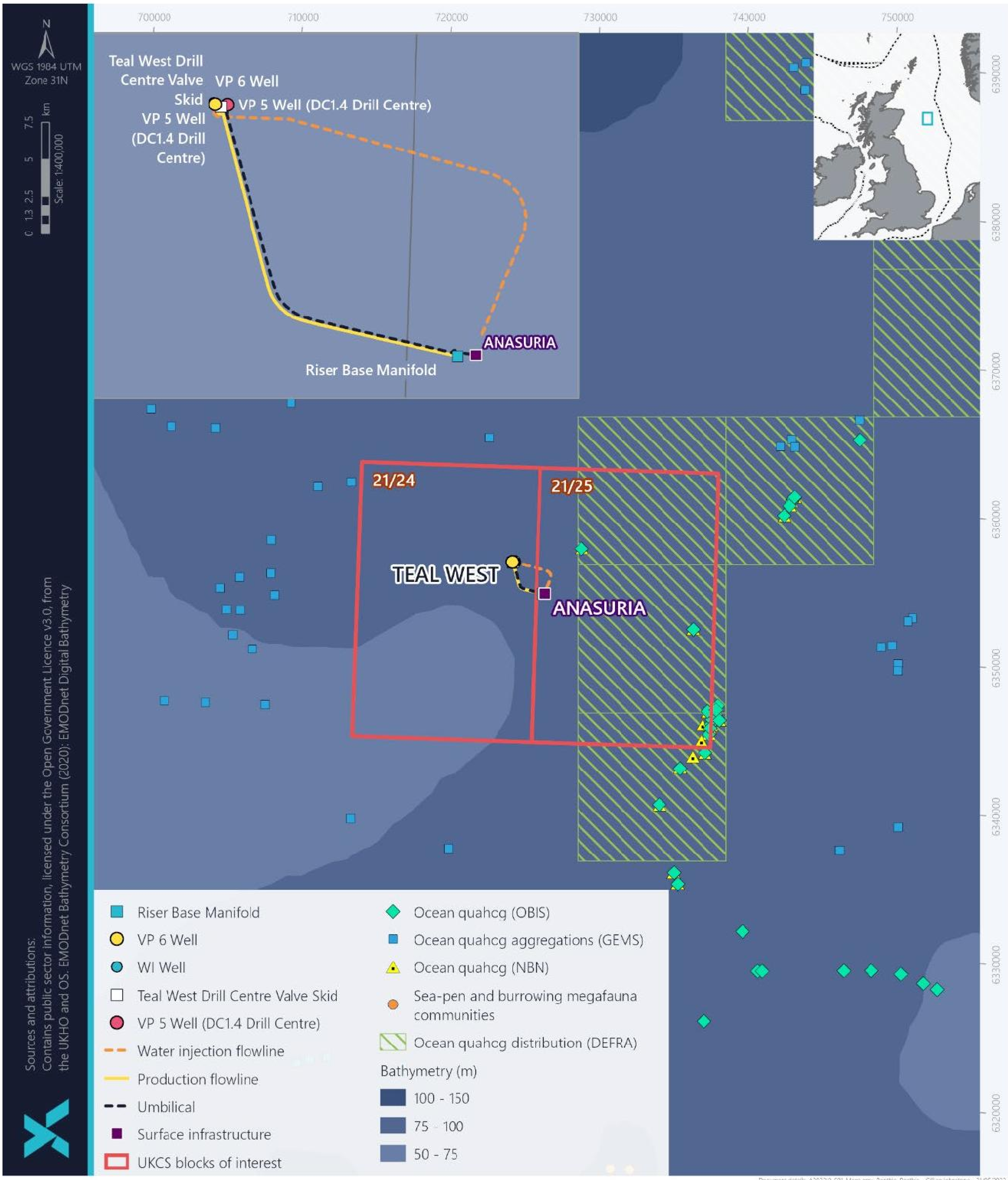


Figure 4-10 - Species of conservation importance

4.5.5. Submarine structures made by leaking gases

The Development does not lie within an area reported by the JNCC as the Annex I habitat 'Submarine Structures Made by Leaking Gases'. However, areas of MDAC, which is characteristic of this habitat type were recorded during the 2021 / 2022 Teal West surveys. As described in Section 4.2.2, pockmarks and potential MDAC were observed in the survey area (Fugro, 2022b).

The Annex I habitat 'submarine structures made by leaking gases' is a Scottish PMF (JNCC, 2014), which comprise rocks, pavements and pillars up to 4 m high made of carbonate cement. This cement is produced by microbial oxidation of gases (mostly methane) which bubble up from below the seafloor, known commonly as MDAC. In UK waters, 'submarine structures made by leaking gases' are predominantly associated with the formation of pockmarks in the northern and CNS. Pockmarks are depressions in soft seabed sediments which can be up to 45 m deep and a few hundred meters wide, where methane gas escapes the seabed leaving a circular depression. Pockmarks can be found in vast numbers across the Witch Ground Basin within the CNS. Most of the pockmarks in the CNS are less than 3 m deep with exception to only a few larger pockmarks which have been awarded further protection (e.g. Scanner Pockmark) (JNCC, 2018b). These are important habitats in which a variety of fauna are attracted. The hard substrate provides sufficient shelter and feeding grounds for those species which can exploit the gases released. Even though pockmarks themselves are a vulnerable habitat, it is the MDAC structures that are considered significant habitats under Annex I of the EU Habitats Directive.

Areas of MDAC were interpreted to be present during the geophysical surveys at the 2021 / 2022 Teal West surveys, associated with areas of high reflectivity within depressions. These MDAC areas were to the north of the survey area (Fugro, 2022b). However, these areas of MDAC were patchy in nature and none overlap directly with the proposed locations of the infrastructure for the Development. Furthermore, the macrofaunal community was interpreted as being homogenous across the survey area, with a single community across all stations, indicating that the presence of MDAC is not influencing the faunal community present.

4.6. Socio-Economic Environment

4.6.1. Commercial Fisheries

The North Sea has important fishing grounds and is fished throughout by both UK and international fishing fleets, targeting both demersal, pelagic and shellfish fish stocks. The seas in the north-east Atlantic region have been divided into a series of administrative rectangles by the ICES. The Development is located within ICES rectangle 43F0.

Table 4-6 - summarises the average landing value (£) and landing weight (Te) within ICES Rectangle 43F0 of demersal, pelagic and shellfish species over a five-year period between 2016 and 2020. In 2019, ICES Rectangle 43F0 was primarily targeted for demersal fish accounted for 92% of the landing value and 97% of the landing weight, with over 630 tonnes of demersal fish species landed. Shellfish species accounted for approximately 8% of landing value and 3% of landing weight in 2019. In 2020, the contribution of demersal species to total landing value and landing weight decreased, with demersal species only contributing 41% of the landing value and 31% of the landing weight. In contrast, pelagic species contributed the highest landing value and landing weight for the year 2020, accounting for 55% of landing value and 68% of landing weight. Despite an increase in shellfish species landing value and landing weight in 2020, as a result of an increase in pelagic species contribution, the proportion of landings value and weight attributed to shellfish species decreased from 2019, accounting for 4% of landing value and 1% of landing weight in 2020 (Scottish Government, 2021).

2020 contributed the largest total landing value and landing weight of demersal, pelagic and shellfish species, totalling £2,081,745 and 2,805 Te within ICES Rectangle 43F0. To put the landing values in context, in 2020, ICES Rectangle 43F0 represented <1% of the total landing value and landing weight across the UKCS (MMO, 2021a).

Table 4-6 - Fisheries Statistics in ICES rectangle 43F0 (Scottish Government, 2021)

Year	Species Type	Landed Value (£)	Landed Weight (Te)
2020	Demersal	£853,432	874
	Pelagic	£1,140,713	1,895
	Shellfish	£87,600	36
	Total	£2,081,745	2,805
2019	Demersal	£779,155	635
	Pelagic	£794	0
	Shellfish	£70,736	21
	Total	£850,685	656
2018	Demersal	£585,135	797
	Pelagic	£506,834	1,363
	Shellfish	£12,835	6
	Total	£1,104,804	2,167
2017	Demersal	£893,518	695
	Pelagic	£1,875	1
	Shellfish	£101,748	29
	Total	£997,141	725
2016	Demersal	£438,354	392
	Pelagic	-	-
	Shellfish	£98,387	23
	Total	£536,741	415

Figure 4-11 illustrates the average value (£) and effort (kWh) for UK vessels operating mobile gear based on Vessel Monitoring System (VMS) data. The effort and value levels for UK vessels operating mobile gear within the vicinity of the Development are low, with an average of 0 – 100 kWh of VMS effort and £0 - £100 VMS value between 2016 and 2019 (MMO, 2021b). Higher levels of average VMS effort and average VMS value within ICES Rectangle 44F0 to the north of the Development. The most recent VMS data available through Marine Scotland via NMPi, covering vessels operating bottom trawls, dredges and vessels fishing for *Nephrops* and crustaceans with bottom trawls also shows low effort in ICES rectangle 4F30, with areas of higher effort to the north and south in ICES rectangle 44F0 and 42F0 (Marine Scotland, 2021b). Similarly, VMS fishing intensity within 1 km of the oil and gas pipelines in the area (available for years 2007 – 2015) is also low (Marine Scotland, 2017).

VMS data available for EU vessels operating within the North Sea, available through EMODnet, indicates that fishing in the wider area surrounding the Development is mainly performed by bottom otter trawls and pelagic trawls, however, effort at the Development itself is low (EMODnet, 2022a).

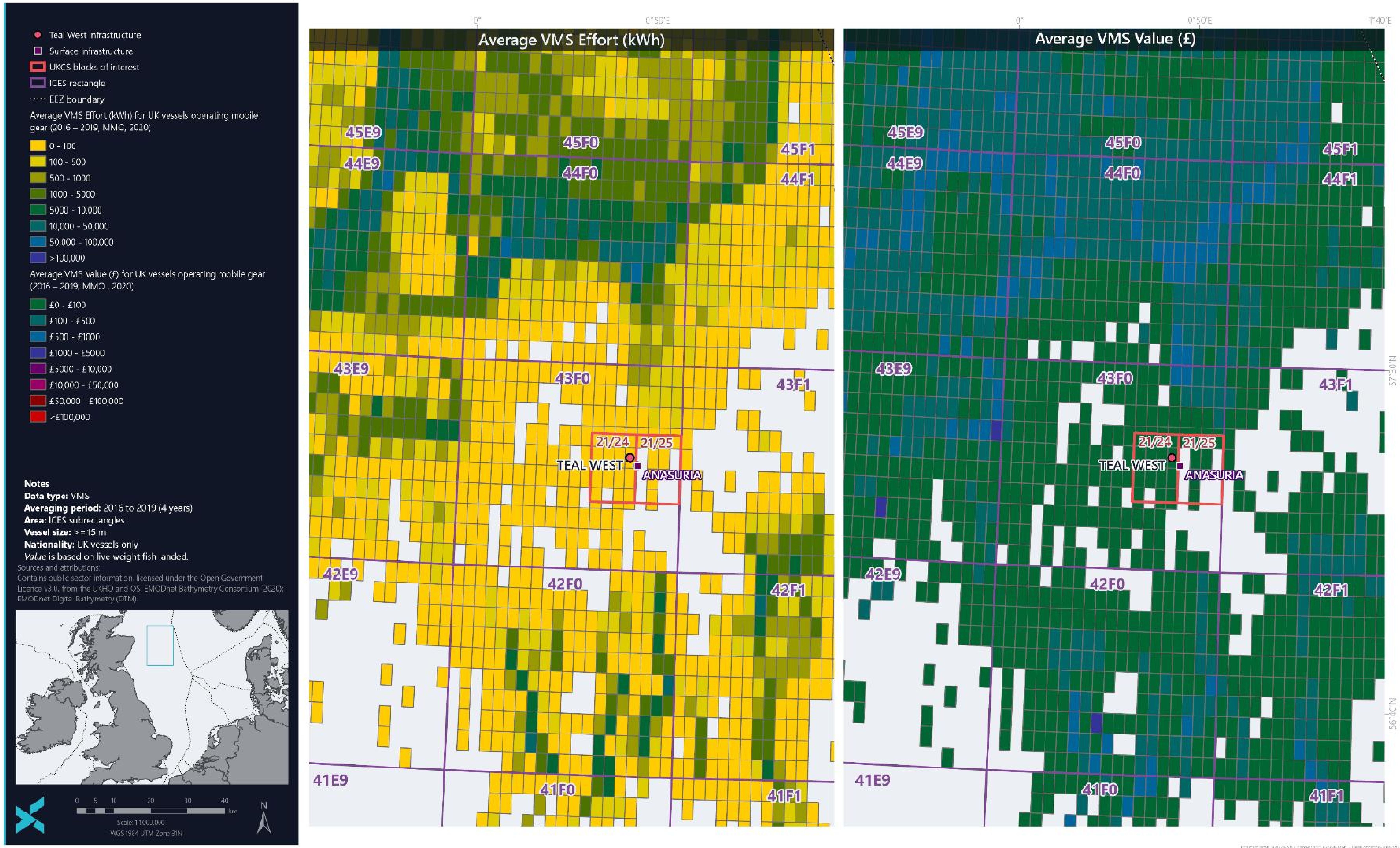


Figure 4-11 - Average VMS value (£) and effort (kWh) for UK vessels operating mobile gear (2016 – 2019) (MMO, 2021b)

Fishing effort (days fished) (all gears) by UK vessels of over 10 m within ICES Rectangle 43F0 is summarised in Table 4-7 -. Fishing effort is largely disclosive in the months of February to May, with fishing effort largely occurring from the months of June to January (Scottish Government, 2021). 2020 saw an increase in fishing effort when compared to previous years, with only two months of disclosive fishing effort in the months of February and April. A total of 107 and 206 days of recorded fishing effort were recorded within ICES Rectangle 43F0 in the years 2019 and 2020 respectively. Lower levels of fishing effort (72 days) occurred in 2018 (Scottish Government, 2021).

Table 4-7 - Days fished (all gears) in ICES rectangles 43F0 between 2016 and 2020 (Scottish Government, 2021)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
2020	14	D	5	D	21	70	13	29	19	9	10	8
2019	19	D	D	-	D	10	D	7	9	6	7	21
2018	8	D	D	D	D	5	D	14	5	7	D	6
2017	D	D	D	-	D	7	17	38	21	3	13	D
2016	19	D	10	D	6	6	D	11	24	6	40	19
Key: green: 0–100 days; yellow: 101–200 days; orange: 201–300 days; red: ≥301 days; D: Disclosive data; - no data.												

4.6.2. Aquaculture

Aquaculture in the North Sea is largely concentrated in Shetland and Orkney with several finfish aquaculture sites also located along the east coast of Scotland and England. The value of aquaculture in this region is lower than the west coast of Scotland where the aquaculture industry forms a key part of the economy (DECC, 2016). Aquaculture is primarily concentrated by the coast and considering the distance of the Development from the nearest coastline, potential significant impacts on aquaculture sites from the Development are unlikely.

4.6.3. Oil and Gas Activities

Other than fishing, the offshore oil and gas industry is the main activity taking place in the CNS region. There is a long history of oil and gas activity in the North Sea, with oil being discovered in the early 1960s and the first well coming online in the early 1970s. Whilst gas activities are most common in the SNS, both oil and gas are found in the central and northern areas. The Development, located in the CNS, is in an area extensively used for oil development (DECC, 2016).

Oil and gas installations within 40 km of the Development are summarised in Table 4-8 and any other wells, pipelines and other subsurface infrastructure are illustrated in Figure 4-12. The nearest surface infrastructure to the Development is the Anasuria FPSO unit that the Teal West production flowline and umbilical will tie-back to, located approximately 3 km to the ESE of the planned VP5 well. There are also several pipelines in the vicinity of the Development, including those associated with the Anasuria FPSO. The production flowline and umbilical will cross the gas lift pipeline from the Anasuria FPSO to the Guillemot manifold (PL1954), operated by Anasuria Operating Company, and the water injection pipeline will cross the production pipeline and gas lift pipeline (piggybacked onto the production pipeline) from Anasuria to the Cook manifold (PL1719), operated by Ithaca, and will tie into an existing Cook Water Injection spool (PL4603). Oil and gas infrastructure within the vicinity of the Development is illustrated in Figure 4-12.

Table 4-8 - Oil and gas surface infrastructure within 40 km of the Development

Asset	Surface Infrastructure	Operator	Approximate distance from the Development (km)
Anasuria	Offloading (FPSO) unit and wave buoy	Anasuria Operating Company	3.0 ESE from production and water injection wells, 0 km from production flowline and umbilical
Gannet A	Platform	Shell	14.2 ESE
Triton	FPSO	Dana Petroleum	20.0 SSE
Kittiwake	Platform	Enquest Heather	26.6 NNW
Arbroath	Platform	Repsol Sinopec	37.1 ENE

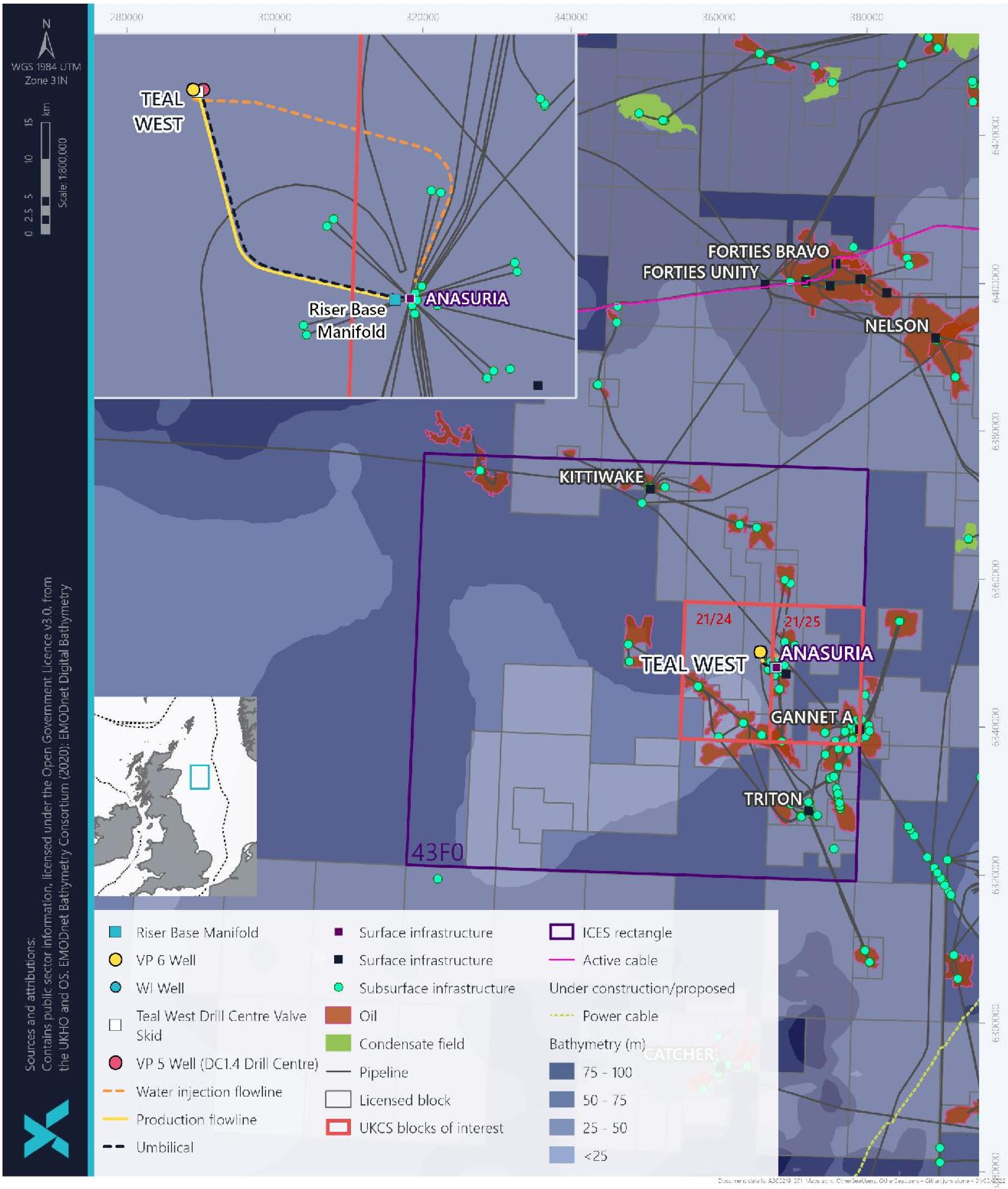


Figure 4-12 - Oil and gas infrastructure in the vicinity of the Development

4.6.4. *Offshore Windfarms*

There are no offshore wind farms in the vicinity of the Development; the closest offshore windfarm is the Seagreen 1 Development, located in the Forth and Tay region at approximately 157 km away. The Development is located within Innovation and Targeted Oil and Gas (INTOG) area E-a.

4.6.5. *Telecommunications and Power Cables*

The Tampnet Central North Sea Fibre Telecommunications Company (CNSFTC) telecommunication cable, operated by Tampnet is the closest subsea telecommunication cable, which is approximately 49 km to the north of the Development. The next closest cable to the Development is the North Sea Link Interconnector, operated by National Grid and Statnett, approximately 50 km to the southeast.

4.6.6. *Military Activities*

Aircrafts, surface crafts and submarines from many countries use the North Sea as a training ground and for routine operations, but the distribution and frequency of these activities is unknown. There are no military restrictions on Blocks 21/24 and 21/25 (Oil and Gas Authority, 2019).

4.6.7. *Shipping*

The North Sea contains some of the world's busiest shipping routes, with significant traffic generated by vessels trading between ports at either side of the North Sea and the Baltic. North Sea oil and gas fields generate moderate vessel traffic in the form of support vessels, principally operating from Peterhead, Aberdeen, Montrose and Dundee in the north and Great Yarmouth and Lowestoft in the south (DECC, 2016).

Blocks 21/24 and 21/25 are considered to be areas of very low shipping activity. Vessel tracks at the Development are patchy and are assumed to be associated with port service craft tracking directly across the Development, with a cluster of non-port service craft activity in the southeast corner of Block 21/25. There are several unknown vessels tracks across the Development area (Oil and Gas Authority, 2016; EMODnet, 2022b).

Most of the vessel activity in the region is service craft associated with oil and gas activities, with vessel tracks concentrated around oil and gas platforms and subsea infrastructure (EMODnet, 2022b). The density of tanker vessels is also relatively high around Anasuria, which is possibly associated with the transport of crude oil from the FPSO via shuttle tankers. Vessels categorised as 'other' are also present within the area, however as these vessels are concentrated around oil and gas platforms and subsea infrastructure, it is likely that these vessels are associated with oil and gas activities (EMODnet, 2022b).

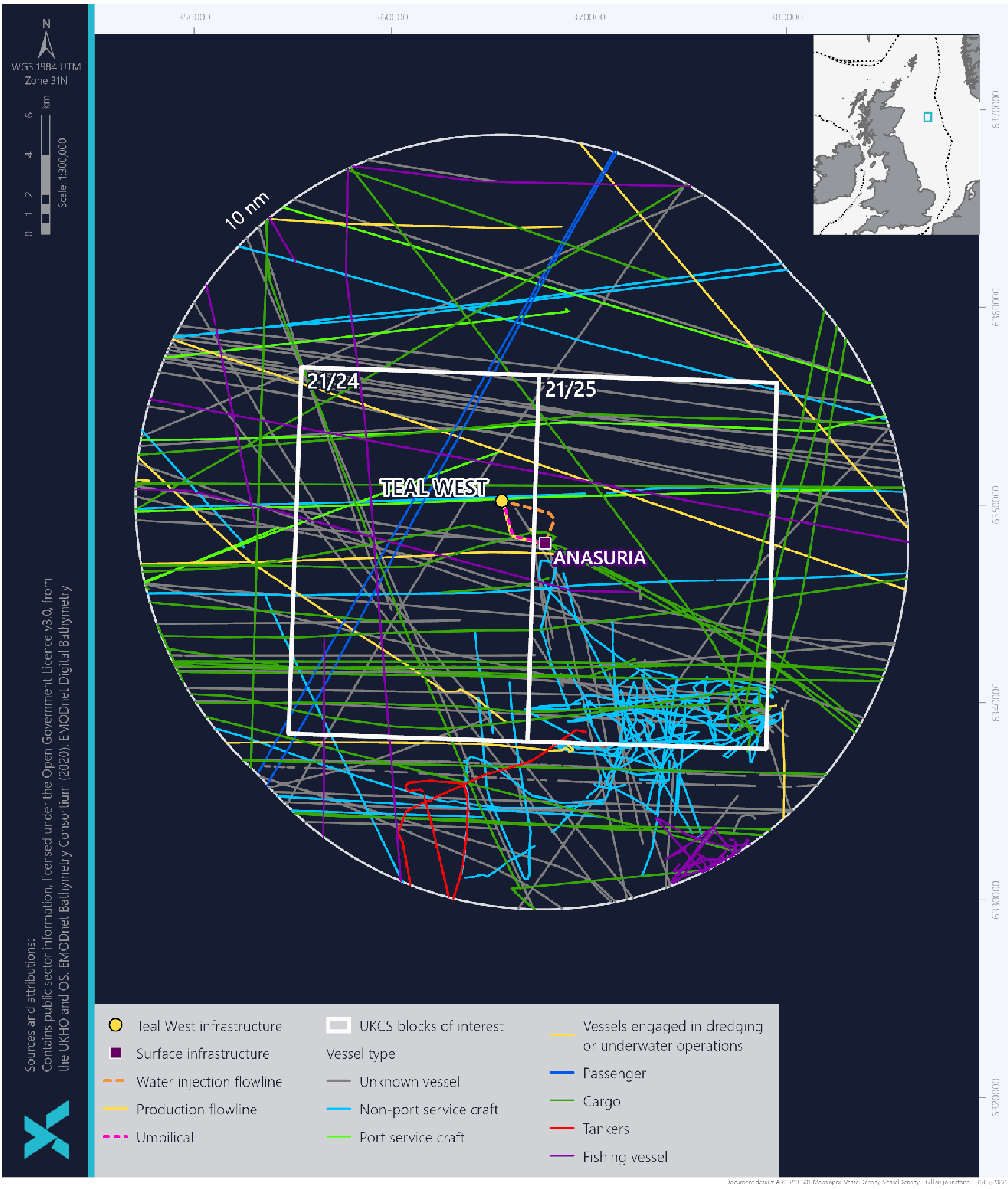


Figure 4-13 - Vessel tracks within the vicinity of the Development

4.6.8. Archaeology

There are a number of wrecks within the vicinity of the Development, as summarised in Table 4-9 -. All wrecks located within 40 km of the Development are classified as non-dangerous wrecks. The closest wreck to the Development is located 2.9 km to the south-southeast; the identity of this wreck is unknown. The closest known wreck to the Development is Zephyus, lying approximately 5.2 km to the west-southwest.

Table 4-9 - Wreck sites located within the vicinity of the Development (UKHO, 2020)

Wreck ID	Distance and bearing from the Development (km)
Unidentified non-dangerous wreck	2.9 SSE
Zephyrus	5.2 WSW
Unidentified non-dangerous wreck	6.6 WSW
Unidentified non-dangerous wreck	10.8 SSW
Unidentified non-dangerous wreck	12.3 SSE
Unidentified non-dangerous wreck	14.9 ENE
Compaganus	15.4 ESE
Unidentified non-dangerous wreck	17.5 km SSE
Unidentified non-dangerous wreck	17.7 WSW
Sendinjen	19.3 SSW
Budding Rose	20.0 ESE
Sirius (probably)	21.2 WNW
Unidentified non-dangerous wreck	22.9 ENE
Unidentified non-dangerous wreck	24.7 WNW
Unidentified non-dangerous wreck	27.8 ENE
Progress	31.8 SSW
Unidentified non-dangerous wreck	34.6 SSE
Unidentified non-dangerous wreck	36.0 NNE
Unidentified non-dangerous wreck	36.4 SSE
Unidentified non-dangerous wreck	37.7 ESE

4.7. Future Marine Climate

This section summarises the current evidence and future predictions for marine climate change, based on outputs from the Marine Climate Change Impacts Partnership (MCCIP) and other publicly available data sources. The MCCIP publishes evidence reviews and summaries on marine climate change, focused on the UK, including regions such as the North Sea, the Celtic Sea, the Irish Sea, the English Channel and the North Atlantic (MCCIP, 2022).

The MCCIP reports summarise the current evidence for climate change, based on observed and modelled trends in climate data and the physical, biological and socio-economic environment. In addition, they also provide future predictions for the physical, biological and socio-economic environment, based on modelled climate projections. The emissions scenarios used for climate projections differ between the different modelling studies reviewed within the MCCIP report. Details are provided within each topic section below. Generally, the future predictions are provided for 2100.

The key uncertainties / difficulties associated with predicting the impact of climate change on the physical, biological and socio-economic environment include:

- Uncertainty in the modelled predictions – based on the uncertainty around the future emissions scenario as well as an uncertainty in other model inputs (e.g. current conditions, parameters etc.);
- Uncertainty around the response of the physical, biological and socio-economic environment to changes in climate variables; and
- Difficulties in attributing changes in the physical, biological and socio-economic environment to climate change.

4.7.1. Physical Environment

Storms and Waves

Analysis of observed and modelled wind and wave data can be used to identify long-term trends in weather patterns. The frequency and intensity of storms within the north of the Atlantic Ocean is increasing, with a much weaker trend observed in the UKCS. However, there is a low confidence in attributing these changes in weather patterns to climate change and the high degree of variability in the data also creates difficulties in identifying trends over time. Time-series data on mean significant wave height, also shows an increase in wave heights in the northeast of the Atlantic Ocean, mainly attributed to Atlantic swell rather than increased wind speeds (Wolf *et al.*, 2020).

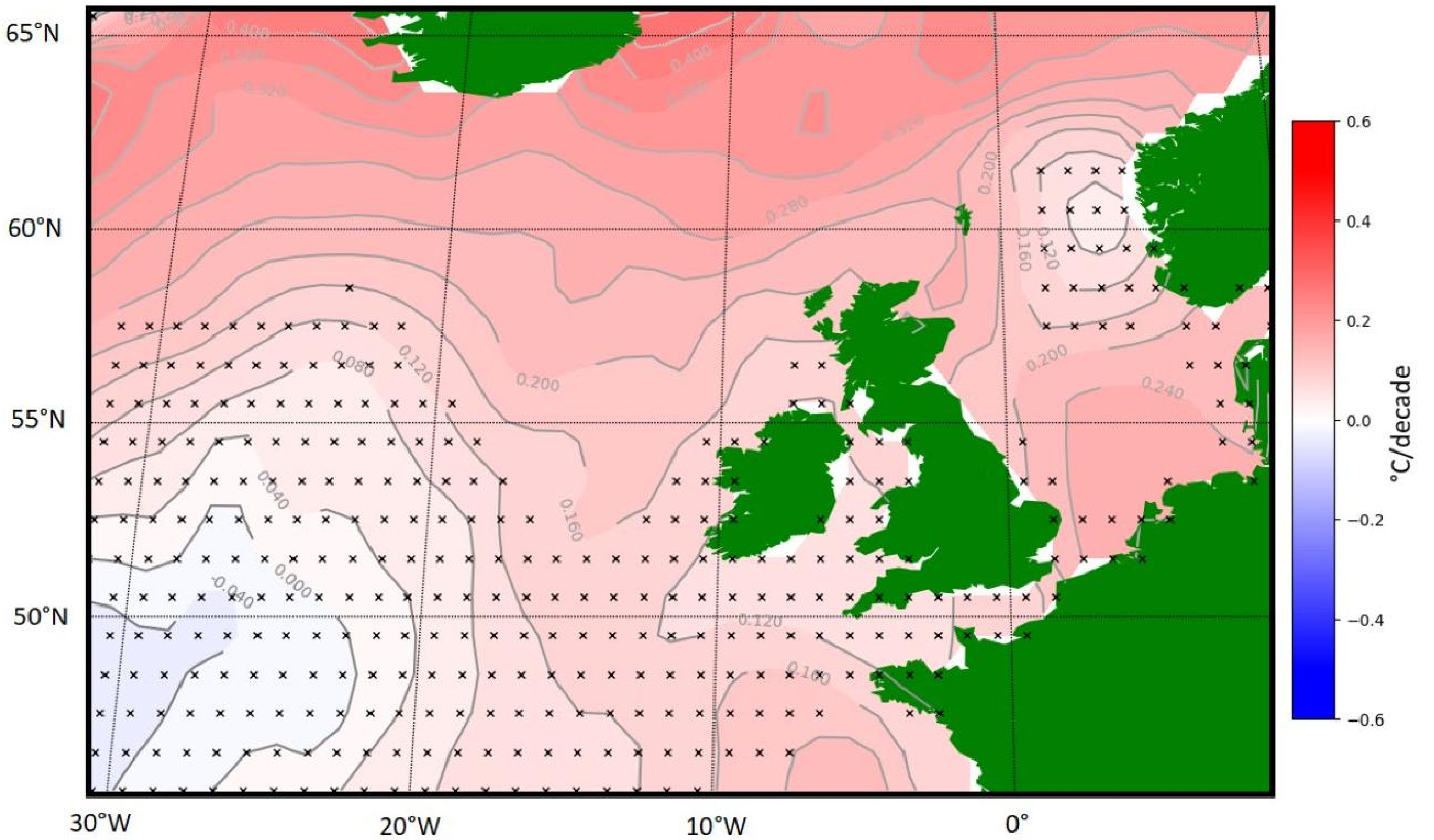
Future predictions for storms and waves are uncertain, and it is expected that natural variability will continue to account for trends observed in the frequency and intensity of waves and storms. In addition, the low confidence in attributing past trends in weather patterns to climate change also presents difficulties in adequately predicting future long-term trends. Nevertheless, it is possible that climate change may influence storm tracks with knock-on effects on winds and wave heights. Climate projections, under the Representative Concentration Pathway (RCP) 8.5 (high emissions scenario), indicate that there may be a reduced frequency in storms and a change in storm tracks, although there is considerable uncertainty in these predictions. It is also predicted that there will be an overall reduction in mean significant wave height, combined with an increase in the mean annual maximum wave height by 0.5 m (i.e. larger waves less frequently) and that wave heights to the north of the UK will increase as a result of a retreating Arctic sea ice (Wolf *et al.*, 2020).

Overall, there is considered to be a low confidence in the future predictions for storms and waves (Wolf *et al.,* 2020).

Sea Surface and Near-Bottom Temperature

Temperatures in the North Sea have generally been increasing since the 1980's. This warming has been interspersed with short-term regional trends of decreasing sea-surface temperatures; however, recent trends (between 2014 and 2017) have seen increases in sea-surface temperatures across all regions of the UKCS (Tinker and Howes, 2020).

Tinker and Howes (2020) analysed the warming of sea-surface temperatures over ~ 30 years (1988 – 2017) (Figure 4.14 - Trend in average sea-surface temperature (°C per decade) (1988 – 2017). Crosses indicate an insignificant increase in sea-surface temperature (Taken from Tinker and Howes, 2020)). The analysis indicates that observed increases in sea-surface temperatures were strongest in the waters to the North of



Scotland (north of Caithness and Sutherland) and in the North Sea, where temperature have increased by up to 0.24 °C per decade (Tinker and Howes, 2020).

Figure 4.14 - Trend in average sea-surface temperature (°C per decade) (1988 – 2017). Crosses indicate an insignificant increase in sea-surface temperature (Taken from Tinker and Howes, 2020)

It is predicted that increases in sea-surface temperatures by 2100 in the North Sea may range from 1 – 4°C (depending on the area and the climate model used). Tinker *et al.,* (2016) simulated increases in sea-surface and near-bottom temperature under 11 different Atmosphere-Ocean General Circulation Models, which represent the physical processes which drive climate change, focussing on the changes in temperature between the 1960 – 1989 and 2069 – 2098 periods under a medium emissions scenario (Special Report

Emissions (SRE) A1B[6]). The purpose of this was to account for the uncertainty in model projections, by reporting the mean value across the different models along with the standard deviation across the projected simulations. The predicted increase in sea-surface temperature and near-bottom temperature for the North Sea is provided in Table 4-10. This increase represents the predicted difference between 1960 – 1989 and 2069 – 2098 (Tinker and Howes, 2020).

Table 4-10 Predicted increases in sea surface and near-bottom temperatures (comparing the 1960 – 1989 and 2069 – 2098 period) (Tinker *et al.*, 2016)

Region	Sea Surface Temperature	Near-Bottom Temperature
Northern North Sea	2.75°C (±0.75°C)	2.53°C (±0.63°C)
Central North Sea	3.15°C (±0.75°C)	2.92°C (±0.63°C)
Southern North Sea	3.26°C (±0.72°C)	3.22°C (±0.71°C)

The confidence in these predictions is high (Tinker and Howes, 2020).

Stratification, Dissolved Oxygen and Salinity

There is some evidence that the timing of thermal stratification has changed over time, with a trend for earlier stratification (i.e. stratification beginning earlier in the year) across the North Sea. At present, there is no indication that this trend will be sustained or that this trend is beyond what would be expected from natural variability (Sharples *et al.*, 2020). However, based on modelled climate projections based on the Special Report Emissions Scenario (SRES) A1B emissions scenario, it is predicted that stratification across UKCS will occur one week earlier by the end of 2100 and that the breakdown of seasonal stratification will occur 5 – 10 days later than present, mainly attributed to increases in air temperature. Additionally, when the RCP 8.5 emissions scenario is considered, it is predicted that the UKCS will become more strongly stratified, as a result of changes in seasonal heating cycles, and this could reduce upward mixing of nutrients and therefore lead to reduced primary production (Sharples *et al.*, 2020).

Within the North Sea, declines in dissolved oxygen levels have been documented in late summer, although no hypoxic conditions have been observed. Ocean warming is expected to account for one third of the decrease in dissolved oxygen levels (due to reduced solubility of oxygen), with the remaining declines being attributed to increased biological oxygen consumption. Dissolved oxygen concentrations are expected to continue to decline through to the end of the century in the North Sea, by up to 11.5% when the period 2090 – 2100 is compared with the period 2000 to 2010 under the SRES A1B emissions scenario (Mahaffey *et al.*, 2020).

Salinity has also shown a general decrease in the west of the UKCS in the last five years, although this trend is weaker in other regions of the UKCS, such as the North Sea, where there is no clear long-term trend (Dye *et al.,* 2020). When the SRES A1B emissions scenario is considered, it is predicted that waters will be less saline in the North Sea by 2100 due to ocean circulation changes driven by climate change (Dye *et al.*, 2020). This trend is weaker in waters to the southwest of the UKCS in the Celtic Sea, Irish Sea and English Channel. The predicted change in salinity is presented in Table 4-11.

Table 4-11 Predicted increases in sea surface and near-bottom salinity (comparing the 1960 – 1989 and 2069 – 2098 period (Tinker *et al.*, 2016)

Region	Surface Salinity (Change In Practical Salinity Unit (Psu))	Near Bottom Salinity (Change In Psu)

[6] *Details on the SRES A1B scenario are available here: https://www.ipcc.ch/site/assets/uploads/2018/03/emissions_scenarios-1.pdf. These have now been superseded by RCP emissions scenarios. SRES A1B is an 'on balance' emissions scenario in a world of rapid economic and population growth, where no one energy source is relied on too heavily.*

Northern North Sea	-0.51 (±0.61)	-0.49 (±0.58)
Central North Sea	-0.48 (±0.53)	-0.47 (±0.48)
Southern North Sea	-0.62 (±0.65)	-0.52 (±0.52)

Ocean Acidification

Ocean acidification is also an impact of climate change which alters the physical properties of the ocean with potential impacts on marine biota. Ocean acidification occurs as increases in anthropogenic carbon dioxide (CO_2) absorbed by the ocean causes a decline in Ph.

One quarter of atmospheric CO_2 is absorbed by the ocean. When CO_2 is absorbed by the ocean, hydrogen ions are released (which therefore reduces Ph) and are available to bond to carbonate ions, which consequently reduces the concentration of carbonate ions available for calcifying organisms. This also reduces the potential for the ocean to absorb and store atmospheric CO_2 in the future.

Atmospheric CO_2 now exceeds 400 parts per million (ppm) (increase of 2.3 ppm per year over between 2010 – 2020). Evidence of ocean acidification has been documented in the Atlantic Ocean which has sustained a decrease in Ph at a rate of 0.0013 per year between 1995 and 2013. Measurements at Stonehaven, on the east coast of Scotland, between 2009 and 2013 showed that the Ph declined by 0.1 in this time period, with the reduction being most evident in summer between March and August (Humphreys *et al.,* 2020).

Under a high-emissions scenario (RCP 8.5), Ph in the UKCS could decrease at a rate of 0.0036 per year (Ph in 2100 of 0.366). This decrease in Ph is expected to vary by location, with the greatest decline occurring in coastal areas such as Bristol Channel, Moray Firth, Celtic Sea and the Inner Hebrides (Humphreys *et al.,* 2020).

The confidence in the predictions is medium (Humphreys *et al.*, 2020).

4.7.2. Biological Environment

The biological environment may be affected by changes in the physical environment, including temperature increases and changes in storm frequencies. Indirect impacts of climate change may also arise through changes in habitats and predator-prey relationships.

Changes in species composition have been documented and may be linked to the thermal affinities of species (e.g. cold or warm-water species). For instance, declines in cold-water species, such as large brown algae, has occurred in the south of the UK, whereas warm-water kelp species (*Laminaria ochroleuca*) have increased in abundance (Mieskowsa *et al.,* 2020; Moore and Smale, 2020). A shift in the distribution of mobile species has also been observed in recent years, potentially linked to changes in temperature. The cold-water zooplankton species, *Calanus finmarchicus,* has declined by over 70% in the North Sea since the 1960's, whereas the distribution of warm-water species, such as *Calanus helgolandicus*, is shifting northwards (Edwards *et al.*, 2020). Similarly, increases in warm-water fish species (e.g. bluefin tuna (*Thunnus thynnus*)) has been documented, as well as shifts in the timing of fish spawning, hatching and migration. Physiological impacts as a result of increased temperatures and reduced oxygen levels may also reduce fish growth as a result of increased metabolic costs (Wright *et al.,* 2020). The impacts on plankton and fish may indirectly affect predator species, such as seabirds and marine mammals (Mitchell *et al.,* 2020). Additionally, a shift in marine mammal distributions has also been observed with northward shifts of warm-water species such as short-beaked common dolphin (Evans *et al.,* 2020).

The species of conservation interest present at the Development include:

- Qualifying features of the East of Gannet and Montrose Fields NCMPA, including ocean quahog and offshore deep sea muds;
- Seapens and burrowing megafauna;
- Offshore subtidal sands and gravels; and
- Submarine structures made by leaking gases.

The benthic communities associated with offshore deep sea muds, offshore subtidal sands and gravels and submarine structures made by leaking gases may undergo changes in response to, or as a consequence of, climate change. For example, evidence exists to suggest that North Sea infaunal species have shifted their distributions in response to changing sea temperature. However, most species have not been able to keep pace with shifting temperatures meaning that they are subjected to warmer conditions which may be unfavourable. It is predicted that there changes in the distribution and abundance of benthic communities may continue, although this will be species-dependent (Moore and Smale, 2020).

The sensitivity of ocean quahog and seapens and burrowing megafauna to increased temperature, decreased salinity, de-oxygenation and ocean acidification is presented in Table 4-12. Increased temperatures may affect ocean quahog recruitment, and ocean quahog are mainly found in northerly latitudes. It is expected that larvae and juveniles are tolerant to temperatures up to 20°C and adults are tolerant of temperatures up to 16°C. Long-term increases in temperature may result in increased mortality in the summer months (Tyler-Walters and Sabatini, 2017). The approximate near-bottom temperature at the Development is 7 – 10 °C and with an expected 2.8°C increase in temperatures in the North Sea for the 2069 – 2098 period when compared to 1960 – 1989 (see Section 4.7.1), the near-bottom temperature is still expected to be below 16°C by the end of the century. Furthermore, within the timeframe of the Development, the magnitude of climate change is expected to be significantly less than what was described in Section 4.7.1.

Increased temperature may also affect seapens. However, seapens and burrowing megafauna are abundant throughout the UK and are *P. phosphorea* are present in the Mediterranean, indicating some tolerance to increased temperatures. The sensitivity of seapens to increasing temperature is recorded as medium in the Marine Life Information Network (MarLin) sensitivity assessment, however, it is expected that this species will be able to tolerate the temperature increases predicted for Scotland (Hill *et al.*, 2020). Seapens and burrowing megafauna are also potentially sensitive to decreases in salinity. *P. phosphorea* are mainly found in deeper and unexposed habitats, suggesting an intolerance to increases in salinity. However, there is limited empirical evidence for the sensitivity of *P. Phosphorea* to decreased salinity and it is expected that the predicted change in salinity of < 1 PSU is unlikely to have a significant impact on this species. Lastly, seapens and burrowing megafauna are also potentially sensitive to de-oxygenation, but again the empirical evidence for this is lacking (Hill *et al.*, 2020). This is considered to be most relevant to hypoxic or anoxic conditions which are not predicted to occur.

Table 4-12 Sensitivity of ocean quahog and seapens and burrowing megafauna to increased temperature, decreased salinity and de-oxygenation (Tyler-Walters and Sabatini, 2017; Hill *et al.*, 2020)

Pressure	Sensitivity	
	Ocean quahog	Seapens and burrowing megafauna
Temperature increase	Medium	Medium
Salinity decrease	Not sensitive	High
De-oxygenation	Not sensitive	Medium

Ocean acidification	N/A	Not sensitive

4.7.3. Socio-Economic Environment

Impacts on the physical and biological environment may also affect human activities in the marine environment. For instance, any impacts on fish stocks will indirectly impact commercial fishing activity, potentially reducing the abundance of species or altering species composition. However, determining the causal factors for these changes is difficult when other factors also influence fish stocks (Pinnegar *et al.*, 2020).

5. EIA METHODOLOGY

5.1. Overview

Offshore activities can involve a number of environmental interactions and impacts due, for example, to operational emissions and discharges and general disturbance. The objective of the EIA process is to incorporate environmental considerations into the Development planning, to ensure that Best Environmental Practice (BEP) is followed and, ultimately, to achieve a high standard of environmental performance and protection. The process also allows for any potential concerns identified by stakeholders to be addressed appropriately. In addition, it ensures that the planned activities are compliant with legislative requirements and AHUK's HSSE policy.

5.2. Identification of Environmental Issues

An EIA is to be focused on the key issues related to the specific activities proposed; the impact assessment write-up should be proportionate to the scale of the development and to the environmental sensitivities of the development area. AHUK undertook an impact identification exercise to identify key environmental sensitivities, discussed sources of potential impact (including an environmental issue identification (ENVID) workshop) and identified those sources which required further assessment. The decision as to which issues required further assessment was based on the specific proposed activities and environmental sensitivities, a review of industry experience of EIA outcomes and on an assessment of wider stakeholder interest. The key issues identified are summarised below and described in more detail in Section 5.7:

- Discharges to sea;
- Seabed disturbance;
- Underwater noise;
- Interaction with other sea users;
- Atmospheric emissions; and
- Accidental Events.

The impact identification process was kept under review throughout the EIA, with mitigation revised as understanding of the Development increased.

5.3. Scoping and Consultation

To solicit feedback on the Development, AHUK issued a Scoping Letter to relevant stakeholders, which outlined the proposed activities and EIA scope and requested feedback on the proposals. Marine Scotland, JNCC the Maritime and Coastguard Agency (MCA) also provided comments to AHUK. OPRED, Marine Scotland and JNCC attended a Scoping Meeting in April 2022.

Overall, MCA, JNCC and Marine Scotland are satisfied with the proposed approach to the EIA, the key environmental issues and potential impacts identified for assessment, and the supporting studies proposed to facilitate the assessment. The issues raised by the consultees have been considered and addressed during the course of the EIA to date. A complete list of scoping comments and responses are provided in Table 5-1.

Table 5-1 – Scoping comments and responses

Issues Raised	Comments on Issues Raised and Environmental Impact Assessment Report (EIAR) section in which addressed
Marine Scotland	
The scoping report does not make reference to Scotland's National Marine Plan (https://www.gov.scot/publications/scotlands-national-marine-plan/). Marine Scotland Science (MSS) advise that the ES demonstrates how the project is aligned with the general policies outlined in Chapter 4 of the National Marine Plan and the sector specific oil and gas policies outlined in Chapter 9.	National Marine Plan is referenced in the Introduction, Section 1.5.3
It is not clear to MSS whether all phases of the development will be considered in the proposed ES or whether these will be applied for under a future ES or amendment.	All phases of development are considered in the ES, including decommissioning
MSS advise the ES demonstrates that the technology used in drilling of the wells represents the Best Available Technology (BAT) The ES should consider whether the sediment type at the site lends itself to new technologies for the conductor sections that would reduce the amount of cuttings and discharge of cement to the seabed	Justification for the drilling technology being used is covered in Section 3.2.3
It is noted that cement discharges are not listed in the potential environmental impacts and risks and MSS advise that any impacts from cement discharges are assessed.	Cement use and disposal is described in Section 3.2.6 and discussed in Section 5 and Section 6
MSS advise the ES discusses whether the produced hydrocarbons are similar in nature to those already being produced at the FPSO with a high level summary of any anticipated changes to chemical usage as a result of this development. MSS understand that produced water will be treated to regulatory standards prior to being discharged.	Nature of the produced hydrocarbons is discussed in Section 3.4 and chemical use is discussed in Section 3.4.7
It is not clear from the document why different routes are proposed for the production and water injection pipelines. Where possible MSS advise pipelines are routed together (in common trenches where technically feasible) in order to minimise seabed disturbance. It is noted that a number of pipeline crossings are likely for the proposed water injection pipeline route which will require protective materials. MSS advise that crossings are minimised where possible. MSS advise the ES fully justifies the chosen option and provides an assessment of alternatives considered.	The route for the WI flowline is dictated by the tie-in point offered by AOC. AHUK intends to use the existing Teal/Cook water injection riser, rather than install an additional riser.
It is not clear at this stage what material the pipelines will be constructed from. As the possibility of upheaval buckling is mentioned, MSS advise that pipelines are designed to minimise the effects of upheaval buckling and the potential use of rock. MSS advise that the use of protective materials are minimised as far as possible and that impacts associated with all protective materials should be fully assessed, taking account of the ability to decommission these in the future. A robust worst case assessment for protective materials should be provided in the ES. It is not clear from the scoping document whether the production pipeline is designed to be piggable. MSS advise the ES considers whether there are any specific management requirements of the produced hydrocarbons that may impact the pipeline operation / integrity.	The pipelines will be flexible rather than rigid pipe construction. UHB is less likely in flexibles but it is not unheard of. Under certain circumstances we have a relatively hot pipeline. The UHB analysis makes certain assumptions as to the (un)evenness of the cut trench and the potential for UHB trigger points. This will be re-visited post installation to determine if the assumptions

Issues Raised	Comments on Issues Raised and Environmental Impact Assessment Report (EIAR) section in which addressed
	made remain valid. Rock dump will be used sparingly if at all.
The document identifies the presence of MDAC structures in the area. Given the potential conservation value of these features, MSS advise and that further consultation is held with the JNCC on the appropriateness of the site survey and to ensure potential impacts on these features are assessed appropriately. MSS advise the location of MDAC structures identified are clearly shown on a map.	Correspondence with Fugro confirm that the areas of potential MDAC are outwith the vicinity of any Teal West infrastructure
The field is located in relatively shallow waters (87-92 m) and the scoping report correctly identifies high intensity sandeel spawning in this area. Sandeel lay their eggs on the seabed and show a high degree of site fidelity. As such, this species is particularly vulnerable to anthropogenic disturbance. MSS advise the ES refers to the Feature Activity Sensitivity Tool (FEAST – http://www.marine.scotland.gov.uk/feast/) when considering the potential impacts on this species.	FEAST is referred to when considering impacts on sandeels in Section 6.3.1
Sandeel prefer spawning substrate with a low clay silt fraction (<10%) in water depths between 20 and 100 m. MSS advise the ES provides a summary of any particle size analysis conducted of the sediments to allow a better understanding of the potential suitability of the sediments in the area for sandeel spawning. The ES should also state whether this species was observed in any of the site surveys undertaken. MSS advise that site specific information is compared to the following reports: Lancaster, J. (Ed.), McCallum, S., Lowe A.C., Taylor, E., Chapman A. & Pomfret, J. (2014). Development of detailed ecological guidance to support the application of the Scottish MPA selection guidelines in Scotland's seas. Scottish Natural Heritage Commissioned Report No.491. Sandeels – supplementary document (Available from NatureScot) and Mazik, K., Strong, J., Little, S., Bhatia, N., Mander, L., Barnard, S. & Elliott, M. (2015). A review of the recovery potential and influencing factors of relevance to the management of habitats and species within Marine Protected Areas around Scotland. Scottish Natural Heritage Commissioned Report No. 771. Available online at https://www.nature.scot/snh-commissioned-report-771-review-recovery-potential-and-influencing-factors-relevance-management.	Particle size analysis is discussed in Section 3.2.3
MSS advise reference to the following paper (José M. González-Irusta, Peter J. Wright; Spawning grounds of Atlantic cod (Gadus morhua) in the North Sea, ICES Journal of Marine Science, Volume 73, Issue 2, 1 February 2016, Pages 304–315, https://doi.org/10.1093/icesjms/fsv180) which provides an update to the cod spawning areas.	This reference has been used in relation to cod spawning areas in Section 6.3.1
Nephrops norvegicus are also identified in the area and MSS advise reference to the following sensitivity review for this species https://www.marlin.ac.uk/species/detail/1672	MarLin reference in regards to Nephrops is used in Section 3.6.1
There is no mention of cumulative impacts in the scoping report and MSS advise that potential cumulative impacts are fully assessed.	Cumulative impacts are discussed in each of the individual impact chapters

Issues Raised	Comments on Issues Raised and Environmental Impact Assessment Report (EIAR) section in which addressed
Decommissioning is not mentioned in the scoping document and should be fully considered in the ES. MSS advise that the ES should demonstrate the ability to remove infrastructure and any protective material should this be the policy in place at the time, or the preferred outcome of a comparative assessment process. MSS advise that the ES also considers the impact this project may have on decommissioning timescales and requirements of other developments connected or impacted by this development.	Decommissioning is discussed fully in Section 3.6 and also in Section 6.6
MSS advise that the chosen options for the various elements of the project are fully justified and it is demonstrated that these represent Best Available Technology (BAT) and Best Environmental Practice (BEP) and take account of decommissioning.	A discussion on the alternatives for the proposed project is provided in Section 2
Details of how other adjacent pipelines and cables are laid is advised.	Details of pipeline / cable laying is outlined In Section 9
Figure 2 showing the pipeline routes would benefit from improved clarity as it is not possible to distinguish between routes C and F. It is not clear what routes D and F relate to.	A revised Field Layout drawing is available AHUK-TW-TW-ENG-DE-001-01/02.
An upfront description of the surveys used in support of the development should be provided. This should include detail of the methods used and justification for the location of sampling stations.	Surveys are discussed in Section 3.2.3.
A local scale bathymetry map for the development area is advised, highlighting any significant seabed features.	Bathymetry map is shown in Section 3.2.2 (Figure 3.1)
The physical characteristics of the environment at the location should be fully described and include, for example, information on currents, wind speed, wave height / power, temperature and salinity. The MS MAPS NMPi: https://marinescotland.atkinsgeospatial.com/nmpi/ is a useful source of information.	Physical environment is discussed fully in Section 3.2
MSS has recently added new spatial layers to the Marine Scotland MAPS NMPi showing predicted seabed habitats (https://marine.gov.scot/maps/68) and sediment types (http://marine.gov.scot/maps/745) which are advised, to provide additional regional context. These spatial layers may be viewed on the Marine Scotland MAPS NMPi web site : https://marinescotland.atkinsgeospatial.com/nmpi/	Seabed habitats / sediment types are shown in Figure 3.2 in the ES
MSS advise that good quality, high resolution images of the local sediment / benthic community, are included in the ES. These should ideally be labelled with a description of the features and fauna observed, provide some scale and be linked to a location on the map.	Seabed habitats / sediment types are shown in Figure 3.2 in the ES
A summary of any particle size analysis and contaminant analysis of sediments should be provided.	Particle size analysis is discussed in Section 3.2.3
MSS advise that ES includes baseline data on plankton and considers any potential impacts on plankton. Useful information is available in the Strategic Environmental Assessment (OESEA3) (https://www.gov.uk/government/consultations/uk-offshore-energy-strategic-environmental-assessment-3-oesea3) and Appendix 1a.1.	Baseline on plankton is discussed in Section 3.3.1
MSS advise that a biotope classification is assigned for the area in accordance with the EUNIS / JNCC indices.	Biotope classification is discussed in Section 3.2.3 and Section 3.3.2

Issues Raised	Comments on Issues Raised and Environmental Impact Assessment Report (EIAR) section in which addressed
Where species of conservation concern or species indicative of habitats of conservation concern are identified, it is advised that the abundance of animals is discussed in accordance with the SACFOR abundance scale (https://mhc.jncc.gov.uk/media/1009/sacfor.pdf).	Habitats of concern and the SACFOR abundance scale is discussed in Section 3.5.2
A basic assessment of the spawning habits and preferred habitats of the main species identified, as compared to the conditions experienced locally, may highlight additional mitigation opportunities.	Spawning habitats discussed in Section 3.3.3
Reference to the following report is advised, which provides a modelled spatial representation of the probability of presence of 0 age group fish (fish in the first year of their life) and the probability of aggregations of 0 age group fish. It is recommended these data are presented visually in conjunction with the Coull et al (1998) and Ellis et al (2012) nursery maps, as there are certain limitations with the data (please see here for full report – (https://data.marine.gov.scot/dataset/updating-fisheries-sensitivity-maps-british-waters) (DOI: 10.7489/1555-1). The report should be cited as; Aires, C., González-Irusta, J.M., Watret, R (2014) Scottish Marine and Freshwater Science Report, Vol 5 No 10, Updating Fisheries Sensitivity Maps in British Waters. Further details are available here: (http://marine.gov.scot/node/12828).	Coull et al.(1998), Ellis et al. (2012) and Aires (2014) have been used and cited in Section 3.3.3
The section states “February, March, April and June in 2019 and February and April in 2020, all record disclosive effort..” It is advised, however, that February, March, May and July were disclosive with no data recorded for April.	This has been reflected Table 3.8 in Section 3.6.1
New aggregated VMS fishing effort data sets for 2010 – 2020 are now available on the National Marine Plan Maps interactive web site (NMPi). The data are split into three groups of fishing method: bottom trawls, dredges and crustaceans caught by bottom trawl (i.e. Nephrops). Further information may be obtained here http://marine.gov.scot/node/12832. Map layers showing average annual fishing effort (Mw fishing hours) in the Greater North Sea Ecoregion during 2015–2018 are also available via EMODNET. Data are split by gear type: beam trawls, bottom otter trawls, bottom seines, dredges, pelagic trawls and seines and static gears. Further information is available here: https://www.emodnet-humanactivities.eu/view-data.php.	This data is discussed in Section 3.6.1
MSS also advise visual representation of the recently added nine new spatial layers to the NMPi showing changes over the last five years of published statistics for: 1. tonnage for demersal, pelagic and shellfish species; 2. value (£) for demersal, pelagic and shellfish species; 3. effort (days) (by UK vessels >10m length) for demersal active (bottom trawls, dredges etc.); pelagic active (pelagic trawls, purse seines etc.); and passive (pots/creels, gillnets etc.).	This data is visually represented in Section 3.6.1 (Figure 3.10)
Tabulated fisheries statistics are advised in addition to any graphics provided.	Fisheries statistics are provided in Tables 3.7 and 3.8
MSS advise that the location of existing oil and gas infrastructure and previously drilled wells in the area is shown. The North Sea Transition Authority quadrant maps would be a useful addition (https://www.nstauthority.co.uk/data-centre/nsta-open-data/pdf-maps/).	Existing oil and gas infrastructure is visually presented in Figure 3.11 (Section 3.6.3)

Issues Raised	Comments on Issues Raised and Environmental Impact Assessment Report (EIAR) section in which addressed
MSS advise that the Sectoral Marine Plan for Offshore Wind Energy 2020 areas (http://marine.gov.scot/information/sectoral-marine-plan-offshore-wind-energy-plan-options), the Sectoral Marine Plan for Offshore Wind INTOG areas (https://marine.gov.scot/information/sectoral-marine-plan-offshore-wind-innovation-and-targeted-oil-and-gas-decarbonisation) and the ScotWind option agreement offer areas as of February 2022 (http://marine.gov.scot/node/15039) are taken into account.	No offshore wind farms within 150 km of the development
Where there is potential for shoreline oiling on the Scottish coastline as a result of an accidental event scenario, MSS advise that impacts on aquaculture and Shellfish Water Protected Areas are considered. The following information sources are advised: The National Marine Plan interactive (https://marinescotland.atkinsgeospatial.com/nmpi/); • Shellfish Water Protected Areas (https://www.gov.scot/policies/water/protected-waters/); • Scotland's Aquaculture website (http://aquaculture.scotland.gov.uk/map/map.aspx); • The Scottish Shellfish Farm Production survey 2020 (https://www.gov.scot/publications/scottish-shellfish-farm-production-survey-2020/) (These statistics are usually published in May each year); • The Scottish Finfish Farm Production survey 2020 (https://www.gov.scot/publications/scottish-fish-farm-production-survey-2020/) (These statistics are usually published in September each year).	Aquaculture impacts from accidental releases are discussed in Section 10.6.6
MSS welcome that modelling work is proposed to demonstrate the impact areas associated with drilling the wells. MSS would like to highlight that impact areas associated with disturbance of sediments during pipeline installation should also be considered. In the event that there is insufficient evidence or literature to support this, modelling work may be useful.	Impacts on sediment from pipeline installation is discussed in Section 6.5
The EIA strategy section discusses 'disturbance to seabed' but no specific reference to impacts associated with protective materials is made.	Discussed in Section 8.4.3
When discussing potential impacts on species or habitats of conservation concern, MSS advise that the Feature Activity Sensitivity Tool – FEAST (http://www.marine.scotland.gov.uk/feast/) and MarLin sensitivity reviews (https://www.marlin.ac.uk/sensitivity/sensitivity_rationale) are referred to.	FEAST is referred to in Section 6.3.1 and 6.3.2 and MarLin is referred to in Section 3.7.2
MSS advises that justification is required to demonstrate thinking behind the separate routing for the WI line, i.e. tie-in to existing water injection line and use of slot 11 in the FPSO turret structure	The WI line will be installed 18 months after the flowline and umbilical. It would therefore be impractical to use the same route for this line as it would require trenching very close to existing lines with the danger of damaging them. The selected

Issues Raised	Comments on Issues Raised and Environmental Impact Assessment Report (EIAR) section in which addressed
	route minimizes the number of crossings
Ministry of Defence	
The Ministry of Defence (MoD) had no objection to the proposed Development activities at the location specified.	
Maritime and Coastguard Agency	
The MCA would expect to see consideration of shipping and navigation contained within the Environmental Statement. The conditions used may vary but should be based on the Navigational Risk Assessment, along with any other mitigation measures in respect of pipeline trenching, mattressing and over-trawlability protection required.	Shipping and Navigation contained in Section 3.6.7 of the ES. AHUK will adhere to the NRA and vessel collision study requirements over the course of the development
JNCC	
The JNCC view rock dumping as a negative environmental impact and is not considered to be a positive environmental impact. It is recognized that rock dumping needs to be done but has to be justified.	Justification for the rock dump is provided in Section 6.4

5.4. Human Health

Human health impacts from routine and accidental events were considered during the EIA and were determined to largely require no further assessment within the EIA process, especially since activities are far from shore / populated areas and will be managed to meet industry requirements for safe operations. Section 5.4 describes possible local air quality issues associated with the Development.

5.5. Environmental Significance

5.5.1. Overview

The decision process related to defining whether a development is likely to have significant impacts on the environment is the core principle of the EIA process; the methods used for identifying and assessing potential impacts should be transparent and verifiable.

The method presented here has been developed by reference to the Institute of Ecology and Environmental Management (IEEM) guidelines for marine impact assessment (IEEM, 2010), the MarLin species and ecosystem sensitivities guidelines (Tyler-Walters *et al.,* 2001) and guidance provided by NatureScot (SNH, 2018) and by The Institute of Environmental Management and Assessment (IEMA) (IEMA, 2016).

The EIA provides an assessment of the environmental effects that may result from a development's impact on the receiving environment. The terms impact and effect have different definitions in an EIA, and one drives the other. Impacts are defined as the changes resulting from an action, and effects are defined as the consequences of those impacts.

In general, impacts are specific, measurable changes in the receiving environment (volume, time and/ or area). Effects (the consequences of those impacts) consider the response of a receptor to an impact. The relationship between impacts and effects is not always so straightforward; for example, a secondary effect may result in both a direct and indirect impact on a single receptor. There may also be circumstances where a receptor is not sensitive to a particular impact and thus there will be no significant effects/consequences.

For each impact, the assessment identifies a receptor's sensitivity and vulnerability to that effect and implements a systematic approach to understand the level of impact. The process considers the following:

- Identification of receptor and impact (including duration, timing and nature of impact);
- Definition of sensitivity, vulnerability and value of receptor;
- Definition of magnitude and likelihood of impact; and
- Assessment of consequence of the impact on the receptor, considering the probability that it will occur, the spatial and temporal extent and the importance of the impact. If the assessment of consequence of impact is determined as moderate or major, it is considered a significant impact.

Once the consequence of a potential impact has been assessed, it is possible to identify measures that can be taken to mitigate impacts through engineering decisions or execution of the project. This process also identifies aspects of the Development that may require monitoring, such as a post-decommissioning survey upon completion of the works to inform inspection reports.

For some impacts significance criteria are standard or numerically based. For others, for which no applicable limits, standards or guideline values exist, a qualitative approach is required. This involves assessing significance using professional judgement.

Despite the assessment of impact significance being a subjective process, a defined methodology has been used to make the assessment as objective as possible and consistent across different topics. The assessment process is summarised below. The terms and criteria associated with the impact assessment process are described and defined; details on how these are combined to assess consequence and impact significance are then provided.

5.6. Baseline Characterisation

In order to make an assessment of potential impacts on the environment it was necessary to firstly characterise the different aspects of the environment that could potentially be affected (the baseline environment). The baseline environment has been described in Section 4 and is based on regional studies combined with site-specific surveys.

Where data gaps and uncertainties remained (e.g. where there were no suitable options for filling data gaps), as part of the EIA process these have been documented and taken into consideration as appropriate, as part of the assessment of impact significance.

The EIA process requires identification of the potential receptors that could be affected by the Development (e.g. marine mammals, seabed species and habitats). High level receptors are identified within the impact assessments (Section 6 to 11).

5.6.1. Impact Definition

Impact Magnitude

Determination of impact magnitude requires consideration of a range of key impact criteria including:

- Nature of impact, whether it will be beneficial or adverse;
- Type of impact, is it direct or indirect etc.;
- Size and scale of impact, i.e. the geographical area;
- Duration over which the impact is likely to occur, i.e. days, weeks;
- Seasonality of impact, i.e. is the impact expected to occur at any time of year or during specific times of the year e.g. spring or summer; and
- Frequency of impact i.e. how often is the impact expected to occur.

Each of these variables are expanded upon in the tables below and provide consistent definitions across all EIA topics. In each impact assessment, these terms are used in the assessment summary table to summarise the impact and are enlarged upon as necessary in any supporting text. With respect to the nature of the impact (Table 5-2), it should be noted that all impacts discussed in this EIAR are adverse, unless explicitly stated.

Table 5-2 – Nature of Impact

Nature of Impact	Definition
Beneficial	Advantageous or positive effect to a receptor (i.e. an improvement)
Adverse	Detrimental or negative effect to a receptor

Table 5-3 – Type of Impact

Type of Impact	Definition
Direct	Impacts that result from a direct interaction between the Development and the receptor. Impacts that are caused by the introduction of the Development activities into the receiving environment, e.g. the direct loss of benthic habitat
Indirect	Reasonably foreseeable impacts that are caused by the interactions of the Development, but which occur later in time than the original, or at a further distance from the Development location. Indirect impacts include impacts that may be referred to as 'secondary', 'related' or 'induced' (e.g. the direct loss of benthic habitat could have an indirect or secondary impact on by-catch of non-target species due to displacement of these species caused by loss of habitat).

Table 5-4 – Duration of Impact

Type of Impact	Definition
Short term	Impacts that are predicted to last for a short duration (e.g. less than one year)
Temporary	Impacts that are predicted to last a limited period (e.g. a few years). For example, impacts that occur during the proposed activities and which do not extend beyond the main activity period for the works, or which, due to the timescale for mitigation, reinstatement or natural recovery, continue for only a limited time beyond completion of the anticipated activity.
Prolonged	Impacts that may, although not necessarily, commence during the main phase of the proposed activities and which continue through the monitoring and maintenance, but which will eventually cease.

Permanent	Impacts that are predicted to cause a permanent, irreversible change.

Table 5-5 – Geographical Extent of Impact

Type of Impact	Definition
Local	Impacts that are limited to the area surrounding the Development footprint and associated working areas. Alternatively, where appropriate, impacts that are restricted to a single habitat or biotope or community.
Regional	Impacts that are experienced beyond the local area to the wider region, as determined by habitat/ecosystem extent.
National	Impacts that affect nationally important receptors or protected areas, or which have consequences at a national level. This extent may refer to either Scotland or the UK depending on the context.
Transboundary	Impacts that could be experienced by neighbouring national administrative areas.
International	Impacts that affect areas protected by international conventions, European and internationally designated areas or internationally important populations of key receptors (e.g. birds, marine mammals).

Table 5-6 – Frequency of Impact

Type of Impact	Definition
Continuous	Impacts that occur continuously or frequently
Intermittent	Impacts that are occasional or occur only under a specific set of circumstances which occurs several times during the course of the Development. This definition also covers such impacts that occur on a planned or unplanned basis, and those that may be described as 'periodic' impacts.

5.6.2. Impact Magnitude Criteria

Overall impact magnitude requires consideration of all impact parameters described above. Based on these parameters, magnitude can be assigned following the criteria outlined in Table 5-7 The resulting effect on the receptor is considered under vulnerability and is an evaluation based on professional judgement.

Table 5-7 – Impact Magnitude Criteria

Magnitude	Criteria
Major	Extent of change: Impact occurs over a large scale or spatial geographical extent and /or is long term or permanent in nature. Frequency/ intensity of impact: high frequency (occurring repeatedly or continuously for a long period of time) and/or at high intensity.
Moderate	Extent of change: Impact occurs over a local to medium scale/spatial extent and/or has a short to medium-term duration. Frequency/intensity of impact: medium to high frequency (occurring repeatedly or continuously for a moderate length of time) and/or at moderate intensity or occurring occasionally/intermittently for short periods of time but at a moderate to high intensity.
Minor	Extent of change: Impact occurs on-site or is localised in scale/spatial extent and is of a temporary or short-term duration.

Magnitude	Criteria
	Frequency/intensity of impact: low frequency (occurring occasionally/intermittently for short periods of time) and/or at low intensity.
Negligible	Extent of change: Impact is highly localised and very short-term in nature (e.g. days/few weeks only).
Positive	An enhancement of some ecosystem or population parameter.
Notes: Magnitude of an impact is based on a variety of parameters. Definitions provided above are for guidance only and may not be appropriate for all impacts. For example, an impact may occur in a very localised area (minor to moderate) but at very high frequency/ intensity for a long period of time (major). In such cases expert judgement is used to determine the most appropriate magnitude ranking and this is explained through the narrative of the assessment.	

5.6.3. Impact Likelihood for Unplanned and Accidental Events

The likelihood of an impact occurring for unplanned/ accidental events is another factor that is considered in this impact assessment. This captures the probability that the impact will occur and also the probability that the receptor will be present. For some types of incident there are historical data available that allows a quantitative estimate of incident likelihood to be calculated; for other impacts, professional judgement must be used to resent a qualitative estimate. The quantitative and qualitative terms used to describe impact likelihood in the impact assessment chapters are defined in Table 5-8.

Table 5-8 - Likelihood for Unplanned and Accidental Events

Likelihood	Quantitative definition	Qualitative definition
Likely	More than once per year	Event likely to occur more than once on the facility
Possible	Once in 10 years	Could occur within the lifetime of the development
Unlikely	Once in 100 years	Event could occur within lifetime of 10 similar developments. Has occurred at similar facilities.
Remote	Once in 1,000 years	Similar event has occurred somewhere in industry or similar industry but not likely to occur with current practices and procedures.
Extremely remote	Once in 10,000 years	Has never occurred within industry or similar industry but theoretically possible.

5.6.4. Receptor Definition

Overview

As part of the assessment of impact significance it is necessary to differentiate between receptor sensitivity, vulnerability and value. The sensitivity of a receptor is defined as ‘the degree to which a receptor is affected by an impact’ and is a generic assessment based on factual information whereas an assessment of vulnerability, which is defined as ‘the degree to which a receptor can or cannot cope with an adverse impact’ is based on professional judgement taking into account a number of factors, including the previously assigned receptor sensitivity and impact magnitude, as well as other factors such as known population status or condition, distribution and abundance.

Receptor Sensitivity

Example definitions for assessing the sensitivity of a receptor are provided in Table 5-9.

Table 5-9 – Sensitivity of Receptor

Receptor sensitivity	Definition
Very high	Receptor with no capacity to accommodate a particular effect and no ability to recover or adapt.
High	Receptor with very low capacity to accommodate a particular effect with low ability to recover or adapt.
Medium	Receptor with low capacity to accommodate a particular effect with low ability to recover or adapt.
Low	Receptor has some tolerance to accommodate a particular effect or will be able to recover or adapt.
Negligible	Receptor is generally tolerant and can accommodate a particular effect without the need to recover or adapt.

Receptor vulnerability

Information on both impact magnitude and receptor sensitivity is required to be able to determine receptor vulnerability. These criteria, described in **Table 5-7** and **Table 5-9**, are used to define receptor vulnerability as per Table 5-10.

Table 5-10 - Vulnerability of Receptor

Receptor vulnerability	Definition
Very high	The impact will have a permanent effect on the behaviour or condition of a receptor such that the character, composition or attributes of the baseline, receptor population or functioning of a system will be permanently changed.
High	The impact will have a prolonged or extensive temporary effect on the behaviour or condition of a receptor resulting in long term or prolonged alteration in the character, composition or attributes of the baseline, receptor population or functioning of a system.
Medium	The impact will have a temporary effect on the behaviour or condition of a receptor such that the character, composition, or attributes of the baseline, receptor population or functioning of a system will either be partially changed post Project or experience extensive temporary change.
Low	Impact is not likely to affect long term function of system or status of population. There will be no noticeable long-term effects above the level of natural variation experience in the area.
Negligible	Changes to baseline conditions, receptor population of functioning of a system will be imperceptible.

It is important to note that the above approach to assessing sensitivity/ vulnerability is not appropriate in all circumstances and in some instances professional judgement has been used in determining sensitivity. In some instances, it has also been necessary to take a precautionary approach where stakeholder concern exists with regard to a particular receptor. Where this is the case, this is detailed in the relevant impact assessment section in Chapter 6 to 11.

Receptor value

The value or importance of a receptor depends on a pre-defined judgement based on legislative requirements, guidance or policy. Where these may be absent, it is necessary to make an expert judgement on receptor value based on the perceived views of key stakeholders, experts and specialists. Examples of receptor value definitions are provided in Table 5-11.

Table 5-11 – Value of Receptor

Value of receptor	Receptor type	Definition (example only – does not cover all receptors)
Very high	Environmental receptors	Receptor of very high importance or rarity, e.g. species that are globally threatened e.g. IUCN Red List of Threatened Species ('Red List') including those listed as endangered or critically endangered and/ or a significant proportion of the international population (> 1%) is found within the Project site.
	Cultural and socio-economic receptors	Receptor has no alternative to utilise an alternative area. Receptor is entirely dependent on the project area for all income/activities. Receptor is the best known/only example to contribute to knowledge and understanding and/or outreach.
High	Environmental receptors	Receptor of high importance or rarity, such as species listed as near-threatened or vulnerable on the IUCN Red List. Habitats and species protected under the European Union (EU)'s Habitats Directive. Bird species protected under the EU Birds Directive. Habitats and species (including birds) that are a qualifying interest of a SAC, SPA or Ramsar site and a significant proportion of the national population (>1%) is found within the Project site. Conservation interests (habitats and species) of Marine Protected Areas (MPAs), Heritage MPAs and MCZs.
	Cultural and socio-economic receptors	Receptors and sites of international cultural importance (e.g. United Nations Educational, Scientific and Cultural Organisation (UNESCO) World Heritage Sites (WHSs). Receptor has little flexibility to utilise an alternative area. Receptor generates the majority of income from the Project area. Receptor is an above average example and/or has high potential to contribute to knowledge and understanding and/or outreach.
Medium	Environmental receptors	Receptor of least concern on the IUCN Red List, listed as a breeding species on Schedule 1 of the Wildlife and Countryside Act 1981, form a cited interest of a SSSI, are listed in the UK Biodiversity Action Plan or on the Birds of Conservation Concern (BOCC) 'Red list' and a significant proportion of the regional population (>1%) is found within the Project site.
	Cultural and socio-economic receptors	Receptor has some flexibility to utilise an alternative area. Receptor is active in the project area and utilises it for up to half of its annual income/activities. Receptor is average example and/or has moderate potential to contribute to knowledge and understanding and/or outreach.
Low	Environmental receptors	Any other species of conservation interest (e.g. BOCC Amber listed species).
	Cultural and socio-economic receptors	Receptor has high flexibility to utilise an alternative area. Receptor is active in the project area and other areas and is reliant on project area for some income/activities.

Value of receptor	Receptor type	Definition (example only – does not cover all receptors)
		Receptor is below average example and/or has low potential to contribute to knowledge and understanding and/or outreach.
Negligible	Environmental receptors	Receptor of very low importance, such as those which are generally abundant around the UK and Ireland with no specific value or conservation concern.
	Cultural and socio-economic receptors	Receptor is very active in other areas and not typically present in the project area. Receptor does not generate any income/activities from the project area. Receptor is poor example and/or has no potential to contribute to knowledge and understanding and/or outreach.

5.6.5. Consequence and Significance of Potential Impact

Overview

Having determined impact magnitude and the sensitivity, vulnerability and value of the receptor, it is then necessary to evaluate impact significance. This involves:

- Determination of impact consequence based on a consideration of sensitivity, vulnerability and value of the receptor and impact magnitude;
- Assessment of impact significance (in accordance with EIA regulations) based on assessment consequence;
- Mitigation; and
- Residual impacts.

Assessment of consequence and impact significance

The sensitivity, vulnerability and value of receptor are combined with magnitude (and likelihood, where appropriate) of impact using expert judgement to arrive at a consequence for each impact, as shown in Table 5-12. The significance of impact is derived directly from the assigned consequence ranking.

Table 5-12 – Assessment of Consequence

Assessment consequence	Description (consideration of receptor sensitivity and value and impact magnitude)	Impact significance (EIA regulations)
Major consequence	Impacts are likely to be highly noticeable and have long-term effects, or permanently alter the character of the baseline and are likely to disrupt the function and status/value of the receptor population. They may have broader systemic consequences (e.g. to the wider ecosystem or industry). These impacts are a priority for mitigation in order to avoid or reduce the anticipated effects of the impact.	Significant
Moderate consequence	Impacts are likely to be noticeable and result in lasting changes to the character of the baseline and may cause hardship to, or degradation of, the receptor population, although the overall function and value of the baseline/receptor population is not disrupted. Such impacts are a priority for mitigation in order to avoid or reduce the anticipated effects of the impact.	Significant

Assessment consequence	Description (consideration of receptor sensitivity and value and impact magnitude)	Impact significance (EIA regulations)
Low consequence	Impacts are expected to comprise noticeable changes to baseline conditions, beyond natural variation, but are not expected to cause long-term degradation, hardship, or impair the function and value of the receptor. However, such impacts may be of interest to stakeholders and/or represent a contentious issue during the decision-making process and should therefore be avoided or mitigated as far as reasonably practicable.	Not significant
Negligible	Impacts are expected to be either indistinguishable from the baseline or within the natural level of variation. These impacts do not require mitigation and are not anticipated to be a stakeholder concern and/or a potentially contentious issue in the decision-making process.	Not significant
Positive	Impacts are expected to have a positive benefit or enhancement. These impacts do not require mitigation and are not anticipated to be a stakeholder concern and/or a potentially contentious issue in the decision-making process.	Not significant

Mitigation

Where potentially significant impacts (i.e. those ranked as being of moderate impact level or higher in Table 5-12) are identified, mitigation measures must be considered. The intention is that such measures should remove, reduce or manage the impacts to a point where the resulting residual significance is at an acceptable or insignificant level. Mitigation is also proposed in some instances to ensure impacts that are predicted to be not significant remain so. Provides detail on these commitments and how any mitigation measures identified during the impact assessment will be managed.

Residual impacts

Residual impacts are those that remain once all options for removing, reducing or managing potentially significant impacts (i.e. all mitigation) have been taken into account.

5.7. Issues Assessed

The ENVID process, consultation and technical review phases resulted in the following issues being considered and agreed for assessment in the EIA.

- Discharges to Sea (Chapter 6)
  - Discharge of WBM, drill cuttings, cementing and completion chemicals from drilling operations into the water column and onto the seabed, resulting in changes in water quality, localised and temporarily increased suspended solid concentrations, and possible impacts to organisms in the water column and to habitats and communities on the seabed.
- Seabed disturbance (Chapter 7)
  - Direct loss of benthic species;
  - Direct loss of existing seabed habitat;
  - Introduction of novel habitat types;

  - Wider indirect disturbance to the benthic environment through the suspension and re-settlement of sediments through vessel anchoring, drilling and cuttings, mud and cement discharges;
- Underwater noise (Section 8)
  - Injury and disturbance to marine mammals and fish through noise from the use of VSP and hammer piling during the Project.
- Interaction with other sea users (Section 9)
  - Interference with shipping and fishing activities that may occur in the area;
  - Loss of access to the area for other vessels on a temporary or permanent basis; and
  - Increased risk of vessel collisions through the presence of the drill rig and other vessels during drilling and pipelay activities.
- Atmospheric emissions (Section 10)
  - Emissions from the embodied carbon of the new infrastructure;
  - Emissions from the drilling and vessel activities; and
  - Operational emissions as a result of the incremental increase in fuel use and flaring/venting at the Anasuria FPSO.
- Accidental events (Section 11)
  - Possible toxicity and smothering impacts to birds, other marine species (e.g. marine mammals) and habitats through the release of hydrocarbons and chemicals from a well blowout.

5.8. Issues scoped out

During the ENVID workshop and as the EIA developed the following issues were reviewed, but it was considered that the potential impacts were too small and likely to be insignificant; it was therefore agreed they would be scoped out of further assessment in the EIA.

- Discharges to sea:
  - Routine discharge of oil-based drill cuttings, including those contaminated with reservoir hydrocarbons (i.e. drilling through payzone) – scoped out as SOBM and cuttings will be skipped and shipped to shore;
  - Routine blackwater production (i.e. sewage), grey water (i.e. from showers, laundry, hand and eye wash basins and drinking fountains) and food waste (macerated) disposal (from vessels and drill rig) – scoped out due to existing, effective management controls in place at Teal West and adherence by all vessels to the Convention for the Prevention of Pollution from Ships (MARPOL) Annex IV;
  - Ballast water – scoped out as no major international movement of vessels expected for construction of the Development resulting in introduction of non-native species from outwith the North Sea;
  - Removal/ fall-off of fouling growth from vessels and drilling rig – scoped out as no dedicated removal is planned and fall-off is expected to be intermittent and of low volume;
  - Routine seawater usage for cooling (e.g. engine cooling) – scoped out due to the highly limited temporal and spatial extent of such discharges and compliance with MARPOL Annex IV; and
  - Mobile sand from within the Teal West reservoir discharged to sea – scoped out as sand quantities expected to be so small that infrequent (e.g. once / several years) manual emptying of separator will be undertaken and will be skipped and shipped to shore.
- Atmospheric emissions:

  - Fugitive emissions (e.g. from seals, welds, valves, pipes, pumps, flanges etc. (drilling rig, vessels and FPSO) – scoped out due to demonstration of BAT, utilisation of maintenance programme and detection systems, leak testing programme to be implemented and use of Forward-looking infrared (FLIR) cameras on FPSO.
- Physical presence:
  - Direct loss of marine archaeological remains – scoped out since there were no wrecks identified during the survey scope at the proposed well locations;
  - Disturbance to ornithological features from drill rig and vessels – scoped out since the activities will occur over the spring and summer when daylight hours are extended, the use of artificial light will be reduced, and the drilling campaign is a temporary short-term activity so light emissions will only be for a short duration and incrementally indistinguishable against the background of lights already present on existing structures in the region and on passing shipping; and
  - Disturbance to marine species in the Teal West area from vessels or collision between vessel and animals – scoped out as the Teal field is in open sea, the drilling and installation campaign is a temporary short-term activity, and thus vessel use is minimised.
- Impact on seascape – scoped out as the limited vessel presence will be far enough offshore not to affect visual amenity.
- Waste:
  - Routine generation and disposal of non-hazardous waste streams – scoped out due to existing, effective management controls in place for waste;
  - Routine generation and disposal of wastes for recycling, e.g. paper, card, toner cartridges, fluorescent tubes, wood and clean metal drums – scoped out due to existing, effective management controls in place for waste, use of licensed waste contractors/sites, waste transfer notes etc.;
  - Routine generation and disposal of special/ hazardous wastes, e.g. oily rags, medical waste, solvents, batteries, computers, fluorescent tubes, oil/grease/chemical cans/drums/sacks, contaminated produced sand, contaminated cuttings, pigging waste – scoped out due to existing, effective management controls in place for waste; and
  - Routine generation and disposal of radioactive wastes (disposal onshore) (e.g. naturally occurring radioactive material (NORM), contaminated cuttings, radiation sources in safety/detection equipment etc.) – scoped out as no radioactive waste is expected from the drilling campaign.
- Accidental events:
  - Accidental deposit of materials on the seabed (e.g. dropped objects, ROV etc.) – scoped out due to existing, effective management controls in place for dropped objects;
  - Limited unplanned operational releases, such as resulting from an overfill of the diesel tank bund – scoped out due to limited volumes and very low likelihood of occurrence; and
  - Natural disasters – it is considered that the implication of any natural disasters affecting the offshore region, such as an earthquake or extreme sea conditions (including tsunami), would most likely be the accidental event scenarios described in Section 11. The implication of release of chemicals and hydrocarbons from the Project is assessed within Section 11.8.2 and natural disasters are therefore not discussed further.
- Recreation and tourism:
  - Long-term restriction of access or amenity – scoped out due to absence of sensitive receptors in the area of potential impact.

5.9. Cumulative and In-Combination Impact Assessment

The European Commission has defined cumulative impact as being those resulting "from incremental changes caused by other past, present or reasonably foreseeable actions together with the project" (European Commission, 1999). As outlined in studies by the European Commission (1999) and US CEQ (1997), identifying the cumulative impacts of a project involves:

- Considering the activities associated with the Development;
- Identifying potentially sensitive receptors/resources;
- Identifying the geographic and time boundaries of the cumulative impact assessment;
- Identifying past, present and future actions which may also impact the sensitive receptors/resources;
- Identifying impacts arising from the proposed activities; and
- Identifying which impacts on these resources are important from a cumulative impacts' perspective.

To assist the assessment of cumulative and in-combination impacts, a review of existing developments (including oil and gas, cables and renewables) that could have the potential to interact with the Development was undertaken; the output of this review is reported in the Environment Description (Chapter 4). The impact assessment has considered these projects when defining the potential for cumulative and in combination impact.

5.10. Transboundary Impact Assessment

The impact assessments presented in Chapters 6 - 11 contains sections which identify the potential for, and where appropriate, assessment of transboundary impacts. For the Development, the UK/Norway median lies approximately 87 km away.

5.11. Habitats Regulations Appraisal (HRA) and Nature Conservation Appraisal

Under Article 6.3 of the Habitats Directive, it is the responsibility of the Competent Authority to make an Appropriate Assessment of the implications of a plan, programme or in this case project, alone or in combination, on a Natura site (SAC or SPA) in view of the site's conservation objectives and the overall integrity of the site.

As part of the assessment of impacts on key receptors, for those receptors that are a qualifying feature of a Natura site, relevant information on SACs or SPAs has also been provided as part of the impact assessment process. This information will then be used by the Competent Authority to determine the need for, and subsequently carry out (if required), an appropriate assessment of the Development.

For offshore areas (12 – 200 NM) the requirements of the Habitats Directive are transposed through the Conservation of Offshore Marine Habitats and Species Regulations 2017. In accordance with these Regulations, the impacts of a project on the integrity of a European site are assessed and evaluated as part of the HRA process. In an analogous process, the Marine (Scotland) Act and the Marine and Coastal Access Act require the potential for significant risk to the conservation objectives of NCMPAs and MCZs (respectively) being achieved to be assessed.

5.12. Data gaps and uncertainties

The North Sea has been extensively studied, meaning that this EIA has been able to draw on a significant volume of published data. This bank of published data has been supplemented by a site survey programme and studies undertaken on behalf of AHUK to collect Project specific environmental data, ensuring a robust baseline is available against which to assess impact. Where appropriate, studies have been commissioned to inform the impact assessment. Studies have included:

- Drill cuttings dispersion modelling, to assist in predicting the fate and impacts of cuttings discharged to the seabed from the drilling process;
- Oil spill modelling, to facilitate assessment of the impacts from worst case scenarios regarding accidental spills of either hydrocarbons or diesel fuel. Although the expected hydrocarbon is oil, there will be some accompanying condensate;
- Underwater noise modelling in order to estimate underwater noise levels, impact zones for injury and disturbance to marine mammals EPS and potential mitigation strategies (as appropriate).

When evaluating and characterising potential impacts that could be associated with the Project, a variety of inputs are used, including baseline environmental data, modelling results, estimation of emissions and Project footprint. These inputs carry varying levels of uncertainty and conservatism and although potential impacts may occur, they are not certain to occur (for example, there is some uncertainty in marine mammal response to certain noise emissions). To account for this uncertainty, worst case assumptions have been made, and where key uncertainties exist, they have been outlined within the impact assessment chapters.

6. DISCHARGES TO SEA

6.1. Introduction

This chapter details the assessment of the discharges to sea associated with the drilling, installation, commissioning, operation, and decommissioning of the Teal West development. Potential impacts from drilling discharges (cuttings, drilling mud, and cement) are discussed in Section 6.5 and aqueous discharges during the installation and commissioning and the operational phases of the development are discussed in Sections 6.6.1 and 6.6.2, respectively. Decommissioning is covered in Section 6.8.

6.2. Regulatory Control

The key regulatory controls that relate to the proposed development activities are:

- Offshore Chemicals Regulations 2002 (as amended) (OCR): The OSPAR Decision relating to the Harmonised Mandatory Control System for the use and discharge of offshore chemicals is implemented on the UKCS by BEIS under the OCR. Under these Regulations, operators using or discharging chemicals in connection with offshore activities will need to apply to BEIS for one of two types of permit to cover both their use and discharge. Uses and discharges at producing offshore installations in UKCS waters or active storage or unloading installations in the UK territorial waters will be covered by 'Production Permits', 'Storage Permits' or 'Unloading Permits', which will be open ended and subject to review every three years. Time-limited uses and discharges during offshore activities such the drilling and maintenance of wells, the commissioning, maintenance and decommissioning of pipelines, and the decommissioning of installations, will be covered by 'Term Permits' (DECC, 2011);
- Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005 (as amended) (OPPC): The OPPC Regulations were introduced to meet the OSPAR goal of reducing discharges of oil to the marine environment from the offshore oil and gas industry. The Regulations require a permit to be in place prior to the discharge of any oil to sea and any unpermitted discharges to be formally reported to BEIS. During drilling operations, the Regulations will apply where any drill cuttings contain reservoir hydrocarbons, or during well clean-up if there are discharges of oil-in-water. Any planned, or potential, discharges of oil to sea during the proposed development will require the relevant Oil Discharge Permit application to be submitted by AHUK to BEIS at the appropriate time;
- Merchant Shipping (Prevention of Oil Pollution) Regulations 1996 (as amended): The Regulations implement MARPOL Annex 1 in the UK and controls oily discharges from any vessel activity including machinery space drainage. The Regulations require all vessels to have in place a UK or International Oil Pollution Prevention Certificate to demonstrate compliance; and
- The Merchant Shipping (Prevention of Pollution by Sewage and Garbage from Ships) Regulations 2008: The Regulations control sewage treatment and discharge and applies to offshore installations and vessels. The main requirement is that all discharges are monitored and recorded.

6.3. Assumptions and Data Gaps

A number of assumptions were made during the modelling study, namely:

- In order to ensure a conservative (worst-case) modelling approach the discharge quantities of the weighting agents, cuttings and other chemicals represented the expected maximums;

- AHUK intends to use chemicals Posing Little or No Risk to the environment (PLONOR) for use and discharge during the drilling operations, avoiding chemicals with substitution warnings where technically possible; and
- The standard particle size distribution for the cuttings, barite and bentonite provided by the Dose-Related Risk and Effect Assessment Model (DREAM) model are applicable for the discharges. These particle size distributions have been used in numerous modelling studies in the North Sea.

It is considered that the information available to inform this assessment has been sufficient to undertake a thorough and accurate assessment of the potential impacts resulting from the discharges to sea resulting from the Teal West development. There were no major gaps identified during the drilling discharge modelling process and the assessment of potential impacts from discharges to sea during well bore testing and clean up, pipeline flooding and cleaning, and from discharges of produced water.

6.4. Description of Potential Impacts

The development will include discharges to sea during the drilling phase including drill cuttings, drilling muds, cement and filtered clean-up/well test fluids. As the bottom hole reservoir section will be drilled using SOBM, there is a potential for the discharged completion brine to contain residual quantities of SOBM and/or reservoir hydrocarbons. This will be minimised by the onboard filtration system to ensure the allowable levels are met prior to being discharged overboard.

There will also be discharges related to the installation of the subsea infrastructure including the chemicals used in pipeline flooding and cleaning, and the installation and commissioning of pipelines, spools, manifolds and umbilicals. Operational discharges of produced water will occur throughout the life of field (LOF) of the development, at an increasing rate to a peak produced water discharge at 2,347 Te/day in year-14 of the development. The Teal west produced water will be comingled with the Anasuria cluster produced water and treated prior to discharge

These discharges could lead to potential impacts to the seabed or water column through the following mechanisms:

- Increased dissolved hydrocarbons in the water column and increased hydrocarbons and heavy metals content in seabed sediments;
- Increased dissolved chemicals in the water column:
- Increased suspended solids in the water column;
- Settlement of cuttings and muds on the seabed that have the potential to:
    - Alter the seabed topography composition and chemical nature of the habitat due to the introduction of foreign material with different grain sizes;
    - Smother the benthic organisms in high deposition areas;
    - Impair the feeding and respiratory systems of benthic organisms due to deposition of fine particles and increased concentrations of suspended particles near the seabed; and
    - Have potential toxic impacts from the muds and chemical additives.

6.5. Drilling Discharges

6.5.1. Drilling Programme Overview

The development concept consists of two subsea production wells and one water injection well. The wells are planned to be developed in separate phases. Phase 1 will be the initial development of the Teal West field through the mobilisation of a mobile offshore drilling jack up unit to drill and complete a single production well (VP5). Upon hook up operations, assuming the production well results and flow behaviour are as expected, a water injection well is expected to be drilled in Phase 2 within 18 months of first oil production followed by a second production well (VP6) in Phase 3. The proposed well locations and information can be found in Table 6-1. This is subject to minor changes based on the outcome of 2DHR and geotechnical surveys.

Table 6-1 – Well information and locations

Well name	Well type	Location (ED50/TM 0N)	
		Easting	Northing
Phase 1			
Well VP5	Producer	546 659.88 E	6 348 467.82 N
Phase 2			
Water Injection Well W11	Water Injection Well	546 488.24 E	6 348 441.18 N
Phase 3			
Well VP6	Producer	546 316.79 E	6 348 367.82 N

The VP5 and VP6 wells will be completed as directional wells with a cemented and perforated 7” OD liner in the reservoir. The wells will initially be drilled riserless with cuttings discharged to the seabed during the 42” x 36” and 26” hole sections. After the 42” x 36” hole is drilled, a 36” OD x 30” OD tapered conductor string will be lowered into the well and cemented with returns discharged to the seabed. The 26” hole will then be drilled and the 20” casing lowered into the hole and similarly cemented, with returns to the seabed. A High Pressure riser and BOP will then be installed and the 17½” hole will be drilled with SOBM. Similarly, the 12¼" hole will be drilled with SOBM followed by running the 9 5/8 “ casing. When cementing the 9 5/8” casing, cement is not planned to be returned to the rig. The 8 ½” hole will then drilled to total depth of the well and a 7” OD liner run and cemented. During these operations, a minimal amount of cement is expected to be seen back on the rig and this will be discharged to the sea. An ROV will be used throughout the drilling operation to provide visual monitoring of activities. Table 6-2 to Table 6-3 presents the drilling programme for the three wells. Table 6-4 to Table 6-5 presents the mass of drilling mud components and cuttings associated with the drilling of the wells.

A skip and ship system will be used for SOBM cuttings for processing and disposal, therefore there are no discharges to sea associated with SOBM use.

Table 6-2 – Drilling programme data for the well single well; VP5

Well Section	1	2	3	4	5	6
Diameter (inches, “)	42”	36”	26”	17 ½ “	12 ¼”	8 ½”

Well Section	1	2	3	4	5	6
Length (m)	80	137	1,900	N/A	N/A	N/A
Discharge type	Continuous	Continuous	Continuous	N/A	N/A	N/A
Drilling rate (m/hr)	15.0	15.0	15.0	N/A	N/A	N/A
Discharge pipe	Riserless	Riserless	Riserless	Skip and Ship	Skip and Ship	Skip and Ship
Discharge orientation	Vertically upwards from seabed		Vertically upwards from seabed	N/A	N/A	N/A

Table 6-3 – Drilling programme data for the single water injector well; W11 and VP6

Well Section	1	2	3	4	5	6
Diameter (inches, “)	42”	36”	26”	17 ½ “	12 ¼”	8 ½”
Length (m)	80	137	1,900	N/A	N/A	N/A
Discharge type	Continuous	Continuous	Continuous	N/A	N/A	N/A
Drilling rate (m/hr)	15.0	15.0	15.0	N/A	N/A	N/A
Discharge pipe	Riserless	Riserless	Riserless	Skip and Ship	Skip and Ship	Skip and Ship
Discharge orientation	Vertically upwards from seabed		Vertically upwards from seabed	N/A	N/A	N/A

Table 6-4 – Mass of drilling mud components and cuttings for the well single well; VP5

Component	Modelled discharges per section					
	1	2	3	4	5	6
Cuttings (Te)	54.38	68.42	497.53	N/A	N/A	N/A
MUD/Fluid name or description	Seawater / hi-vis sweeps	Seawater / hi-vis sweeps	Seawater / hi-vis sweeps	SBM	SBM	SBM
Barite (Te)	12.51	17.98	186.96	N/A	N/A	N/A
Bentonite (Te)	3.84	5.52	57.42	N/A	N/A	N/A
Non PLONOR chemicals (e.g. biocide)	Nil	Nil	Nil	N/A	N/A	N/A
Total mud (Te)	64.57	92.77	964.72	N/A	N/A	N/A

Table 6-5 – Mass of drilling mud components and cuttings for the single water injector well; W11 and VP6

Component	Modelled discharges per section					
	1	2	3	4	5	6
Cuttings (Te)	54.38	68.42	494.93	N/A	N/A	N/A
MUD/Fluid name or description	Seawater / hi-vis sweeps	Seawater / hi-vis sweeps	Seawater / hi-vis sweeps	SOBM	SOBM	SOBM
Barite (Te)	12.51	17.98	185.98	N/A	N/A	N/A
Bentonite (Te)	3.84	5.52	57.12	N/A	N/A	N/A
Non PLONOR chemicals (e.g. biocide)	Nil	Nil	Nil	N/A	N/A	N/A
Total mud (Te)	64.57	92.77	959.67	N/A	N/A	N/A

Drilling chemicals are used to maintain the desired technical composition of the mud to facilitate the drilling of the well. Chemicals for offshore use are approved by the Centre for Environment, Fisheries and Aquaculture Science (Cefas) and categorised by applying the Offshore Chemical Notification Scheme (OCNS) ranking based on its aquatic and sediment toxicity, biodegradability and bioaccumulation potential. This scheme is the UK's implementation of the OSPAR Harmonised Mandatory Control Scheme (HMCS). Under this scheme chemicals are categorised through the assigning of either a letter indicating its potential for environmental impact ranging from A (highest) to E (lowest) or a colour code representing its hazard to the environment with purple representing the highest hazard and gold the lowest hazard. The majority of the drilling chemicals likely to be used are designated as PLONOR. The pipe dope used on risers, casing and tubing are also typically environmentally friendly dope and as such are designated as PLONOR. The details of the actual chemicals to be used or discharged and their quantities will be the subject of permit applications.

6.5.2. Cementing

As detailed in 3.2.6, steel casings will be installed in the wells to provide structural strength to support the wellheads and XTs, isolate unstable formations and separate formations which have different pressures and fluids. Each steel casing will be cemented into place to provide a structural bond and an effective seal between the casing and formation. Up to 200% excess cement may be required in the two upper well sections to ensure well casing integrity. As a worst-case, this could result in up to approximately 67 t of cement discharged around the top-hole of each well, some of which will go into the water column and be diluted and some discharged directly to the seabed, forming a small 'cement patio' on the seabed. To limit the quantity of a cement in subsequent hole sections, it is anticipated that all cement will be mixed as required and typically only minimal amount of cement slurry will be discharged to sea due to the clean-out of mixing pits and cement lines following cementing operations.

All chemicals to be used within the cement will be selected based on their technical specifications and environmental performance. Chemicals with sub warnings will be avoided where technically possible. The cementing chemicals to be used have not yet been determined but will be selected following AHUK's chemical management and selection policy.

6.5.3. Well Clean-up and Testing

As detailed in Section 3.2.8, during well clean-up and completion operations, the proposed wells will be cleaned to remove any drilling fluids waste and debris and prevent damage to the pipeline or topside production facilities.

The production wells will be cleaned up with a clean-up package rigged up on the drilling rig. The wells will be flowed to the drill rig for planned 24hrs with rates +/- 3000 bbls/day at controlled choke sizes to separators and burners. A surge tank will be rigged up to ensure zero spill overboard with a flare system to burn flowed oil and gas at surface. A filtration system will also be rigged up to ensure fluid is filtered to required levels prior to discharge, specifically less than 30mg/l averaging over a month or no more than 100 mg/l at any one given time. It is anticipated that the maximum discharge volume of this brine will be up to approximately 400 bbls per well based on the predicted annular volume.

As the bottom-hole section of each well will be drilled using SOBM, there is a potential for the discharged completion brine to contain residual quantities of SOBM and/or reservoir hydrocarbons. This will be closely monitored during well completion and measured for any contamination. Efforts will be made to reduce the quantity of contaminated brine being discharged. There will be minimal completion chemical used and therefore discharged during well completion. Permits will be applied for to cover any residual SOBM/

hydrocarbon discharged during clean-up activities. Any discharges will be appropriately permitted prior to undertaken drilling.

6.5.4. Behaviour of Drill Cuttings at Sea

Modelling Overview

The potential impacts of the drilling programme were informed by modelling conducted using the ParTrack module within SINTEF's DREAM (included in Marine Environmental Modelling Workbench (MEMW) version 13.1.0). This model was used to assess the dispersion and potential environmental impact of the drilling discharges from three wells that will be drilled as part of the Teal West development. The parameters used to undertake the modelling are briefly described here to provide some context to the findings and their relevance to the realistic drilling scenario. Whilst the results of modelling cannot be directly substituted for observed impacts occurring during a real situation (due to model limitations and differences in data resolution), modelling is a useful tool to help assess the risk of potential impacts and to inform Project decision-making. A single scenario was modelled incorporating all three wells to present the potential worst-case discharges that could occur during the Teal West development. The modelling was done over a compressed timescale for the drilling activity however in the current drilling programme the wells will be drilled over a longer period.

Particulate size distributions in the discharge (cuttings, barite and bentonite) were included in the model using default values. A conservative approach was taken in the modelling in that it was assumed that the template toxicity value represented the whole product. In reality it's likely that the actual toxicity of the product will be less than that used in the modelling, as many components may have negligible toxicity to marine organisms. The metals attached to barite were set up according to Table 6-6.

Table 6-6 - Concentration of metals attached to barite

Metal	Parts per million
Cadmium (Cd)	0.26
Mercury (Hg)	1.63
Lead (Pb)	76.61
Zinc (Zn)	260.00
Chromium (Cr)	5.59
Copper (Cu)	27.55

Environmental Impact Factor

The Environmental Impact Factor (EIF) is a relative measure of the risk to the biota in the marine environment. It is calculated using the PEC/PNEC approach, where the predicted environmental concentration (PEC) of a contaminant is divided by the predicted no effect concentration (PNEC); the highest concentration at which no environmental effect is predicted. A ratio of >1 indicates there may be an environmental effect.

The PNEC values within the ParTrack model are the estimated highest concentrations at which toxic effects are not expected. The PNEC values for each substance have been defined by laboratory tests. These have been divided by an assessment factor to produce a value that is considered to be protective of all but the most sensitive 5% of species. This approach is internationally accepted in the regulatory assessment of chemicals. Sintef have adapted this methodology by using experimental data to calculate pseudo-PNECs for non-toxic stressors such as burial, sediment grain size change and oxygen depletion.

The PEC for each contaminant is modelled by simulating the behaviour of contaminants in the water column. Processes, including dilution, partitioning, degradation and deposition into the sediment, are simulated in order to generate a PEC for each contaminant over time. EIFs for the sediment compartment are more complex; they incorporate the toxicity of the contaminants as well as processes such as oxygen depletion, change in median grain size and burial effects.

Within the model the entire water volume in the modelled area is split into compartments measuring 100 m x 100 m x 10 m (0.0001 km^3). Each compartment where the PEC/PNEC ratio is >1 contributes a value of 1 to the water EIF. Sediment EIFs are calculated based on area rather than volume. The sediment is divided into compartments measuring 100 m x 100 m (1 hectare or 0.01 km^2). Each compartment where the PEC/PNEC ratio is >1 contributes a value of 1 to the sediment EIF. The EIFs generated for the Teal West drilling discharge modelling are discussed in the following sections.

Potential Seabed Impacts

Particulate material deposited on the seabed during drilling of the top-hole sections (without a riser in place) may form a localised cuttings pile at the seabed around the discharge points. The material deposited will be a mixture of cuttings (removed from the wells), drilling mud (bentonite and barite), some cement associated chemicals and the cement patio. The potential impacts on the seabed resulting from cement discharges immediately around the wellhead are assessed in Chapter 7 Seabed Impacts.

The burial of benthic organisms may result in their mortality depending on the depth of cuttings deposition. Filter feeding organisms (for example hydroids and bryozoans) rely on suspended particles as a source of food. More mobile species may be able to avoid unfavourable conditions, and to work their way back through the cuttings to the surface.

Feeding structures of benthic species may become clogged with increased suspended solids in the water column just above the seabed and therefore feeding could be temporarily limited. Due to the short-term and one-off nature of drilling activities the increased suspended solids loading is not expected to persist. The water column impacts as a result of suspended solids are further discussed in Section 11.

The modelled thickness of the deposited cuttings and drilling mud is presented in Figure 6-1 and Figure 6-2 in both plan and section view. There was a large overlap predicted from the discharges to produce one single cuttings pile with two peak thicknesses relating to the discharges due to the close proximity of the wells. The three wells are together predicted to produce a cuttings pile with a maximum thickness of 33 cm from wells VP6 and W1 and 23 cm from well VP5. The predicted thickness decreases rapidly with distance from the discharge points, such that within 110 m the cuttings thickness decreases to less than 1 mm . The thickest area of the mud and cuttings pile was predicted to be predominantly formed to the immediate south-west of each drilling locations. The direction of the wider-scale deposition of sediment is dominated by prevailing currents at levels that are not easily detectable in the environment. Therefore, any potential seabed impacts are likely to remain localised.

Drill cuttings dispersion modelling also allowed estimating the total area of seabed impacted by drill cuttings deposition. It showed, that while the drill cuttings dispersed over a wide area, only a small area was impacted by a thickness greater than 1 mm. Drill cuttings deposited with a thickness greater than 1 mm over a 0.05 km^2 area, whilst these deposited within a 0.005 km^2 area at the 10 mm thickness contour. No EIF is predicted from the sediments deposited.

After deposition, the particulate material would be subject to redistribution through the action of seabed currents. It is anticipated that recovery of the seabed will start immediately following cessation of drilling due to bioturbation and re-colonisation of smothered sediments as species move back into the disturbed area either by migration from adjacent undisturbed areas or via settlement from the plankton. Such recovery is often well advanced within a year. As detailed in section 3.2.2, drilling will occur during different phases of the development which will allow for recovery of the environment between drilling periods. The model has used a compressed timescale for the drilling activity, therefore this presents a worst-case scenario of the impact to the seabed. However, the short-term impact could affect the composition of the benthic community in the radius inferred from the modelling around the drilling location.

In addition to the potential impacts associated with deposition of material to the seabed, the potential impacts associated with drilling chemicals needs to be considered. Barite consists of barium sulphate, an insoluble, chemically inert mineral powder that normally contains measurable concentrations of several trace metals. Barium is considered biologically unavailable, of low toxicity and is unlikely to have a measurable impact on the benthic fauna (Jenkins *et al.* 1989, Hartley, 1996; Starczak et al., 1992). The potential environmental impact of other trace metals will depend on their concentration in the Water Based Muds (WBM) cuttings, which in turn depends partially on the geological source of barite. Neff *et al.* (2008) found that metals associated with drilling mud barite are virtually unavailable to marine organisms that might come into contact with discharged drilling fluids.

Some drilling fluid chemicals may be considered more harmful than others i.e. they are known to be toxic and/or are known to bioaccumulate. Under the HMCS some chemicals contain components that have been identified for substitution require further justification in regulatory permits. OSPAR Recommendation 2006/3 requires that contracting parties phase out the discharge of these chemicals, as soon as practicable; there are exceptions for those chemicals where, despite considerable efforts, it can be demonstrated that replacement is not feasible due to technical or safety reasons.

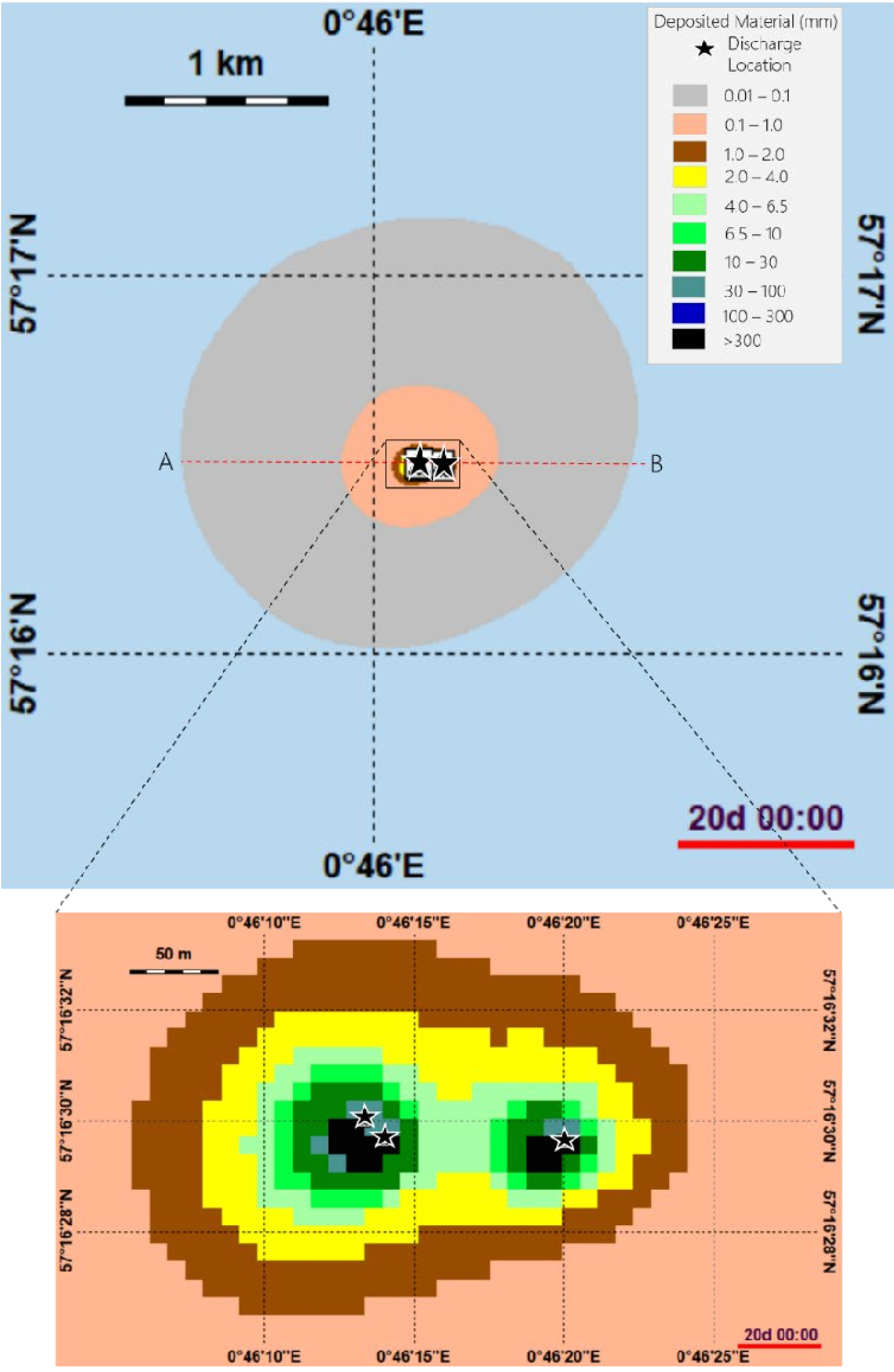


Figure 6-1 – Modelled Cuttings Accumulation on the Seabed

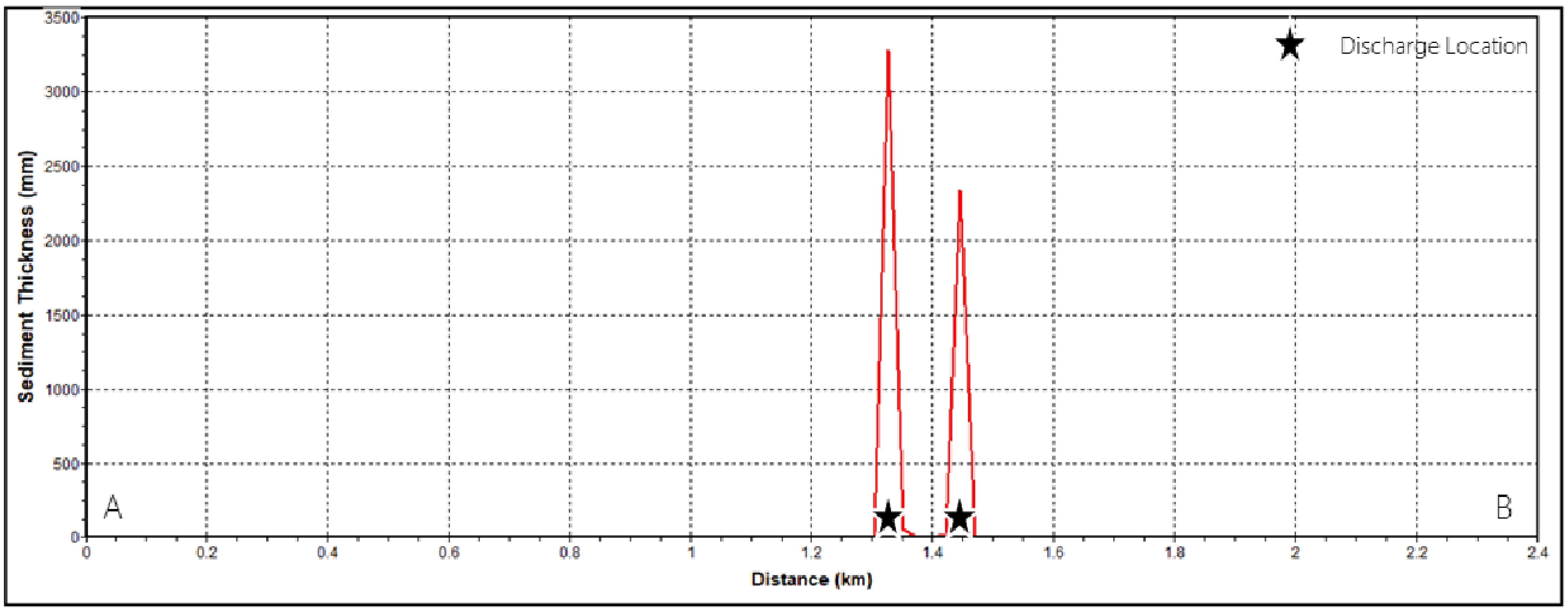


Figure 6-2 – Sediment thickness on the seabed along transect A-B

Potential Water Column Impacts

Both the physical and chemical impacts of drilling discharges to sea can result in potential impacts to the seabed and to the water column. Discharge to the water column have the potential to effect fish, planktonic organisms and organisms living at or near the seabed. The organisms affected could experience interference with feeding, respiration and migration.

A timeseries map showing the developing risk to the water column during drilling is shown in Figure 6-3 The model only considered the particulate material likely to be discharged during the drilling programme. The quantity of particulate material included in the model was a worst-case estimation of discharge.

The lateral extent of the section of the water column predicted to have an impact risk on more than 5% of the species present extends to a maximum of 5.0 km to the north of the release sites and 4.5 km west. As is usually predicted with drilling programmes, the water column impact is very transitory, with most of the risk in the water column occurring between days 1 and day 11. The risk is shown to dissipate rapidly after this, falling below 1% by 14.5 days and zero by 18.5 days after the start of drilling. The end of the drilling discharges occurs at 7.4 days, therefore it takes 11.1 days for the risk to fully decrease to zero after the drilling discharges occur. Figure 6-4 also displays the water column risk along transect A-B. This shows that the water column risk is predicted near the seabed, where the discharge occurs. The model has used a compressed timescale for the drilling activity; however, the Teal West wells will be drilled sequentially, during different phases of the development as detailed in 3.2.2. Thus, the modelling presents an extreme worst-case scenario as there will be three discrete transient impacts through the drilling programme with no overlap in risk to the water column.

The key receptors in the water column are plankton, since these largely drift in the water currents and are unable to avoid unfavourable conditions. Alldredge *et al.* (1986) showed that primary production in the vicinity of drilling platforms is not significantly impacted by drilling discharges. As primary productivity is highest in the surface layers, plankton abundance and biomass are likely to decrease with depth in the water column. As such, the ability for drilling discharges to impact these receptors also decreases with depth. The drill cuttings dispersion modelling conducted for the Teal West development shows that the 5% risk is limited to the water column near the seabed, with no risk occurring further than 60 m above the seabed.

Increased suspended solids, especially near the seabed, may result in direct irritation to certain types of marine benthic organisms, abrading protective mucous coatings and increasing their susceptibility to parasites and infections, as well as affecting growth, reproduction and feeding. Cephalopods, fish and marine mammals are not as vulnerable to these discharges due to their mobility, although there is the potential for bioaccumulation through the food chain.

The development of the water column risk as described by the EIF values is presented in Figure 6-5. This shows three adjoining peaks in EIF corresponding to the individual wells. The maximum computed EIF is 4340 which returns to 0 by day 11. All the modelled sections from all the wells contain bentonite and barite which results in the largest contribution to water column particle stress due to the small size of the particles and their slow settling in the water column. However, potential water column impacts are predicted to be short-term and localized and near to the seabed, which aligns with the findings published from potential impact studies for drilling such as the 1,000-fold dilution that is expected within 10 minutes of discharge (Neff, 2005).

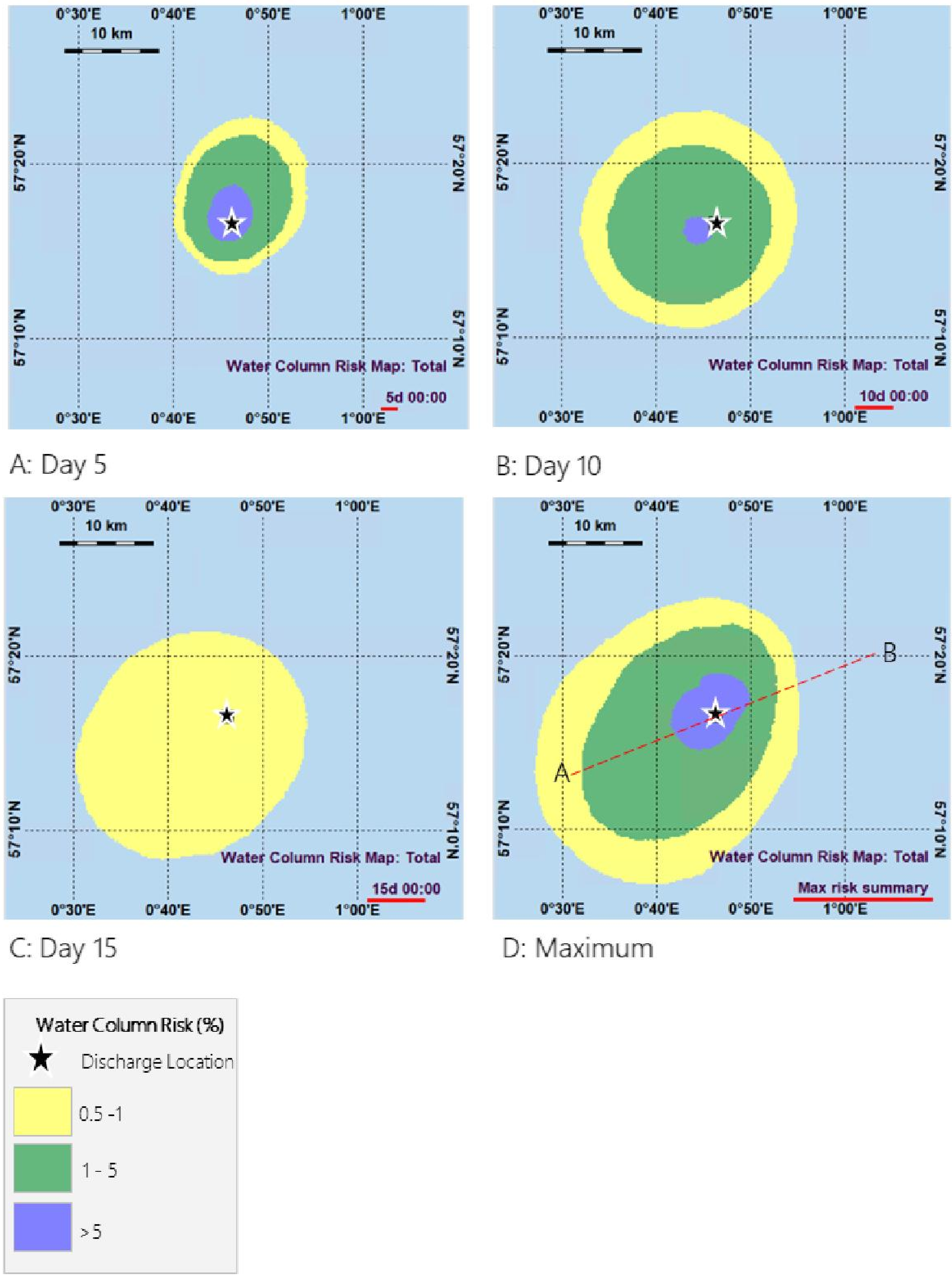


Figure 6-3 – Development of water column risk (%) due to particulate material discharged during drilling over time[7]

[7] Due to the close proximity of the well discharges one symbol has been used to represent the three well discharge locations.

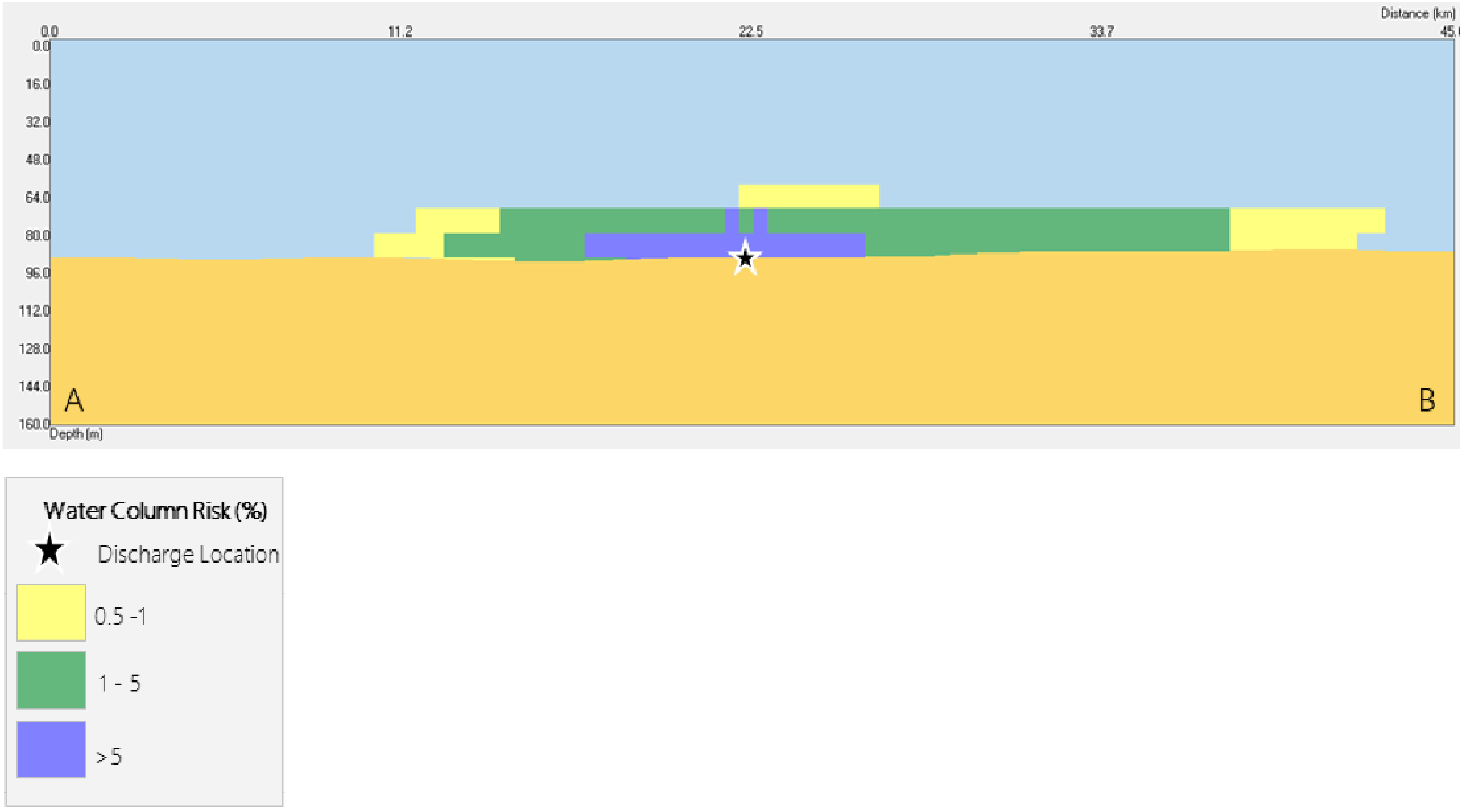


Figure 6.4 - Water Column Risk (%) Along Transect A-B Shown in Figure 6 3

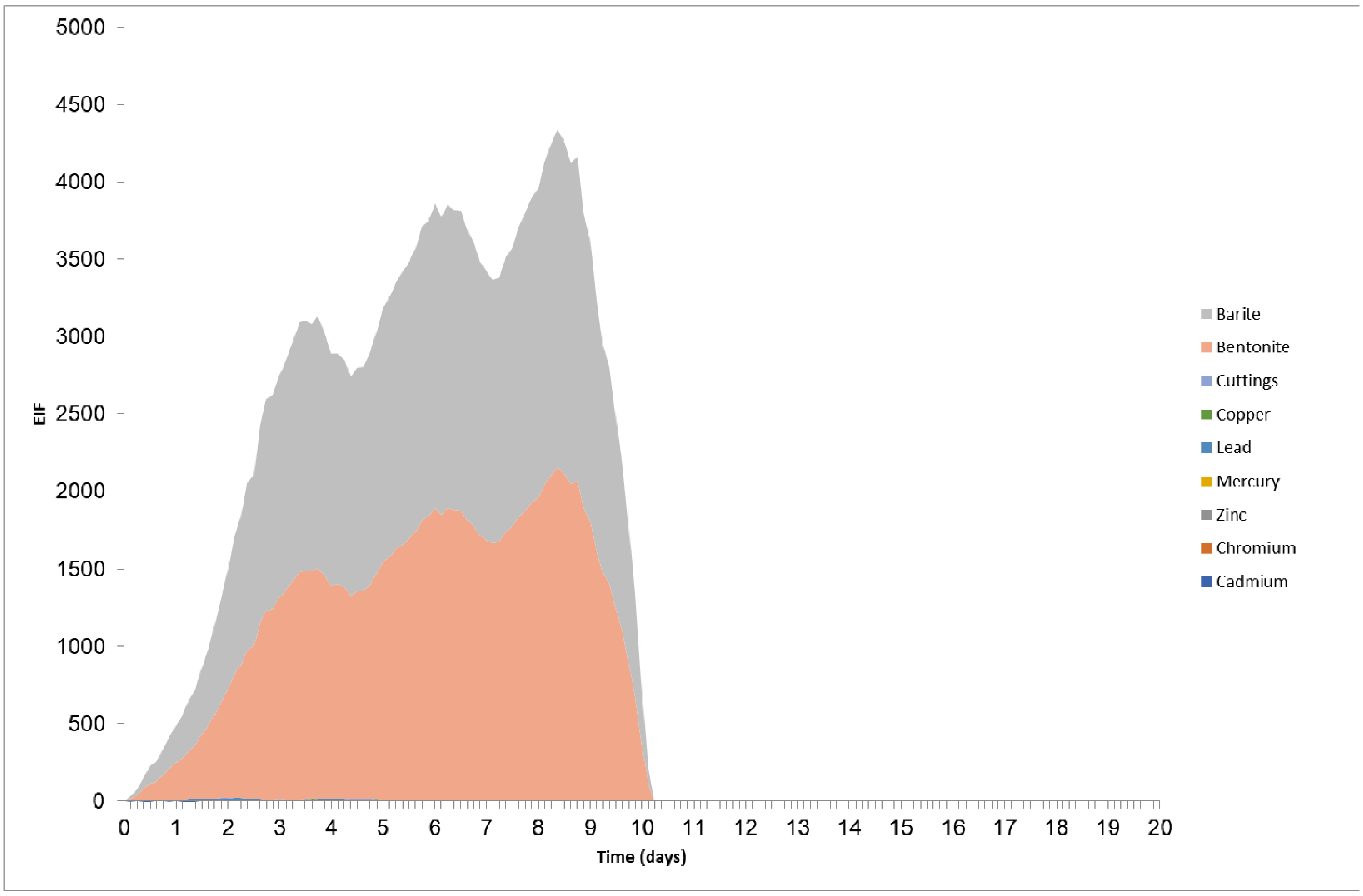


Figure 6-5 – Development of the water column impact in terms of EIF during drilling

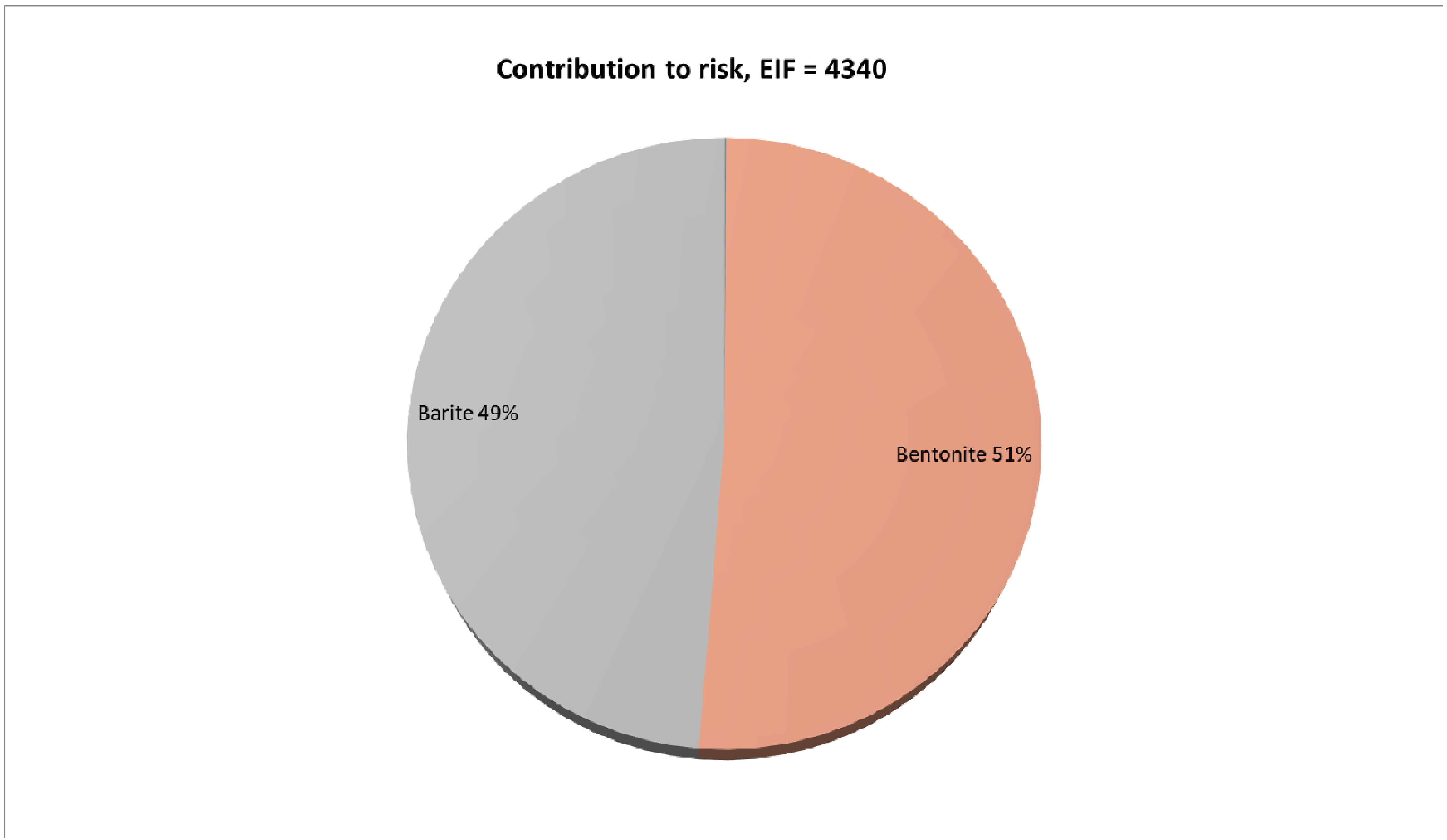


Figure 6-6 – Contribution to water column risk in terms of EIF

6.6. Aqueous Discharges

6.6.1. Installation and Commissioning Overview

The production and water injection flowlines will pass through a series of pre-commissioning operations as described in Section 3.4.6 The production and water injection flowlines will be pressure/leak tested after initial installation and then again after being tied-in. No detailed pre-commissioning plan is available at the time of writing, and once this has been developed all chemical use will be subject to the appropriate risk assessment and permits and approvals. The filtered seawater used to flood and hydrotest the water injection flowline will be 'inhibited' to prevent internal corrosion or bacterial growth the water injection flowline. This means that it will be dosed with chemicals including biocides, corrosion inhibitors and oxygen scavengers, and natural dye (colour) may be used to assist in leak detection. Typical dosages for these chemicals, based on industry experience of the product type and application, include 25 ppm for dyes and 475 ppm for biocides, corrosion inhibitors and oxygen scavengers.

There is no intention to discharge control fluids during tie-ins or commissioning. The umbilical will be a closed-loop system and a dedicated return core used to ensure fluids return to the FPSO for clean-up / disposal. Couplers will be fully rated (connection under pressure) and poppet sealed. During connection of couplers there is a potential negligible discharge (less than 1cc / ml). During commissioning all used fluids will be returned to the FPSO as in normal operations.

Any potential environmental impact which results from the discharge of the chemicals entrained in the filtered seawater will be assessed in a chemical permit prior to commencement of the operations. Depending on which parts of the process plant have been commissioned, these discharges may be direct to sea or through the Anasuria FPSO produced water / slops system.

6.6.2. Operational Discharges

Well Intervention Discharges

The wells are designed for minimal workover/operation activities. As such, no workovers are planned on the Teal West wells. However scale squeeze operations are expected to be required once every 18 months after the commencement of water injection. Therefore there is the potential for scale squeeze chemicals to be used and discharged during operations through the life-of-field. These will be discrete discharges throughout the life of the development and will be fully risk assessed and subject to appropriate permits and consents under OCR before they are used or discharged meaning that there is no possibility of impact to species in the water column.

Produced Water Discharges

Produced water may contain residues of reservoir hydrocarbons (oil), dissolved organic and inorganic compounds present in the geological formation and chemicals added during the production process. Examples of the types of chemicals which may be used on the FPSO include defoamer, demulsifier, wax inhibitor, biocide, reverse emulsion breaker, scale inhibitor and oxygen scavenger. The produced water treatment system is designed to remove the majority of residual hydrocarbons; but is not expected to have any impact on any chemicals or naturally occurring substances which have dissolved in the water phase.

Produced water will be commingled with existing Anasuria Cluster produced water in the First Stage Separator and Produced Water system. Produced water will be treated and discharged overboard in compliance with the Anasuria's OPPC Permit. As shown in the Project Description (Section 3.4.4), produced water volumes rise significantly in year five of production to >1800 t/day as seawater injection takes effect. As water injection continues and a further production well is drilled, the high case produced water generated gradually increases before peaking at 2,318 te/day.

The Anasuria FPSO produced water system has a capacity of 100,000 bbl/d. The combined Anasuria cluster and Teal west high case profiles do not exceed this capacity throughout the field life presented in Figure 6-7. Therefore, there is ample installed capacity considering the increased produced water resultant from the Teal West development and no modifications are required.

The Anasuria OPPC Permit will be updated to include Teal West's produced water volumes and chemistry. There will be no change in the produced water treatment strategy and the oil discharge permit will be reviewed annually as applicable. Whilst it is currently too early in the project to specify the production chemicals that will be present in any produced water discharged, these will be fully assessed and permitted in accordance with the OCR once the need for specific chemicals has been fully identified.

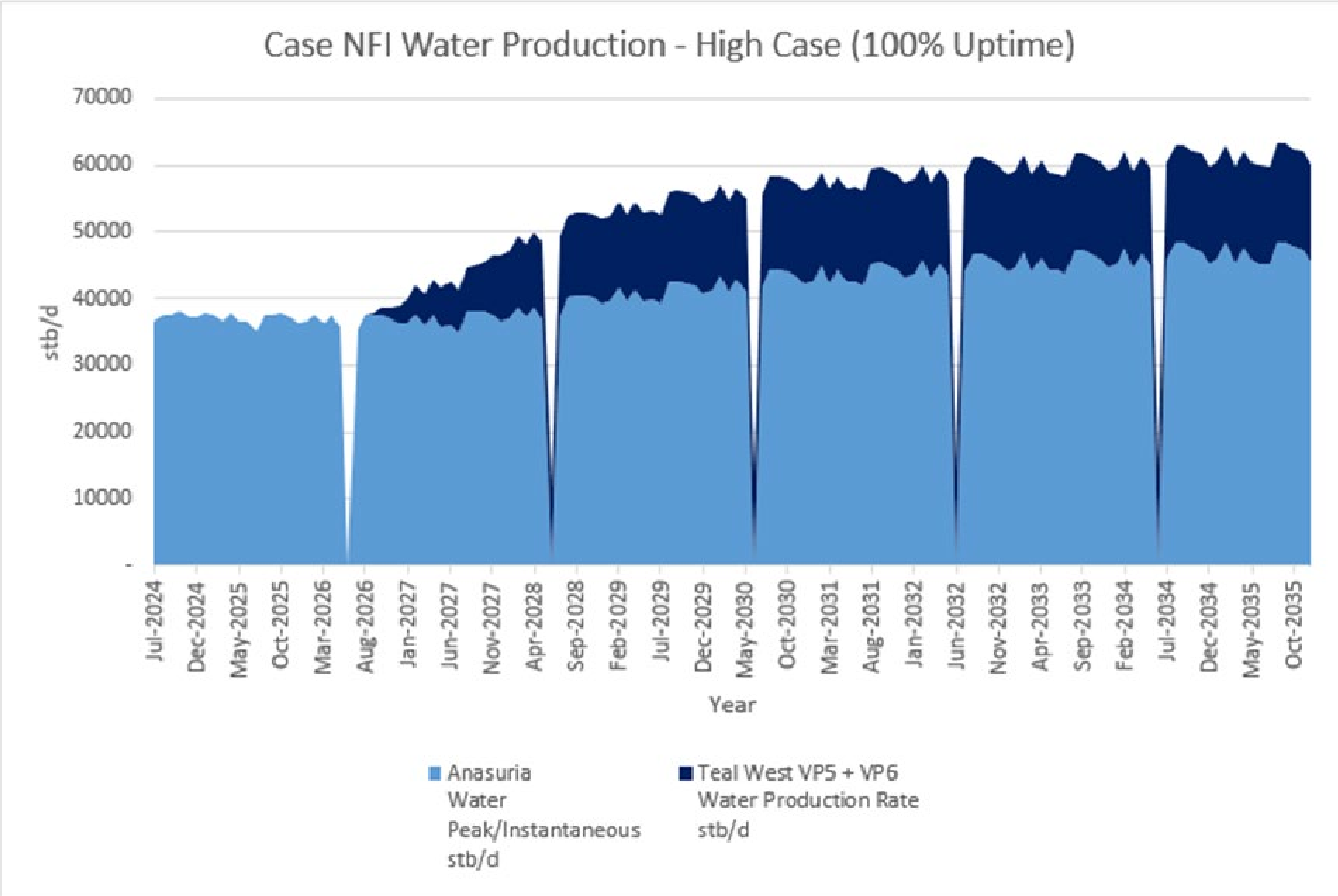


Figure 6-7 – Combined Anasuria Cluster and Teal West Water Production Profile

Potential Water Column Impacts

Discharges from the installation and the commissioning as well as the produced water have the potential to affect water quality with potential effects on plankton and animals in the water column.

The potential for impacts on water column receptors from produced water discharges, pre-commissioning and commissioning discharges depends on many factors. These include the sensitivity of the receptor organisms (which can vary widely between species), the nature of the chemicals used, and the concentration of the chemicals and hydrocarbons in the discharge stream. Most studies on produced water toxicity and dispersion have concluded that the necessary dilution to achieve a No Effect Concentration (NEC) would be reached at <10 to 100 m, and usually less than 500 m from the discharge point (IOGP, 1994; OLF, 1998; Riddle *et al.*, 2001; Berry and Wells, 2004; DECC, 2016).

Plankton abundance is influenced strongly by the physical environment and variables such as water temperature, current velocity, stratification in the water column, and nutrient concentration. As a result, they are particularly vulnerable to the introduction of chemicals and hydrocarbons to the water column. Plankton may be exposed to these contaminants through passive diffusion, active uptake, or through eating contaminated prey. As plankton spend most of their lives in the water column, they will be exposed to those contaminants that remain in solution (Sheahan *et al.,* 2001). Produced water can affect recruitment in calanoid copepods (Hay *et al.*, 1988), with lowered fecundity and increased offspring mortality reported for some plankton, as outcomes of hydrocarbon contamination (Van Beusekom & Diel-Christiansen, 1993). Strømgren *et al.* (1995) found that acute toxicity in the diatom Skeletonema spp. Was only likely in individuals in the immediate vicinity of the source of produced water, where concentrations of contaminants are highest.

The OSPAR (2010b) Quality Status Report (QSR) noted that water column monitoring to determine possible effects from polycyclic aromatic hydrocarbons (PAHs) and other chemicals such as alkyl phenols discharged with produced water has been carried out to a limited extent in the OSPAR area. Monitoring with caged mussels in the Netherlands and Norwegian sectors of the North Sea has shown that mussels exposed to produced water discharges may accumulate PAH and show biological responses up to 1,000 m from the discharge. Concentrations of PAHs and alkyl phenols and measured biological responses in wild fish such as cod and haddock caught in the vicinity of offshore installations from Norwegian waters in 2002 and 2005 showed a mixed pattern mostly with no increased concentrations, but some elevated biological responses suggesting past exposure. Exposure of cod sperm cells to environmentally relevant concentrations (100, 200, 500 ppm) of produced water from the Hibernia platform, Newfoundland, did not result in a strong toxicity to the cells (only subtle changes were observed) or a significant change in fertilisation rate (Hamoutene *et al.*, 2010 in DECC, 2016).

Bakke *et al.* (2013) reviewed research on the biological effects of offshore produced water discharges, with focus on Norwegian waters. Produced water discharges are a continuous source of contaminants to continental shelf ecosystems, and alkylphenols and PAH were found to accumulate in cod and mussels caged near the discharge points, but these compounds are rapidly metabolized in cod. Such compounds may affect reproductive functions, and various chemical, biochemical and genetic biomarkers, but Bakke *et al.* (2013) concluded that the risk of widespread impact from such operational discharges is low.

The largest discharges to the water column during pre-commissioning and commissioning will be associated with flowline dewatering operations, which will be discrete discharges. Whilst a range of chemicals (e.g. biocide, corrosion inhibitor, oxygen scavenger) used to inhibit the seawater, are used to fill the pipe during storage and hydrotest, these chemicals are used up and degraded by the reactions involved in providing their primary function of protecting the pipeline. Small discharges occur shortly after the chemicals are added to the pipeline (e.g. hydrotest), however, the dewatering discharge is by far the largest discharge during commissioning and will involve the discharge of inhibited anaerobic seawater with low residual chemical concentration. These discharges are likely to be rapidly dispersed in the turbulent offshore environment meaning that there is no possibility of impact to species in the water column.

During production of Teal West, the Anasuria produced water operating philosophy will remain the same and aim to achieve as low an oil-in-water (OIW) concentration as possible (<30 mg/l monthly average) in produced water that will be discharged overboard after treatment. Teal West discharges will add to existing Anasuria Cluster produced water in which all produced water will be discharged overboard to sea. This increase in produced water is not expected to have any significant impact on the existing facility produced water process. Considering the above, no major impact is foreseen in relation to these categories.

6.7. Management and Mitigation

6.7.1. Drilling Discharges

A number of mitigation measures will be applied to the development to limit, where practicable, the potential environmental impacts of discharges to sea, including:

- Drilling muds will be re-cycled as far as practicable to reduce discharges;
- Cuttings contaminated with SOBM will be transferred to shore for proper treatment and disposal via industry standard skip and ship processes;
- Completion brine contaminated with hydrocarbon or SOBM will be treated on the rig, transferred to vessel for onshore waste processing;

- Alternatives to chemicals carrying substitution notifications will be sought;
- Chemicals will only be used in accordance with the Drilling Permit conditions and according to AHUK's internal procedures;
- A rig audit will be conducted to the ensure the drilling rig is in compliance with all relevant guidelines and legislation;
- An environmental risk assessment will be carried out as part of OCR approval process, and identification of measures to reduce risk including chemical selection procedures, to obtain approval for chemical use prior to operations commencing;
- Cementing procedures will be implemented to reduce unused cement discharges; and
- BEIS sampling requirements will be followed when drilling through the reservoir section.

6.7.2. Aqueous Discharges

The main form of mitigation for water column impacts from flowline installation and commissioning discharges, which include flowline flooding and dewatering will be the selection of chemicals. Selection of chemicals will be made in accordance with AHUK's procedures and with relevant permit requirements.

The produced water system is designed to reduce the oil content in the produced water to a target of below 30 mg/l monthly average, for overboard discharge

Once the final chemical requirements are known, and prior to the commencement of operations, AHUK will submit the relevant permit applications, supported by appropriate detailed chemical risk assessments, to OPRED under the OCR in order to obtain approval prior to chemical use and discharge.

6.8. Decommissioning

As part of the detailed planning for decommissioning (Section 3.6), a full assessment will be conducted of the potential for discharges to sea of hydrocarbons or chemicals during cleaning or removal of the infrastructure, involving consultation with the regulator and consultees and best environmental practice at the time. The mitigation measures described in this chapter with respect to selection and optimisation of chemical use will also apply to the decommissioning process, and chemical risk assessments will be conducted in line with the applicable regulations.

Consideration will also be given to the potential impacts from re-suspension of deposited cuttings; however, as no oily discharges will be made during drilling, significant impacts from cutting piles during decommissioning are not expected. Recovery is expected to commence immediately after the cessation of drilling through the natural dispersion of cuttings and colonisation of benthos. It is unlikely that significant hydrocarbon content would remain in the deposited cuttings as no oily discharges to seabed are intended to occur. Therefore, disturbance of any remaining accumulations of cuttings on the seabed is unlikely to be a significant issue at the time of decommissioning.

6.9. Cumulative and Transboundary Impacts

The area of seabed sediment impacted by the discharged cuttings pile is predicted to have a maximum thickness of approximately 33 cm, impacting a 0.005 km^2 at the 10 mm thickness contour. The cuttings pile thickness is predicted to rapidly decrease with distance from the drill centre and the seabed impacts from this pile is assessed in Section 6.5.4.

Impacts to the water column include the effects from discharges from drilling, water injection flowline commissioning and operations. The first two are transient, but the operational produced water discharges timing are currently assumed to be continuous during the Teal West development. Negligible volumes will be discharged in the first year and will marginally increase in the first 3 years of production. Following this, produced water quantities will increase significantly once the seawater injection well comes online (Section 3.4.6)

Produced water discharges from Teal West will be treated along with the produced water already processed at the existing Anasuaria FPSO. Produced water will be discharged overboard with OIW concentrations of less than 30mg/l average over a month. Residual hydrocarbons and chemicals associated with these are expected to disperse rapidly through the water column, therefore no cumulative impacts are expected on the water column from other activities occurring in the area, such as other oil and gas activities, commercial fisheries or shipping. Produced water from Teal West will add to the discharges of produced water already taking place from Anasuria FPSO. The combined Anasuria cluster and Teal west high case profiles do not exceed this capacity throughout the field life. There is ample installed capacity considering the increased produced water resultant from the Teal West development, thus no cumulative impacts are predicted.

Dewatering operations are expected to cause a small and short-lived plume which could potentially contain toxic levels of some of the chemical(s) used during the installation of the pipeline. However, exposure of organisms in the water column to toxicity will be short-term and spatially limited and no impact to the benthic environment is expected.

The limited quantity of chemicals discharged during the life of the Teal West development and the use of appropriate management and mitigation measures reduces the likelihood of any measurable cumulative impacts to the benthic environment. Additionally, dilution of the releases during the field life will likely be rapid and the potential impacts will be transient in nature. Considering this, no significant cumulative impacts are expected with regards to the water column.

Considering that the discharge to sea will occur approximately 87 km from the UK/Norway median line, no transboundary impacts are expected.

6.10. Protected Sites

No discharges to sea associated with the Teal West development will occur in any SACs, SPAs, NCMPAs, SSSIs or Ramsar sites. The nearest protected area is the East of Gannet and Montrose Fields which is located approximately 3.4 km from the well discharge locations and 0.9 km from the FPSO discharge locations. This site is designated for the presence of ocean quahog including sands and gravels as their supporting habitat. The modelling of discharges demonstrates that the discharges do not spread sufficiently far to interact with the East of Gannet and Montrose Fields. Produced water will be discharged to sea via the Anasuria FPSO following treatment, and oil-in-water concentrations will be below 30 mg/l, with dispersion occurring throughout the water column, therefore no significant impacts on the nearby MPA features are anticipated.

As such, there is considered to be no LSE on SACs, SPAs, NCMPAs and MCZs and hence no impact on any conservation objectives or site integrity is expected by discharges to sea.

6.11. Residual Impacts

6.11.1. Residual Seabed Impacts

Where cuttings settle on the seabed then losses of fauna are likely to occur. Mortality and community composition change is therefore likely at the well location due to discharge of the two riserless upper sections. However, considering the relatively limited area over which benthic habitats and species have the potential to be impacted, drilling activity at Teal West is not likely to represent a significant residual impact to benthic species.

For benthic organisms, a general threshold for mortality resulting from burial is 10 mm for non-mobile organisms. Therefore, it can be expected that there will be some localised changes to benthic community structure in the immediate vicinity of the wells with recovery expected in the medium term.

In terms of features of conservation interest, the drilling locations are not located within any protected areas and no other protected habitats and species have been identified within the potential impact zones of the drilling discharges.

<table>
<tr><th>Receptor</th><th>Sensitivity</th><th>Vulnerability</th><th>Value</th><th>Magnitude</th></tr>
<tr><td>Seabed</td><td>Low</td><td>Low</td><td>Low</td><td>Minor</td></tr>
<tr><td colspan="5">Rationale</td></tr>
<tr><td colspan="5">The deposition of cuttings on the seabed is modelled to cover a wide area, but, except in the immediate vicinity of the wellheads, it is modelled to result in a layer less than 0.01 mm thick which is unlikely to be detectable in the marine environment. The sediment deposition extent predicted by the model showed a relatively small area (0.005 km² area at the 10 mm thickness contour) with only a very small area reaching a deposition of around 33 cm. The seabed surrounding the Teal West development is typical of this area of the North Sea and predominantly muddy sand. As such, the value of the seabed receptor is considered low.

The impact footprint is low within 110 m the cuttings thickness will have decreased to less than 1 mm thick. As the impact will result from a one-off event, vulnerability and sensitivity are considered low and the magnitude is considered minor.

The worst-case has been modelled, which potentially over-estimates the seabed area affected. Given that drilling at each of the drilling locations will occur in different phases of the development, there is likely to be further redistribution of deposited cuttings between drilling events that mean the potential for overlap is restricted.
The overall residual impact is therefore considered minor and hence not significant.</td></tr>
<tr><td colspan="2">Consequence</td><td colspan="3">Impact Significance</td></tr>
<tr><td colspan="2">Low</td><td colspan="3">Not significant</td></tr>
</table>

6.11.2. Residual Water Column Impacts

Water column residual impacts relate to both the physical and chemical affects experienced predominantly by biota within the water column, including marine mammals, fish and planktonic species.

Considering the relatively limited area over which the water column is predicted to be affected, drilling activities at the Teal West development are not considered to represent a significant residual impact to the water column. Species are considered of low sensitivity with recovery likely to occur within 1-year of the cessation of drilling activity.

In terms of installation and pre-commissioning discharges, although there are likely to be a number of discharges of inhibited seawater during pre-commissioning operations, discharges will be limited in quantity and occur only intermittently. These are likely to be rapidly dispersed in the turbulent offshore environment.

Operational discharges of produced water will be treated and discharged overboard via the Anasuria FPSO. Produced water discharges due to Teal west will be very low in the first year of production and gradually increase as water injection takes effect and water cut increases, these are expected to contain small quantities of reservoir hydrocarbons and chemicals used during production which will be rapidly dispersed from the sea surface where these will be discharged. The oil content of the produced water will be less than 30 mg/l monthly average prior to discharge to sea. Whilst it is currently too early in the project to specify the production chemicals that will be present in any produced water discharged, these will be fully assessed and permitted in accordance with the OCR once the need for specific chemicals has been fully identified.

There is potential for scale squeeze fluids to be discharged, however, these will occur only intermittently is required and will be transient impacts. These discharges to sea are likely to be rapidly dispersed in the offshore environment meaning that there is no possibility of measurable impact to species in the water column.

Receptor	**Sensitivity**	**Vulnerability**	**Value**	**Magnitude**
Water Column	Low	Low	Negligible	Low
Rationale				
Plankton are particularly susceptible to impacts from drill cuttings because they are generally non-motile and cannot move away from an affected area. Produced water will be treated to an acceptable level within the legislative requirement of 30 mg/l monthly average, and 100 mg/l at any given time which is not expected to result in significant impacts to plankton. Plankton occur in large numbers, are borne in large moving water masses, and have extremely high natural mortality rates. Therefore, due to the regulated conditions of chemical use, the small discharge volumes in relation to the receiving environment, and the large dilution and dispersion available, impacts are expected to be largely non-measurable. Thus, sensitivity and vulnerability are considered to be low. Discharges of inhibited seawater during pre-commissioning operations associated with flowline dewatering operations will be discharged at the Anasuria FPSO. These will be limited in quantity and occur only intermittently. These are likely to be rapidly dispersed in the offshore environment therefore the magnitude is negligible and there is no possibility of minor impact to species in the water column. No water column species of conservation concern are expected to occur in the proximity of the development; therefore, the value of the water column receptor is therefore considered to be negligible. In terms of drilling discharges, the modelling presents a worst-case scenario due to reducing the time between the drilling discharges. In reality, the wells will be drilled in different phases of the development and well sections will be drilled with breaks. Breaks between sections and wells will allow some recovery of the environment due to the transient water column impacts between drilling periods. The overall residual water column impacts are therefore considered to be minor and not significant.				
Consequence		**Impact Significance**		
Low		Not significant		

7. SEABED IMPACTS

7.1. Introduction

This chapter describes the nature of potential impacts on seabed habitats and fauna arising from the Teal West Development activities and assesses the significance of these impacts.

The key Development activities that may impact the seabed area are:

- The jack-up rig deployment for drilling of up to two subsea production wells and one water injection well from a new drill centre . Rig spud can penetration and its impact to seabed are included in this activity;
- The deposition of water-based drill cuttings directly at the seabed. The seabed impacts from drill cuttings (informed by the drill cuttings modelling that was undertaken for the project) are covered in more detail in Chapter 6;
- Installation of the DCVS, RBM, DUTA, wellheads, and associated infrastructure.
- Trenching and laying of pipelines, control umbilicals, and jumpers; and
- The placement and presence of subsea infrastructure protection materials including concrete mattresses, sandbags and clump weights. Rock dumping can be used as a contingency for mitigating upheaval buckling of the pipeline.

The existing Anasuria FPSO is planned to be used as the host production facility for the Development, therefore its anchors footprint has not been assessed.

The above activities have the potential to lead to changes in the seabed and potential negative impacts on the biota, including:

- Direct loss of benthic species;
- Direct loss of benthic habitat;
- Introduction of new hard substrate; and
- Wider indirect disturbance to the benthic environment through the suspension and re-settlement of sediments.

7.2. Regulatory Controls

In addition to the EIA regulations detailed in Section 1.5, there are other requirements of UK legislation, international treaties and agreements relevant to the assessment of impacts on disturbances of the seabed.

The following legislation is key in relation to seabed disturbance from the proposed Development in terms of the potential impacts to the seabed and benthic habitats offshore:

- Marine (Scotland) Act 2010;
- Marine and Coastal Access Act (2009);
- Petroleum Act 1998;
- Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 (as amended);
- Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 (as amended);
- The Convention for the Protection of the Marine Environment of the North-East Atlantic (The OSPAR Convention);
- Convention on Biological Diversity; and
- The Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention).

On behalf of the Scottish Government, JNCC, NatureScot and Marine Scotland have together developed recommended lists of PMFs in Scotland's seas (SNH, 2014; Tyler-Walters *et al.*, 2016). The lists have not been developed in accordance with any specific legislation, agreement or convention; but were developed to guide policy decisions regarding the conservation of Scotland's seas through the identification of priority species and habitats. The list of recommended PMFs in Scotland's offshore waters was adopted in 2014 and contains 81 habitats and species considered to be of conservation importance.

7.3. Description and Quantification of Seabed Impact

Physical disturbance to the seabed will result from the siting of a jack-up rig, the installation of pipelines, umbilicals, flexible risers, wellheads, DCVS, RBM, DUTA, electrical leads and jumpers, and the placement of protection materials. The impact on the seabed has been assessed based on the following:

- The drilling of two subsea production wells and one water injection well will be conducted by a jack-up rig. Each spud can will have a base area of up to 244 m^2 which will penetrate the seabed up to 19 m. With the wells planned to be drilled at different times, the worst-case assessment has taken into account three separate rig deployments (i.e., total of nine spud can footprints);
- The new subsea drill centre valve skid, measuring 5 m x 7 m, will be placed 100 m from the wells, and is expected to be piled using 4 x 24 m pin piles;
- The new RBM/DUTA (treated as a single structure), measuring 6.5 m x 8 m, will be placed close to FPSO end of the development to serve as the terminus for the production and umbilical risers. Two 6 x 6 m clump weights will be located at the riser-base tie-in to the Anasuria FPSO. Note that the detailed design of the riser base structure is ongoing, the included sizing is based on a worst-case outcome with respect to seabed impact;
- The production flowline and the control umbilical will be buried in separate trenches at 30 m distance. The length of each will be up to 3,600 m and the trenching method will impact a 3 m wide corridor. A water injection flowline of 4,000 m length will be installed at a later time in a similar manner; and
- Any crossings between jumpers, pipelines, umbilicals, subsea drill centre valve skid, water injection spools and trees will be physically protected with concrete mattresses and sandbags. Rock placement (up to 4500 te) may be required in spot locations at crossings with existing pipelines and to mitigate against upheaval buckling.

Although it is assessed in more detail in Chapter 6, the impacts from drill cuttings at the seabed are included in this chapter also to represent a complete picture of seabed impacts. The drill cuttings dispersion modelling that was undertaken for the Teal West Development estimated that this will result in a seabed footprint of 0.005 km^2 at the 10 mm thickness contour (see modelling results in Section 6.5).

7.3.1. Physical Loss or Abrasion of Benthic Habitats or Species

The drilling of three wells will be conducted from a jack-up drilling rig. Jack-up rigs use spud cans on the bottom of the legs to support the rig on the seabed. Spud cans will penetrate and compress seabed causing mortality or displacement of benthic biota up to an area of 732 m^2. AHUK will aim to minimise the footprint by re-using the existing spud can depressions during subsequent drilling campaigns (dependent on the availability of the same rig). In a worst-case scenario three rig placements (i.e. total of 9 spud can footprints) will have 2,196 m^2 footprint. The benthic assemblage within this area will be inevitably lost whilst the rig is on location. However, the overall impact will be localized and temporary in nature given the small footprint and short duration of the drilling operations. The impacted area can be re-colonised in a number of ways, including mobile species moving in from the edges of the area or from burrowing species digging back to the surface.

The installation of pipelines, control umbilical, jumpers, electrical / hydraulic leads, wellheads and other associated subsea infrastructure, as well as the placement of protection materials may cause mortality or displacement of benthic species due to habitat loss within their direct footprint. The significance of habitat loss and mortality of seabed organisms depends on the area of disturbance, the level of tolerance of the affected habitat and species to physical disturbance, the conservation value of the affected habitat or species and their uniqueness to the area. The total direct footprint of subsea installations at seabed surface (excluding flow lines and umbilicals) is estimated as 573 m^2. This impact on seabed will be long-term as these structures are expected to remain in place until the end-of-field-life.

On the other hand, trenching and backfilling activities, while affecting a wider area (direct footprint of 0.033 km^2), are likely to result in a lesser impact. Some level of recovery will occur in the sediments following the cessation of trenching operations. The longevity of the physical disturbance and scars on the seabed is dependent on the sediment type and energy of the local benthic environment, as indicated by the studies carried out for seabed disturbance by towed fishing gear (Løkkeborg, 2005). Scars in higher energy, sandy or shallow environments may disappear within days or months of initial disturbance, whilst those in lower-energy silty and deeper areas may still be faintly visible after 18 months (Marine Scotland, 2013). The main sediment type observed within the Development area was rippled muddy sand or sand, with varying proportions of shell fragments. This sediment type was classified as the EUNIS biotope complex 'Deep circalittoral sand' (A5.27) (Fugro, 2022a). The higher level 'Sublittoral sand' (A5.2) habitat also specifies that the habitats are subjected to a degree of wave action or tidal currents, which limited the silt and clay (mud) content to < 15%. Therefore, in this medium energy environment seabed scars from trenching and backfilling may persist for up to several months. Furthermore, the 'Deep circalittoral sand' is illustrative of the broad UK BAP habitat 'subtidal sands and gravels' and is widely distributed in the CNS and represented elsewhere in the Marine Protected Area (MPA) network (JNCC, 2021).

Seabed sediments provide support, protection and the food source for many macrofaunal species. The sediment macrofauna, most of which are infaunal (living within the sediment), are therefore particularly vulnerable to external influences that alter the sediments' physical, chemical or biological nature. Such infaunal animals are largely sedentary and are thus unable to avoid unfavourable conditions. The review by Løkkeborg (2005) nevertheless notes that biological communities in physically disturbed seabed typically show recovery well before the scars themselves have disappeared.

The environmental baseline and habitat assessment survey conducted at Teal West in 2021-2022 revealed a diverse range of polychaetes, amphipods, bivalves and echinoderms (Fugro, 2022a). The phyletic composition, in terms of both taxa and abundance, was broadly consistent across all stations within the Teal West survey area, with annelids the most abundant and diverse, followed by molluscs and arthropods, typical for this region in the CNS. Annelids also contributed six of the top ten taxa, with the polychaetes *Paramphinome jeffreysii*, *Scoloplos armiger*, *Spiophanes bombyx* constituting the top three taxa. The community recorded was broadly consistent with the previous observations within the Teal field in 2006 (OGUK, 2021), with the exception of the higher abundance of *P. jeffreysii*. The epifaunal community throughout the survey area was generally sparse and included hermit crabs (Paguridae) and starfish (*Asterias rubens*), sea pens (*Pennatula phosphorea*), anemones (Actiniaria, including Hormathiidae and *Metridium* sp.), soft coral (Alcyonacea, including *Alcyonium digitatum*) growing on faunal tubes and faunal turf (Hydrozoa/Bryozoa). While the physical environment was associated with the biotope complex of 'Deep circalittoral sand', the biological community was concluded to be a variation of the biotope '*Paramphinome jeffreysii*, *Thyasira* spp. And *Amphiura filiformis* in offshore circalittoral sandy mud' (A5.376) but with a physical mismatch.

The biotope 'Sea pens and Burrowing Megafauna Communities', listed as PMF in Scottish waters on the OSPAR List of Threatened and/or Declining Habitats and Species, was identified as potentially being present during the 2021 – 2022 Teal West surveys. The JNCC (2014) habitat guidelines state that the seabed must be 'heavily bioturbated by burrowing megafauna with burrows and mounds forming a prominent feature of the sediment surface'. Guidelines also state that burrows should be at least 'frequent' on the SACFOR scale to be classified as a 'sea pens and burrowing megafauna community'. Faunal burrows sized 3 cm to 15 cm were recorded at only half of the stations and transects. The minimum criteria of 'frequent' was recorded at seven stations and one transect. However, the density of burrows at these locations were at the lower end of 'frequent' category with densities of burrows recorded as 1 to 2 burrows per 10 m^2. Burrows were typically small and those created by the Norway lobster (*Nephrops norvegicus*) were not recorded at any of the stations or transects. The sediments were predominantly rippled muddy sands, with no evidence of mounds. The 'Sea pens and Burrowing Megafauna' biotope is particularly sensitive to physical abrasion or disturbance of the sediment surface and to habitat loss (OSPAR, 2010). The Scottish Government's Feature Activity Sensitivity Tool (FEAST) provides information on the sensitivity and recoverability of NCMPA features to a range of pressures. The tool indicates that the habitat feature expected in the area 'burrowed mud' may show a moderate sensitivity to surface and sub-surface penetration (Marine Scotland, 2013). Although this biotope may be present, it is also extensively represented throughout the UKCS and particularly in this region of the North Sea, and the Teal West Development area is not considered to be of particular conservation importance for this biotope. The Development activities would result in the loss of burrowing fauna and habitat within the immediate footprint of the infrastructure and installation activities, which is small in comparison to the area of distribution of this biotope.

The Teal West Development is located in the vicinity of the East of Gannet and Montrose fields NCMPA designated to protect the ocean quahog *Arctica islandica*, as well as the PMF 'Offshore deep-sea muds' habitat. The closest distance to NCMPA from the RBM is approximately 700 m. Ocean quahogs were recorded at seven of the Teal West survey stations, at a density ranging from 1 to 7 individuals per station (Fugro, 2022a). As displayed on Figure 4-10, there are ocean quahog records in the vicinity of the Development area, mainly to the east, within the NCMPA, and also to the west. The presence of adult individuals of the ocean quahog (siphons) was not reported. Considering that the Development lies outwith the general distribution area for this species, and the low densities of ocean quahogs recorded during the survey, the Teal West Development area is not expected to be of a particular conservation value for this species. Ocean quahog lives at the surface of sediments while feeding and burrows to depths of 14 cm; therefore, it is vulnerable to physical abrasion and penetration of infrastructure into the sediments. It is a long-lived bivalve which takes 5 – 15 years to reach sexual maturity and spawns over a short period in the year. Recruitment is sporadic and variable (Tyler-Walters & Sabatini, 2017). Considering this, the recoverability of ocean quahog to physical abrasion and disturbance is very low. While scattered individuals of ocean quahog may occur in the Teal West Development area, it would not be expected to occur either in significant densities or in communities of specific conservation value.

The Teal West Development does not lie within an area reported by the JNCC as the Annex I habitat 'Submarine Structures Made by Leaking Gases', also listed as Scottish PMF (JNCC, 2014). However, the methane-derived authigenic carbonate (MDAC) features characteristic of this habitat type were recorded as potentially present in the northeast of the survey area (Fugro, 2022b). These were reported to be patchy in nature and outside the proposed locations of the Development infrastructure. MDAC are typically formed by microbial oxidation of gases that seep up from below the seafloor and can therefore occur in areas of pockmarks. Pockmarks were also observed along the flowline and umbilical routes within the Teal West Development area (Fugro, 2022b). Pockmarks can be found in vast numbers across the Witch Ground Basin (70km northeast of Teal West) within the CNS. Most of the pockmarks in this area are less than 3 m deep with exception to only a few larger pockmarks which have been awarded further protection (e.g. the Scanner Pockmark, which is a designated SAC and is located approximately 110 km to north-east of the Teal West Development area) (JNCC, 2018b). These are important habitats in which a variety of fauna are attracted. The hard substrate provides sufficient shelter and feeding grounds for those species which can exploit the gases released. Even though pockmarks themselves are a vulnerable habitat, it is the MDAC structures that are considered significant habitats under Annex I of the EU Habitats Directive. Pockmarks are regarded by the oil and gas industry as a possible hazard to safe operations during pipeline and other seabed infrastructure installations, and therefore avoided wherever possible (OESEA2, 2011). Considering a limited number of pockmarks recorded within the Teal West Development, the impact, if any, is expected to be highly localised.

As discussed in Section 4.3.3, the Teal West Development is located within ICES rectangle 43F0, in an area of spawning and nursery grounds for important fish species, including high intensity spawning ground for sandeels (*Ammodytes marinus)*. Sandeel prefer a spawning substrate with a low clay silt fraction (<10%) (Mazik *et al.* 2015), and as discussed in Section 4.2.3, the sediment in the vicinity of the Teal West development has a clay/silt fraction of 7-12% which is not optimum for sandeels, although there remains the potential for sandeels to be present. Sandeel lay their eggs on the seabed and show a high degree of site fidelity. As such, they are particularly vulnerable to anthropogenic disturbance. The Feature Activity Sensitivity Tool (FEAST) states that the physical removal of sandeel habitat is of a high feature sensitivity due to the nature of how sandeel spawn in the burrowed sand. Therefore any potential spawning grounds in the immediate area and adjacent to the new infrastructure will be temporarily disturbed during construction and decommissioning. In areas where rock placement occurs (resulting in a change of seabed substrate), any available spawning grounds will be permanently lost. In addition, any fish in the vicinity will be temporarily disturbed by the temporary construction and decommissioning activities. However, they are highly mobile organisms and are likely to avoid areas of turbulence during the activities. Overall, given the localised area of impact associated with the Teal West Development activities, and the largely transient nature of the disturbance to benthic sediments, the disturbance to sandeels is not expected to be significant.

The Development is also within a region of cod spawning grounds. Cod are a species known to aggregate over specific grounds to spawn and aggregate on a spawning arena where males hold small territories in a lek-like mating system. This aggregative behaviour together with seasonal site fidelity makes cod, especially vulnerable to anthropogenic impacts (González-Irusta *et al.* (2016)). However, the spawning ground for cod is widespread across the North Sea and the small and temporary impacts of the construction of the Development is not likely to cause any significant impacts.

The MarLin sensitivity review for Nephrops indicates that the species could be present close to the Development. However, the baseline surveys (Section 3.5.2) show that Nephrops was absent from the survey stations and therefore the abundance is likely to be insignificant. Furthermore, it is a species that is widespread across the North Sea and only a very small proportion would be potentially impacted.

The seabed area likely to be directly impacted by the proposed Development is provided in Table 7-1.

In addition to the physical loss and/or disturbance of benthic habitats, the disturbance of the seabed sediments will also potentially lead to the smothering of benthic species due to sediment suspension and re-settlement; this is known as an indirect impact. The quantification of indirect impact is also provided in Table 7-1 and a description of indirect impacts and how these estimates have been calculated are described further.

Drill cuttings dispersion modelling was undertaken for the Teal West Development. Impacts from drill cuttings discharges are assessed in Section 6.4; however, for the purpose of quantifying the total footprint of the Teal West activities, the footprint of drill cuttings discharges has been incorporated in Table 7-1. Results indicate that the estimated footprint of drill cuttings dispersing from the drilling location within the 10 mm contour is 0.005 km^2.

Table 7-1 – Footprint of the proposed Teal West Development activities

Structure	Parameters	Direct footprint (m^2)	Direct footprint (km^2)	Indirect footprint (km^2)
Production Flowline (DCVS to RBM)	• 3600 m Length; and • Trenched and buried in 3 m wide trench.	10,800	0.0105	0.021
Controls Umbilical (DCVS to RBM)	• 3600 m Length; • Trenched and buried in 3 m wide trench; and • Separate trench from production flowline (30 m apart).	10,800	0.0105	0.021
Water Injection line (Water Injection XT to Teal / Cook tie in spools)	• 4000m Length; and • Separate 3 m wide trench.	12,000	0.012	0.024
6" Production Riser	• 300 m (75 m on seabed); and • 1 m impact corridor.	75	0.000075	0.00015
Umbilical Riser	• 300 m (75 m on seabed); and • 1 m impact corridor.	75	0.000075	0.00015
Wellheads/ XTs (including protection structure)	• 3 wellheads; and • 14 m^2 footprint each.	42	0.000042	0.000084
Drill Centre Valve Skid	• 5 m x 7 m	35	0.000035	0.00007
Riser Base Manifold	• 6.5 m x 8 m	52	0.000052	0.000104
Clump Weights for dynamic risers/umbilical	• 2 clump weights (10 te each); and • Each clump weight is 6 m x 6 m.	72	0.000072	0.000144
Production jumpers (DCVS to XT)	• 2 jumpers; OD 6'; • 150 m length each; and • Surface laid; mattress protected.	75	0.000075	0.00015
Electrical flying leads (DCVS to XTs)	• Leads; OD 5.5 cm; • 150m length each.; and • Surface laid; mattress protected	49.5	0.000057	0.000011
Hydraulic flying leads	• 3 leads; OD 18 cm; and • Length: 10 m (on Valve skid), 150m (From Valve skid to XTs).	86.4	0.0000864	0.00017
Drilling rig spud cans	• 3 spud cans; 244 m^2 footprint each; and • 3 separate deployments.	2,196	0.0022	0.0044
Water Injection Spools	• 100 m length, OD 22.1 cm	22.1	0.000022	0.000044
Concrete Mattresses	• 300 mattresses; and • Each mattress is 6 m x 3 m.	5,400	0.0054	0.0108
Sandbags	• Up to 4000 25kg sand bags; and	720	0.00072	0.000072

Structure	Parameters	Direct footprint (m^2)	Direct footprint (km^2)	Indirect footprint (km^2)
	• 0.3 m x 0.6 m.			
Rock placement	• Contingency rock (4500 te); and • Max 3600m length, 2m wide berm.	7200	0.0072	0.0144
Subsea Infrastructure (excluding flow lines and umbilical)		584	0.00058	0.0012
Trench Footprint (for flow lines and umbilical)		33,600	0.0336	0.0672
Drilling Rig Spud Cans Footprint		2,196	0.0022	0.0044
Protection Materials Footprint (including rock)		13,320	0.0132	0.0264
Total (excluding drill cuttings)		49,700	0.05	0.1
Drill Cuttings Footprint at the 10 mm Contour		5000	0.005	n/a
Total (All)		**54,700**	**0.055**	**0.1**

7.3.2. Smothering of Benthic Habitats or Species

The second impact mechanism, indirect disturbance, is that which occurs outside of the physical infrastructure footprint. It is typically caused by the suspension and re-settlement of natural seabed sediments disturbed during various subsea operations. This secondary impact pathway is considered temporary. In the context of the Teal West Development, indirect seabed disturbance may occur during subsea infrastructure installation, trenching, pipelay, jack up rig deployment and placement of protection materials, resulting in the smothering of benthic fauna in the immediate vicinity due to sediment suspension and re-settlement. The scale of indirect disturbance is assumed to be double the direct disturbance area for all structures and activities taking place (Table 7-1).

Exposure to higher than normal loads of suspended sediment has the potential to negatively affect adjacent fauna and biotopes. Marine Scotland's FEAST tool indicates that burrowed mud habitats have a low to medium sensitivity to increased levels of siltation. The majority of species within this feature are burrowing megafauna living in the sediment and are likely to have some level of tolerance and recoverability to a temporary increase in levels of suspended sediment (Marine Scotland, 2013). The re-settlement of sediments can result in smothering (Gubbay, 2003), with the degree of impact related to the ability of buried species to return to the surface of sediments or to clear particles from their feeding and respiratory surfaces. However, DEFRA (2010) states that the impacts arising from sediment re-suspension are short-term (generally over a period of a few days to a few weeks); in addition, infaunal communities are naturally habituated to sediment transport processes and are therefore less susceptible to the direct impacts of increased sedimentation rates and will work their way back to the seabed surface through blanket smothering.

Sea pens, associated with the OSPAR-listed biotope 'Sea pens and Burrowing Megafauna', have been found in the Teal West Development area. Studies on the disturbance and recovery of sea pens have been reviewed to inform the potential indirect effects of sediment resuspension. *P. phosphorea* were found to right themselves when dislodged, with all individuals re-established after 72 hours. *V. mirabilis* was found to withdraw into its burrow rapidly and could not be uprooted by dragged creels (Hill & Tyler-Walters, 2018). In a study conducted by Hill & Tyler-Walters (2018), *P. phosphorea* were observed to recover within 72-96 hours after experimental smothering for 24 hours by pot or creel fishing gear and recovered within 96-144 hours of smothering for 48 hours. Both species have been found to recover rapidly from being dislodged, displaced, and smothered. Recovery from partial removal of the local sea pen population will depend on the recruitment process, and little is known about the life history and population dynamics of these species. It is thought that patchy and episodic recruitment, slow growth and long lifespan are typical for sea pens, suggesting a low ability to recover from partial removal (Hill & Tyler-Walters, 2018). In conclusion, if undamaged, sea pens have a high ability to recover from physical displacement, abrasion of surface sediments or smothering. Given the indirect area of impact of the Development is very small (0.1 km^2), with an additional 0.005 km^2 impacted by drill cuttings within the 10 mm thickness contour, the impact on the faunal community structure will not compromise the OSPAR conservation objectives for the biotope, which include protecting and restoring the habitat in the OSPAR maritime area (OSPAR, 2010).

Ocean quahogs, which were observed within the Development area, are highly resilient to smothering and increases in siltation rates. In field studies, *A. islandica* was able to burrow to the surface of 40 cm of sediment and no effect on its growth or population structure was evident (Powilliet *et al.*, 2009). The sediments disturbed during subsea installation activities, will deposit in the immediate vicinity of the location of disturbance and the thickness of deposits will decrease with the distance from the location of disturbance. Deposits of fine material are unlikely to have a negative impact on ocean quahog, which show a low vulnerability and high resistance to smothering (Tyler-Walters & Sabatini, 2017; Hill & Tyler-Walters, 2018). Some individuals may be buried deeper in sediment berms that may form during trenching activities; however, given the low abundance of ocean quahog expected to occur in the Teal West Development area and the small footprint of the Development activities, only a limited number of individuals are likely to be lost. This will not impact the population structure and will not compromise the conservation objectives of *A. islandica*, which include strengthening the protection of the ocean quahog at all life stages to allow population recovery, improving its status and to ensure that the population is effectively conserved in the OSPAR maritime area (i.e. the Greater North Sea area; OSPAR, 2009).

The presence of potential MDAC was, identified approximately 2 km to the northeast of the Teal West Drill Centre (Fugro, 2022b). Due to the distance from the proposed Teal West development infrastructure, there are no expected impacts to potential MDAC habitat. Pockmarks were recorded along the pipeline routes, however, there was no indication of any active pockmarks or any other Annex I priority features or habitats in the vicinity of the Teal West infrastructure.

7.3.3. Introduction of Hard Substrata

Introduction of hard substrata on a soft seabed type, such as muddy sand and sand, identified within the Teal West Development area during the 2021-2022 environmental baseline survey, may affect the seabed species that depend on this habitat.

Where subsea installations, jumpers, and protection materials (concrete mattresses and sandbags, and potentially rock) will be installed at the seabed surface, the sedimentary substrata will be replaced with hard substrata and the benthic communities, including those associated with the 'Sea pens and Burrowing Megafauna' biotope or ocean quahog, will be lost. It should be noted that the majority of rock placement requirements are contingency for UHB on the production flowline and this will be minimised wherever possible (see Section 7.4). Mattresses will be used primarily for the protection of pipeline crossings where the trenched lines transition out of the sediment. Given the very small footprint of these installations (0.013 km^2) and the wide distribution of ocean quahog and sea pens in the North Sea, the impact on these sensitive seabed features is considered negligible. In principle, all installed seabed infrastructure (with the exception of rock) is designed to be removed at the end of field life, thus allowing long term recovery and recolonisation of the directly affected sediments.

7.4. Management and Mitigation Measures

The measures that will be in place to mitigate potential seabed impacts associated with drilling and subsea installation include:

- The pipelines and umbilical shall be trenched and buried over the majority of their lengths with protection mattresses only being used where necessary;
- The flexible design of the production flowline is anticipated to be less vulnerable to UHB than a rigid pipe, thus rock requirements will be kept as low as possible (subject to UHB analysis);
- Rock placement will be undertaken using fall pipe vessel to ensure the accuracy and optimisation of deposited rock, thus limiting the seabed impact to as low as reasonably practicable;
- Survey data will be used to inform the placement of concrete mattresses/grout bags;
- Pockmarks will be avoided wherever possible; and
- Consultation will be undertaken with relevant authorities, organisations and stakeholders, including Marine Scotland, JNCC and Scottish Fishermen's Federation (SFF).

Additionally, the jack-up rig footprint will be minimised by re-using the existing spud can depressions during second and third drilling campaigns, where possible, subject to the same or similar rig being deployed.

7.5. Cumulative and Transboundary Impacts

DECC (2016) identifies that the sources of cumulative physical disturbance to the seabed associated with oil and gas activities include drilling rigs, wellhead placement and recovery, subsea template and manifold installation and piling, umbilical and pipeline installation and trenching and decommissioning of infrastructure. Of these, pipelay is considered to account for the largest spatial extent. The Development will result in a predicted direct total disturbance of approximately 0.05 km^2, with an additional 0.005 km^2 impact from drill cuttings deposition within the 10 mm thickness contour (0.055 km^2 in total), and an overall indirect impact of approximately 0.1 km^2 from the suspension and resettlement of sediments in the immediate vicinity of the subsea installation activities, as detailed in Table 7-1.

The majority of this area is expected to endure a short-term disturbance, while representing a small percentage relative to the available similar habitat in the vicinity and in the wider CNS. The macrofaunal community across the Development area was diverse and dominated by annelids, typical for the region of the CNS. The 2021-2022 survey indicated that the community was consistent across the survey area and did not appear to be affected by any existing infrastructure or previous drilling related activity in the area (Fugro, 2022a).

The seabed habitat in the Teal West Development area may host the biotope ‘Sea pens and Burrowing Megafauna Communities’, however, this habitat is widely distributed in the region and the loss of fauna and habitat for this biotope is expected to be minimal due to the small area of seabed directly disturbed. A limited number of individual ocean quahog that can be potentially affected by the Teal West Development is unlikely to have a significant cumulative effect with other stressors on this conservation specie within the nearby East of Gannet and Montrose Fields NCMPA.

There are a number of other oil and gas infrastructures within a 40 km radius of the Development, as listed in Table 4-8. The nearest surface infrastructure to the Development is the Anasuria FPSO that the production flowline and umbilical will tie-back to. There are also several pipelines in the vicinity of the Development, including those associated with the Anasuria FPSO. The production flowline and umbilical will cross the gas lift pipeline from the Guillemot manifold to the Anasuria FPSO (PL1954), and the water injection pipeline will cross the Production / piggybacked gas lift pipeline from Anasuria to the Cook manifold (PL1719), operated by Ithaca, and will tie into a spool in the existing Cook Water Injection Pipeline

(PL4603) at the Teal / Cook Water Injection Riser Base. The footprints of these developments are similarly small, will have a minimal overlap with the Teal West Development, and the seabed type in the region is extensive and relatively homogenous (Figure 4-3); therefore, the cumulative impact of the Development on the seabed is considered to be negligible. There are no other known planned developments in Blocks 21/24 and 21/25 (NMPI, 2020).

The Offshore Energy Strategic Environmental Assessment (OESEA) for UKCS waters (DECC, 2009) states that seabed impacts are unlikely to result in transboundary effects and even if they were to occur, the scale and consequences of the environmental effects in the adjacent state territories would be less than those in UK waters and would be considered unlikely to be significant. Given the distance of the proposed Development to the UK/Norway median line (84 km), transboundary impacts to the seabed are very unlikely.

7.6. Decommissioning

Any potential impacts as a result of decommissioning operations (e.g. removal of the Teal West Development subsea infrastructure) will occur in the area that experienced seabed disturbance during the installation operations.

It is possible that there may be some re-suspension of low toxicity deposited cuttings during the removal of wellhead infrastructure, but recovery and re-colonisation would be expected to occur rapidly. The potential impacts from decommissioning operations are likely to be similar in magnitude to those experienced during installation and thus not considered significant.

All infrastructure is designed to be removed at the end of field life (with the exception of contingency rock). Therefore, the proposed development does not prejudice any future comparative assessments of the available decommissioning options.

7.7. Protected Sites

The Teal West Development does not occur within any areas designated for conservation purposes, and the closest site of conservation interest is the East of Gannet and Montrose Fields NCMPA, located 700 m east from the planned riser base manifold. Ocean quahog and its supporting habitat are the protected features of this NCMPA.

Seabed impacts from the Development activities will be predominantly localised. Predicted drill cuttings thickness rapidly decreases with increasing distance from the wells, reducing to 1 mm thickness within 110 m radius in a worst-case scenario (Chapter 6). Therefore, there is unlikely to be any direct or indirect impact on the nearby NCMPA. Given the low abundance of ocean quahog expected to occur within the Teal West Development area and the small footprint of the subsea infrastructure, only a limited number of individuals are likely to be affected. This is not expected to impact the population structure or compromise the conservation objectives of the East of Gannet and Montrose Fields NCMPA.

No other designated sites are located close to the proposed Teal West Development.

7.8. Blue Carbon

Marine sediments, and particularly deep sea sediments, are the primary store of biologically derived carbon (mostly inorganic carbon). Scotland's biogenic marine habitats are highly productive places, with a very high rate of assimilation of carbon into plant material (662 Gc/m^2/yr), mostly in coastal areas. Yet their overall contribution to the carbon budget is relatively small compared to sediments (Burrows *et al.*, 2014; 2017). Carbon stored in organisms can be broadly defined as either 'transient' stores, such as the carbon stored in seagrass beds, kelp and macroalgae; and 'long term' biological stores, such as biogenic structures (e.g. coral reefs, serpulid reefs, mussel beds).

Carbon may be sequestrated in marine sediments as precipitated carbonates or as particulate organic carbon (POC). While it is known that sediment accumulation rates tend to be faster nearer to land (e.g. in sea lochs), it is unclear what processes maintain the accumulation basins on the shelf, or whether any of the rich supply of organic material from phytoplankton in productive shelf waters becomes refractory and remains there (Burrows *et al.*, 2014). The principal threat to long term carbon burial in sediments is any process that stirs up the sediment, particularly the top few millimetres of sediment. Resuspension of sediment allows rapid consumption of buried carbon by organisms and its subsequent release as carbon dioxide. This effectively reduces the carbon burial rate significantly and reduces the blue carbon inventory.

Total standing stock of organic carbon in Scotland's marine sediments was estimated as 18.1 MtC, and total sequestration capacity of Scottish seas as 7.2 MtC/yr. Patterns of standing stocks and sequestration capacity of organic carbon follow the distribution of mud and mud-sand-gravel combinations. Most organic carbon and the largest capacity for sequestration of organic carbon appears to be in deep mud off the continental shelf (Burrows *et al.*, 2014). A review of sediment accumulation rates showed that the burial rates for organic carbon are strongly dependent on sediment type.

The seabed type within the Teal West Development area is classified under the habitat complex 'deep circalittoral sand', EUNIS habitat code A5.27 (MD5: Offshore circalittoral sand). Burial rates for organic carbon into sand/mud sediments, such as those at Teal West, are moderate compared to other sediment types (50.6 Gc/m^2/yr).

Overall, the sediments in the Development area are considered to have a low carbonate value, and there is an absence of other habitats with blue carbon potential (e.g. kelp beds, seagrass beds) in the area. Consequently, the Teal West is not considered to represent an area of high blue carbon potential and so the activities associated with the development are unlikely to impact the carbon sequestration potential of the immediate seabed and associated habitats.

7.9. Residual Impacts

7.9.1. Physical Loss or Abrasion of Benthic Habitats or Species

Receptor	Sensitivity	Vulnerability	Value	Magnitude
Benthos	Moderate	Low	Moderate	Minor
Seabed habitats	Moderate	Low	Moderate	Minor
Rationale				
The seabed surrounding the Development is typical of this region of the CNS and predominantly consists of rippled muddy sands with no evidence of mounds. The benthic surveys conducted within the Teal West Development area between November 2021 and January 2022 identified the potential presence of the OSPAR and PMF listed biotope 'Sea pens and Burrowing Megafauna Communities' due to recorded sea pens and low-density burrows (1 to 2 burrows per 10 m^2). Burrows were typically small and those created by the Norway lobster (*Nephrops norvegicus*) were not recorded at any of the stations or transects. This habitat is widely distributed in the region and the loss of fauna and habitat for this biotope is expected to be minimal due to the small area of seabed directly disturbed. The long-lived bivalve ocean quahog was also identified in low abundance within the Development area, which is likely to be linked to the nearby East of Gannet and Montrose Fields NCMPA designated for protection of this specie and its habitat. MDAC recorded during the 2021-2022 surveys was not in the vicinity of the Teal West development and the pockmarks present in the area were not considered to be of important conservation value. Overall, The conservation value of all these receptors is **moderate**. Ocean quahog and 'Sea pens and Burrowing				

Megaufauna Communities' are particularly sensitive to abrasion and removal of the seabed surface, which may occur during installation of the subsea infrastructure and pipelay at the Teal West field, and placement of protection materials as well as jack-up rig deployment. The sensitivity of the benthos overall is thus considered **moderate** for the Development area. There will be a loss of seabed habitats and fauna within the immediate footprint of seabed infrastructure, including pipelines, umbilical, jumpers, wellheads, and protection materials (0.05 km^2). Seabed compression and abrasion will occur due to the placement of jack-up rig (0.002 km^2). The total direct seabed impact is therefore 0.055 km^2. In addition, the impact footprint of cuttings of a thickness with the potential to bury benthic organisms (10 mm) will result from a one-off event, impacting an estimated area of 0.005 km^2. The sediments disturbed within the footprint of subsea installation and trenching activities will resettle in the vicinity of the disturbed area, causing an indirect impact within a 0.1 km^2 area. This direct impact will result in a one-off event, resulting in a localised loss of seabed habitat and fauna. The impact will not affect long-term function of the ocean quahog population, or sea pens and burrowing megafauna communities, which are widely distributed in this region of the North Sea. The potential abrasion of pockmarks and associated MDAC habitat is unlikely as their presence is limited and will be avoided wherever possible. Therefore, the vulnerability of these receptors to the direct seabed impact resulting from the Development activities is **low**. No other seabed habitats of conservation importance were identified in the vicinity of the Teal West field, and it is understood that the habitat is typical of the CNS. Whilst the value of the receptors is high and sensitivity is moderate, their vulnerability to physical loss or abrasion are considered to be low due to the small footprint of the Development, which will not affect the long-term function of the communities of conservation importance that may be present at Teal West. The resulting impact is thus considered **minor** and **not significant.** The consequence is therefore assessed as low and therefore not significant in EIA terms.	
Consequence	**Impact Significance**
Low	Not significant

7.9.2. Smothering of Benthic Habitats or Species

Receptor	Sensitivity	Vulnerability	Value	Magnitude
Benthos	Low	Low	Moderate	Minor
Seabed habitats	Low	Low	Moderate	Minor
Rationale				
The disturbance of seabed sediments during subsea infrastructure installation, and placement of the jack-up rig as well protection materials will potentially lead to the smothering of benthic species and habitats. This is considered as an indirect impact from the Development. The benthic surveys conducted within the Teal West Development area and in the surrounding fields identified the potential presence of the OSPAR and PMF listed biotope 'Sea pens and Burrowing Megafauna Communities, and of the long-lived bivalve ocean quahog in low numbers. The conservation value of these receptors is **moderate**. However, while both ocean quahog and sea pens are vulnerable to physical abrasion, they can tolerate some level of burial that will occur in the areas surrounding the Development infrastructure. Therefore, the sensitivity of the benthos to smothering is considered **low**. Because only a very small proportion of the sea pens and ocean quahog population may be smothered and they both present some level of recoverability to smothering, the impact is not likely to affect the long-term function of these communities. The impact will be result from a one-off event, impacting a small area of the seabed (0.01 km^2), with effects that will not be noticeable in the long term. Therefore, the vulnerability is considered **low**.				

MDAC features observed in the northeast of the survey area were ~2km away and will not be affected by the proposed Teal West Development. Pockmarks were recorded in the survey area but were not considered to be of conservation importance. No other seabed habitats of conservation importance were identified in the vicinity of the Teal West Development area and it is expected that the habitat will be typical of the CNS. Considering this and the other mitigation measures that will be in place for the Teal West Development, the residual impact from indirect disturbance of the seabed is considered **minor** and **not significant.** Whilst the value of the receptors is high, their sensitivity and vulnerability to smothering are considered to be low due to their capacity to accommodate some level of smothering. The small area of seabed that will experience smothering is not likely to affect the long-term function of the ocean quahog population or seapens and burrowing megafauna communities that may be present in the Teal West area. The resulting impact is thus considered **minor** and **not significant.** The consequence is therefore assessed as low and therefore not significant in EIA terms.	
Consequence	**Impact Significance**
Low	Not significant

8. UNDERWATER NOISE

8.1. Introduction

This chapter provides an assessment of the potential impacts associated with noise emissions from the drilling, installation and operation of the Teal West development. The most up to date scientific information and the recent guidelines have been utilised to address the potential noise impacts to marine wildlife, including marine mammals and fish. This chapter also includes an assessment of the potential for the proposed operations to cause a disturbance to European Protected Species.

Underwater sound is generated by natural sources such as rain, breaking waves and marine life, such as whales, dolphins and fish, contributing to the ambient, or background, sound. Humans use of the marine environment adds additional sound from numerous sources including shipping, oil and gas exploration and production, aircraft and military activity. In this assessment, sound is used as a term for anything that an individual animal can hear. The term noise is reserved herein for anthropogenic sound that may have some form of potential impact (for example, it may affect behaviour). Whilst all 'noise' is also 'sound', not all 'sound' will be considered 'noise' unless it is from an anthropogenic source and may potentially elicit a response.

Many species found in the marine environment (including seabirds, fish and marine mammals) use sound to understand their surroundings, track prey and communicate with members of their own species. Some species, particularly cetaceans (whales, dolphins, and porpoises), also use sound to build up an image of their environment and to detect prey and predators through echolocation.

8.2. Regulatory Controls

In terms of the potential impacts from underwater noise associated with the Teal West Development, the important legislative drivers are those that enact the EU Habitats Directive into UK and Scottish law. These regulations include the following:

- Conservation of Offshore Marine Habitats and Species Regulations 2017;
- Offshore Petroleum Activities (Conservation Habitats) Regulations 2001 (as amended); and
- Conservation (Natural Habitats, &c.) Regulations 1994 (as amended in Scotland).

The regulations above make it an offence to:

- Deliberately capture, injure or kill any wild animal of a European Protected Species; or
- Deliberately disturb wild animals of a European Protected Species in such a way as to:
    - Impair their ability to migrate, hibernate, survive, breed, or rear or nurture their young; or
    - Significantly affect the local distribution or abundance of the species to which they belong.

According to the Regulations, an assessment of the potential to injure and disturb such species must be undertaken for any operations that may emit noise. The assessment should determine:

- The extent to which injury or disturbance may occur (or indeed if it will occur); and
- Whether a European Protected Species licence to conduct the operations is necessary.

European Protected Species are animals (but not birds) listed on Annex IV of the Habitats Directive whose natural range includes Great Britain. All whales and dolphins are designated as European Protected Species; the information presented in Chapter 4.3.5 shows that such species likely to be found in the Teal West Development area include the harbour porpoise, bottlenose dolphin, white-beaked dolphin, white-sided dolphin and minke whale. There are no fish species listed as European Protected Species that are likely to occur in the Teal West Development area (Chapter 4.3.3); note, however, that basking sharks (occasionally sighted on the continental shelf) are given a similar level of protection as European Protected Species by the Wildlife and Countryside Act 1981, which prohibits killing, injury or disturbance of any individuals. Atlantic salmon inhabit the surface waters and shelf edge waters of the Faroe-Shetland Channel during northwards migrations, but this species is only afforded protection (by the Habitats Regulations) in freshwater.

According to the regulations detailed at the start of this section, a project's applicant must assess if the noise-emitting operations described in this chapter have the potential to cause injury or disturbance to any species designated as a European Protected Species. If injury or disturbance is considered likely, AHUK will be required to apply for a European Protected Species licence. The process involves a two-stage approach to risk assessment. The first step (a Stage I European Protected Species risk assessment) requires an assessment of the likelihood of injury or disturbance, where alternatives and mitigation measures are taken into account. The Stage I European Protected Species risk assessment consists of two main components:

- Determination of the likelihood of an injury; and
- Determination of the likelihood of disturbance.

This requires a review of:

- the duration and frequency of the activity;
- the intensity and frequency of sound and extent of the area where injury and disturbance thresholds could be exceeded, taking into consideration species-specific sensitivities;
- the interaction with other concurrent, preceding or subsequent activities in the area (potential cumulative impacts);
- the Southall *et al*. (2007) thresholds for injury and behavioural responses, and other relevant published studies; and
- whether the local abundance or distribution could be significantly affected.

If the Stage I European Protected Species risk assessment concludes that an offence of either form is still likely, and the applicant determines that there are no other available options or methods, the European Protected Species licence assessment process (a Stage II European Protected Species licence assessment) must be initiated. The requirement for a European Protected Species licence is considered further in Section 8.10. Importantly for this assessment, it must be considered that the definition of the potential for significance disturbance differs inshore and offshore, in that inshore disturbance of an individual European Protected Species would be considered an offence whilst in offshore waters it is disturbance of a significant group of animals that would be considered an offence.

Relevant to the potential impact of noise in terms of how the emissions may impact upon bird species is The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended) and Conservation of Offshore Marine Habitats and Species Regulations 2017 which make it an offence to kill, injure, or take any wild bird.

8.3. Assumptions and Data Gaps

In order to ensure that the underwater noise assessment reflects the realistic worst-case scenario; key assumptions have been made regarding the following:

- The thresholds used to understand potential disturbance ranges are those at which the onset of possible disturbance could occur; in reality, estimated ranges will likely be lower, since not all animals will be disturbed at those larger estimated ranges; and

- Where environmental parameters are likely to be variable in time or space, the underwater noise modelling has made use of the worst-case values. For example, a sea state of zero has been assumed since it results in the greatest propagation of noise compared to other sea states, whilst a conservative marine mammal swim speed of 1.5 m/s has been used since it will result in animals receiving a greater amount of noise.

Noise propagation models which define noise impact criteria are limited by the available data used to inform the model's metrics. At present, there are no direct measures of PTS in marine mammals. Noise-modelling work has so far been generally based on measured TTS responses. Data on TTS thresholds have been extrapolated to determine PTS values using auditory weighting functions (AWF). There is some discourse within the scientific community as which extrapolation metric is most appropriate for each hearing group (i.e. high-frequency, mid-frequency, and low-frequency cetaceans, and the true- and eared-seals). However, this remains the best methodology for determining hearing thresholds in marine mammals given current data limitations.

8.4. Marine Mammal Impact Criteria

Underwater sound has the potential to affect marine life in different ways depending on its sound level and characteristics. Richardson *et al.* (1995) defined four zones of sound influence which vary with distance from the source and level. These are:

- The zone of audibility: this is the area within which the animal is able to detect the sound. Audibility itself does not implicitly mean that the sound will have an effect on the marine mammal;
- The zone of responsiveness: this is defined as the area within which the animal responds either behaviourally or physiologically. The zone of responsiveness is usually smaller than the zone of audibility because, audibility does not necessarily evoke a reaction;
- The zone of masking: This is defined as the area within which sound can interfere with detection of other sounds such as communication or echolocation clicks. This zone is very hard to estimate due to a paucity of data relating to how marine mammals detect sound in relation to masking levels (for example, humans are able to hear tones well below the numeric value of the overall sound level); and
- The zone of hearing loss, discomfort, and injury: this is the area where the sound level is high enough to cause tissue damage to auditory or other systems. This can be classified as either a temporary threshold shift (TTS) or permanent threshold shift (PTS). At even closer ranges, and for very high intensity sound sources (e.g. underwater explosions), physical trauma or even death are possible.

For this assessment, the zones of injury in terms of PTS and disturbance (i.e. responsiveness) are of concern. To determine the potential spatial range of injury and disturbance, a review has been undertaken of available evidence, including international guidance and scientific literature. The following sections summarise the relevant thresholds for onset of effects and describes the evidence base used to derive them.

8.4.1. Injury (Physiological Damage)

The JNCC (JNCC, 2010) recommends using the injury criteria proposed by Southall *et al.* (2007), which are based on a combination of linear (i.e. un-weighted) peak pressure levels and mammal hearing weighted (M-weighted) sound exposure level (SEL).

In 2018, the National Marine Fisheries Service (NMFS) provided details of the acoustic thresholds at which individual marine mammals are predicted to experience changes in their hearing sensitivity for acute, incidental exposure to all underwater anthropogenic sound sources (NMFS, 2018). These new thresholds reflect new/updated scientific formation that has demonstrated differences between the marine mammal hearing groups first categorised in Southall *et al.* (2007).

Southall *et al.* revaluated their proposed injury criteria in light of the scientific advances and as a result revised sound exposure criterion to predict the onset of auditory effects in marine mammals were published (Southall *et al.,* 2019). The only significant difference between Southall *et al.* (2019) and NMFS (2018) is the re-categorisation of mid-frequency and high frequency groups to High Frequency (HF) and Very High Frequency (VHF) respectively i.e. very high frequency for greater clarity. This report retains the categorisation used in NMFS guidance, namely, Mid-Frequency (MF) and HF.

The hearing weighting functions used in NMFS are designed to represent the bandwidths of each group within which acoustic exposures may have auditory effects. This study uses the NMFS (2018) hearing group frequency categories:

- LF cetaceans — i.e. marine mammal species such as baleen whales with an estimated functional hearing range between 7 Hz and 35 kHz;
- MF cetaceans — i.e. marine mammal species such as dolphins, toothed whales, beaked whales and bottlenose whales with an estimated functional hearing range between 150 Hz and 160 kHz;
- HF cetaceans — i.e. marine mammal species such as true porpoises (including harbour porpoise), river dolphins and *cephalorhynchus* with an estimated functional hearing range between 275 Hz and 160 kHz; and
- Pinnipeds in Water (PW) — i.e. a suborder of carnivorous aquatic mammals that includes seals, walruses and other similar animals having finlike flippers with an estimated functional hearing range between 50 Hz and 86 kHz (for underwater).

These are presented graphically in Figure 8.1. Note this figure includes sirenians and otariid pinnipeds for completeness, but these taxa are not included in this assessment.

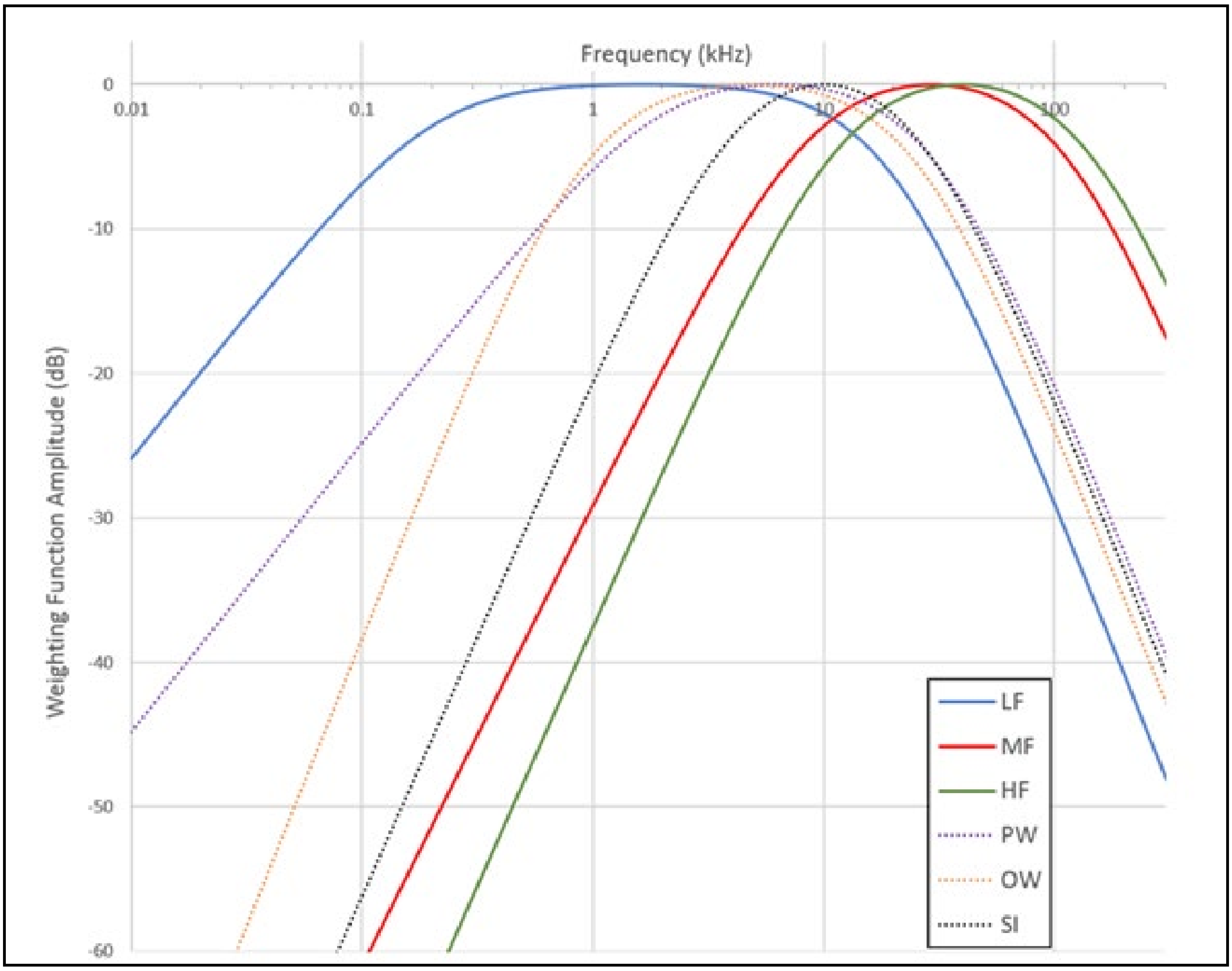


Figure 8.1 - Auditory weighting functions for pinnipeds and cetaceans (NMFS, 2018)

8.4.2. Disturbance

The JNCC guidance (JNCC, 2010) proposes that a disturbance offence may occur when there is a risk of a significant group of animals incurring sustained or chronic disruption of behaviour or when a significant group of animals are displaced from an area, with subsequent redistribution being significantly different from that occurring due to natural variation.

There is an intra-hearing group category as well as intra-species variability in behavioural response. Therefore, this assessment adopts a simplified approach in the absence of further scientific information and uses the US NMFS Level B harassment threshold of 160 Db re 1 µPa (rms) for impulsive sound.

Level B Harassment 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. This is similar to the JNCC (2008) description of non-trivial disturbance and has therefore been adopted 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 defined in the legislation. 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.

8.4.3. Criteria Summary

The PTS criteria adopted within the study were those presented in NMFS (2018) for impulsive sound. These have been reproduced in Table 8-1.

Table 8-1 – Permanent threshold shift (PTS) onset thresholds for marine mammals exposed to non-impulsive noise. SEL thresholds in Db re 1 µPa²s (NMFS, 2018)

Marine mammal group	Type of sound	PTS threshold criteria	
		SPL_{peak}, Db re 1 µpa (unweighted)	Cumulative SEL[8], Db re 1 µpa²s (weighted)
LF Cetaceans	Single or multiple pulses e.g. impulsive	219	183
	Non-impulsive e.g. continuous sound	-	199
MF Cetaceans	Single or multiple pulses e.g. impulsive	230	185
	Non-impulsive e.g. continuous sound	-	198
HF Cetaceans	Single or multiple pulses e.g. impulsive	202	155
	Non-impulsive e.g. continuous sound	-	173
Phocid Pinnipeds (underwater)	Single or multiple pulses e.g. impulsive	218	185
	Non-impulsive e.g. continuous sound	-	201
Behaviour change (disturbance)	Single or multiple pulses e.g. impulsive	SPL_{rms} > 160 Db re 1µPa	
	Non-impulsive e.g. continuous sound	SPL_{rms} > 120 Db re 1µPa	

This Section presents the underwater noise impact assessment for the Teal West Development area. The objectives of the underwater noise impact assessment are to:

- establish the level of noise likely to result from the 2D HR seismic (3 x 250 in³ Sercel G gun array) , the temporary piling operations and associated vessel operations;
- undertake underwater noise calculations to determine the propagation characteristics based on the prevailing environment in the vicinity of the project site;
- assess the spatial range of effects of noise on marine mammals and fish using established criteria; and
- where appropriate, make recommendations to minimise the effects of noise from activities associated with the survey activities.

In support of this study, a mitigation plan based on JNCC (2017) recommendations has been developed and are presented herein.

[8] The recommended accumulation period is 24-hours

8.5. Description of Potential Impacts

8.5.1. Underwater Noise Sources

Increasing the distance from a noise source usually results in the level of sound becoming lower, due primarily to the spreading of the sound energy with distance, analogous to the way in which the ripples in a pond spread after a stone has been thrown in, in combination with attenuation due to absorption of sound energy by molecules in the water. This latter mechanism is more important for higher frequency sound than for lower frequencies.

The way that the sound spreads (geometrical divergence) will depend upon several factors such as water column depth, pressure, temperature gradients, and salinity as well as surface and bottom conditions. Thus, even for a given locality, there may be seasonal variations to the way that sound will propagate. However, in simple terms, the sound energy may spread out in a spherical pattern (deep water) or a cylindrical pattern (shallow water) depending on several factors (primarily the water depth), or somewhere in between. In shallow waters the propagation mechanism is more complex due to multiple reflections from the seabed and the water surface.

Source sound levels are normally described in Db re 1 µPa at 1 m (as if measured at 1 m from the source). In practice, it is not usually possible to measure at 1 m from an active seismic source. However, this standard allows different source levels to be compared and reported.

For far-field source modelling the following basic assumptions apply:

- At some far distance from the source the energy from the source elements add constructively; and
- The source level is derived by back projecting a far field calculation to 1 m.

For this study, the source sound levels have been based on a combination of those provided in the data sheet for the seismic energy source, supplemented by measured sound data from Breitzke *et al.* (2008), Tolstoy *et al.* (2009) and Richardson *et al.* (1995), in order to produce low- and mid-frequency data. The low- and mid-frequency data has been extrapolated to derive the third-octave frequency spectra at higher frequencies based on the gradient of the power spectral density and third-octave band plots.

The SEL allows a comparison of the total energy of different sounds lasting for different time periods. As a pressure pulse from a source array propagates towards the receiver, the duration of the pulse increases. Thus, the relationship between the peak SPL and the SEL changes with distance. The SEL was calculated based on the SPL_{rms} normalised to a one second time interval. The single pulse SEL values have been combined for each pulse as part of the various cumulative SEL modelling scenarios.

It is important to note that the SPL_{rms} will depend upon the integration window used or, in other words, the measurement time for the rms. Using a longer duration measurement would result in a lower SPL_{rms} than using a shorter one.

The source levels provided in the sections below are likely to be overestimated in the near field as the model back calculates to 1 m and does not consider the interaction between the source elements. This in turn overestimates near-field received levels, which are then compared to animal thresholds. As a result, near field source sound levels will be lower than that predicted by this vertical far-field calculation. The spatial extent of the near-field effect can be derived from acoustic first principles (e.g. Urick, 1983) and is proportional to the square of the largest array dimension and frequency.

Another important factor affecting the received sound pressure level from seismic source arrays is the source directivity characteristics. Source arrays are designed so that the majority of acoustic energy is directed downwards towards the ocean bottom. Therefore, the amount of energy emitted horizontally can be significantly less than directed downwards. This is a frequency dependent effect and is more pronounced at higher frequencies than at lower frequencies.

8.5.2. Definition of Potential Sound Sources

There are a number of vessels associated with surveys, drilling, subsea installation, intervention activities and production for the Development which are detailed further in Chapter 3.

Teal West Development activities related to underwater noise emissions that were identified in the ENVID Workshop as having potential significant effects before application of mitigation measures were:

- Conventional VSP surveys;
- Use of impact piling for the installation of manifold and valve skid;
- Thruster operations of maintenance or supply vessels during the operation of FPSO; and
- Use of helicopters during drilling operations and the operation of FPSO.

The noise emission from construction activities e.g. trenching or rock placement, are usually dwarfed by the noise emission from the vessels themselves (DECC, 2011). The vessels associated with the seismic survey, drilling, subsea installation and production for the Development are not expected to cause significant impacts to marine mammals or fish. Of the activities listed above, only the use of seismic sources (VSP) and impact piling are considered to have the potential to impact the hearing of sensitive marine species because they form the greatest sound source in both power (i.e. pressure levels) and in character (i.e. as an impulsive sound). For this reason, seismic and piling activities are considered to constitute the worst-case activities and will form the focus of this assessment. It should be noted that, for the seismic modelling, a version using a static array and a towed array were modelled separately to investigate the difference between the two. It was found that the acoustic impacts from a static array were more significant and therefore this modelling will be presented as part of the assessment.

8.5.3. Assessment Methodology

Approach

The underwater sound assessment was conducted using Xodus' Xposure model, a set of tools developed for common sound sources (e.g. piling, surveys, etc). This modelling tool is based on an extended version of the semi-empirical model developed by Marsh & Schulkin (1962). The sound propagation model uses several concepts including:

- Refractive cycle, or skip distance;
- Geometric divergence;
- Deflection of energy into the bottom at high angles by scattering from the sea surface;
- A simplified Rayleigh two-fluid model of the bottom for sand or mud sediments; and
- Absorption of sound energy by molecules in the water.

The following inputs are required within the model:

- Third-octave band source sound level data;
- Discreet range (distance from source to receiver);
- Water column depth and sediment layer depth;
- Sediment type (sand/mud);
- Sea state; and
- Source directivity characteristics.

The Marsh & Schulkin model is based on a combination of acoustic theory and empirical data from around 100,000 measurements and has been found to provide good predictions.

As well as calculating the un-weighted rms and peak sound pressure levels at various distances from the source, it is also necessary to calculate the SEL for a mammal using the relevant auditory weightings described earlier, taking into account the number of pulses to which it is exposed. For operation of the survey source, the SEL sound data for a single pulse was utilised, along with the maximum number of pulses expected to be received by marine mammals in order to calculate cumulative exposure. Two conditions were modelled:

- A marine mammal staying stationary in relation to a stationary source array[9;] and
- A marine mammal moving away from a stationary source array at a constant speed of 1.5 m/s.

Both cases were modelled for a range of start distances (initial or closest distance between the animal and vessel) in order to calculate cumulative exposure for the scenarios. In each case, the pulses to which the mammal is exposed in closest proximity to the vessel dominate the sound exposure. This is due to the logarithmic nature of sound energy summation.

It should be noted that the sound exposure calculations are based on the simplistic assumption that the source is active continuously over a 24-hour period, being activated at the same interval. In the real-world the situation is more complex with the device not activated during turns for example. However, the SEL calculations do not take any breaks in activity into account and therefore the activation period is assumed to be consecutive and therefore worst case. However, the potential for recovery is not accounted for in the multiple pulse sound criteria described in NMFS (2018) and so as far as the SEL calculation is concerned breaks in activity are not considered in the assessment.

8.5.4. Model Inputs

Source data for the seismic array and impact piling has been based on data supplied by AHUK. The data used in the calculations are summarised below in Table 8-2 and Table 8-3.

Table 8-2 – Source data for seismic array

Model/Type	Sercel G-Guns
Total energy source volume (in^3)	750 (3 x 250 in^3)
Number of airguns in array	3
Deployment method	Rig deployed
Source depth (m, below sea level)	5
Shot interval (seconds)	2
SPL (Db re 1 µpa)	242
SEL (Db re 1 $µpa^2s$)	216
Maximum survey time per 24 hours	5 hours
Water depth (m)	90
Sediment type	Sand

[9] This is referred to as the baseline case, as it is considered that marine mammals will not move away from the source without being impacted upon by the received sound level.

Table 8-3 – Source data for impact piling

Model/Type	Impact Piling
Number of piles	4
Maximum diameter of pile	610 mm
Pile material	Carbon Steel
Pile length (m)	23 m
Duration of hammering (hours)	3
Hammer strike rate (blows/minute)	25
Soft start duration (mins)	20
Water depth (m)	90
Sediment type	Sand

For this study, the source sound levels were based on a combination of those provided in the data sheet for the seismic energy source, supplemented by measured sound data from Breitzke *et al.* (2008), Tolstoy *et al.* (2009) and Richardson *et al.* (1995), to produce low- and mid-frequency data. The low- and mid-frequency data was extrapolated to derive the third-octave frequency spectra at higher frequencies based on the gradient of the power spectral density and third-octave band plots.

The SEL represents the total energy of an event or number of events normalised to a standardised one second interval. This allows a comparison of the total energy of different sounds lasting for different time periods. As a pressure pulse from a source array propagates towards the receiver, the duration of the pulse increases. Thus, the relationship between the peak SPL and the SEL changes with distance. The SEL was calculated based on the SPL_{RMS} normalised to a one second time interval. The single pulse SEL values have been combined for each pulse as part of the various cumulative SEL modelling scenarios.

It is important to note that the rms SPL will depend upon the integration window used or, in other words, the measurement time for the rms. Using a longer duration measurement would result in a lower rms SPL than using a shorter one.

8.5.5. Summary of Results

The radii of the potential injury zones and behavioural change zone for the different modelled situations are summarised in Table 8-4 and

Table **8-5**, and are based on a comparison of the calculated sound level against the criteria described in Section 8.4.3. Injury zones are presented relative to the leading edge of the array for the main shooting operations.

Table 8-4 – Estimate of injury and disturbance ranges from seismic activities (Static 750 in^3 array)

Situation	Radius of effect, m			
	LF Cetaceans	MF Cetaceans	HF Cetaceans	Pinnipeds
Peak pressure (SPL) physiological damage	15	4	101	17
Peak pressure (SPL) physiological damage + soft start	5	1	33	5
SEL of a static mammal and static vessel	915	385	1,660	565
SEL of mammal swimming away from a static vessel	177	52	416	89
SEL of mammal swimming away from a static vessel + soft start	60	15	226	20
RMS behavioural change	568			

Table 8-5 – Estimate of Injury and Disturbance Ranges from Piling Activities

Situation	Radius of effect, m			
	LF Cetaceans	MF Cetaceans	HF Cetaceans	Pinnipeds
Peak pressure (SPL) physiological damage	1	-	9	1
Peak pressure (SPL) physiological damage + soft start	-	-	3	-
SEL of a static vessel and moving mammal	4	-	9	1
SEL of static vessel and moving mammal + Mit	1	-	2	-
RMS behavioural change	176			

The distances presented reflect the start point of the mammal relative to the source when the source first starts up. The mammal would then move away source so the distance between the mammal and the source would increase over time.

The potential ranges presented for injury and disturbance should not be interpreted as a hard and fast contour 'line' within which an impact will occur. The contour provides a conservative distance estimate at which sound levels will decrease to below SEL threshold values for PTS, which in reality is probabilistic; combination of a range of variables; exposure dependency in PTS onset, individual variations in hearing, uncertainties regarding behavioural response and swim speed / direction.

Peak Pressure

The results show that cetaceans avoid being exposed to a level of peak SPL exceeding the NMFS (2018) criteria if they are beyond 101 m from the seismic array, pinnipeds beyond 17 m. This assumes no soft start. With a soft start period set at 20 minutes, cetaceans are not exposed above the guideline limits at distances of 33 m or more, with pinnipeds at 5 m; a reduction of two-thirds over the unmitigated case. Cetaceans would avoid exposure to a peak SPL level a maximum of only 9 m away from impact piling.

The peak pressure levels for the base case and soft start conditions for the static seismic array is represented graphically in Figure 8-2.

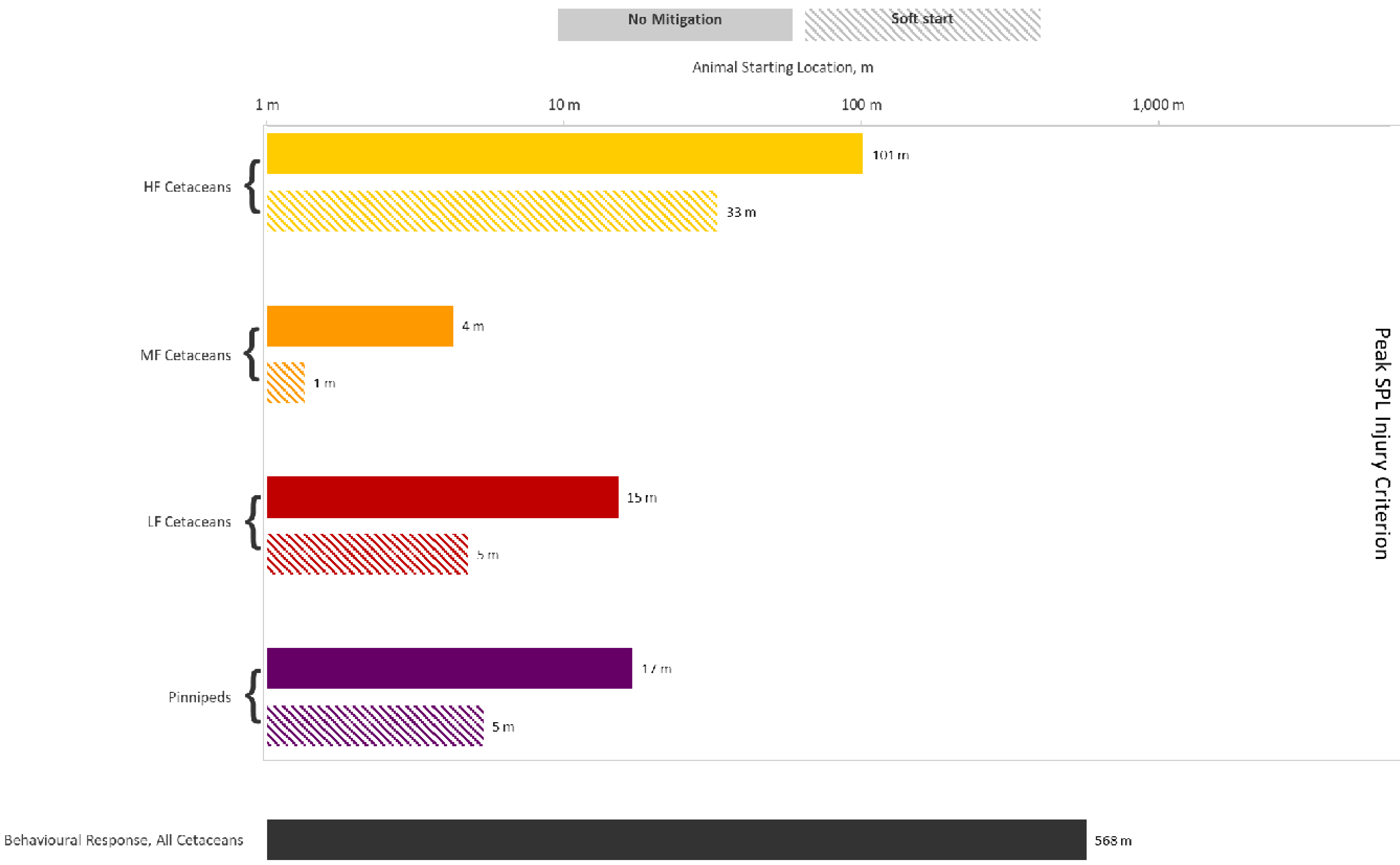


Figure 8-2 – Start Distances Resulting in Exceedance of Guideline Peak Criteria for Onset of Injury to Marine Mammals (Static Array)

Cumulative Weighted SEL

The sound exposure level for; i) a marine mammal staying stationary in relation to a stationary source array and ii) a marine mammal moving away from a stationary source array at a constant speed of 1.5 m/s is shown in Figure 8-3.

The assumption that the mammal would stay stationary during a period of survey activity is considered to be unrealistic. A more realistic assumption is that, upon hearing the onset of source activity, the mammal would move away from the sound source, hence the first pulse would provide the highest 'dose' of sound, with each subsequent pulse contributing less to their exposure as they move away from the source. Swim speeds of the species most likely to be observed in the area have been shown to be up to 5 m/s e.g. a cruising minke whale swims at a speed of 3.25 m/s (Cooper *et al.*, 2008) and harbour porpoise up to 4.3 m/s (Otani *et al.*, 2000). Further, Scottish Natural Heritage (SNH) (2016) has provided standard parameter values for various mammals which include mean swimming speeds. For example, for harbour porpoises the mean speed is 1.4 m/s (Westgate *et al.*, 1995); harbour seal / grey seals 1.8 m/s (Thompson, 2015); minke whale 2.1 m/s (Williams, 2009). Therefore, to take a representative approach, the predicted exposures of marine mammals moving away from the sound source have been calculated using a mean swim speed of 1.5 m/s.

This section will therefore consider a marine mammal moving away at a 180-degree angle from a static vessel source array at a constant speed of 1.5 m/s.

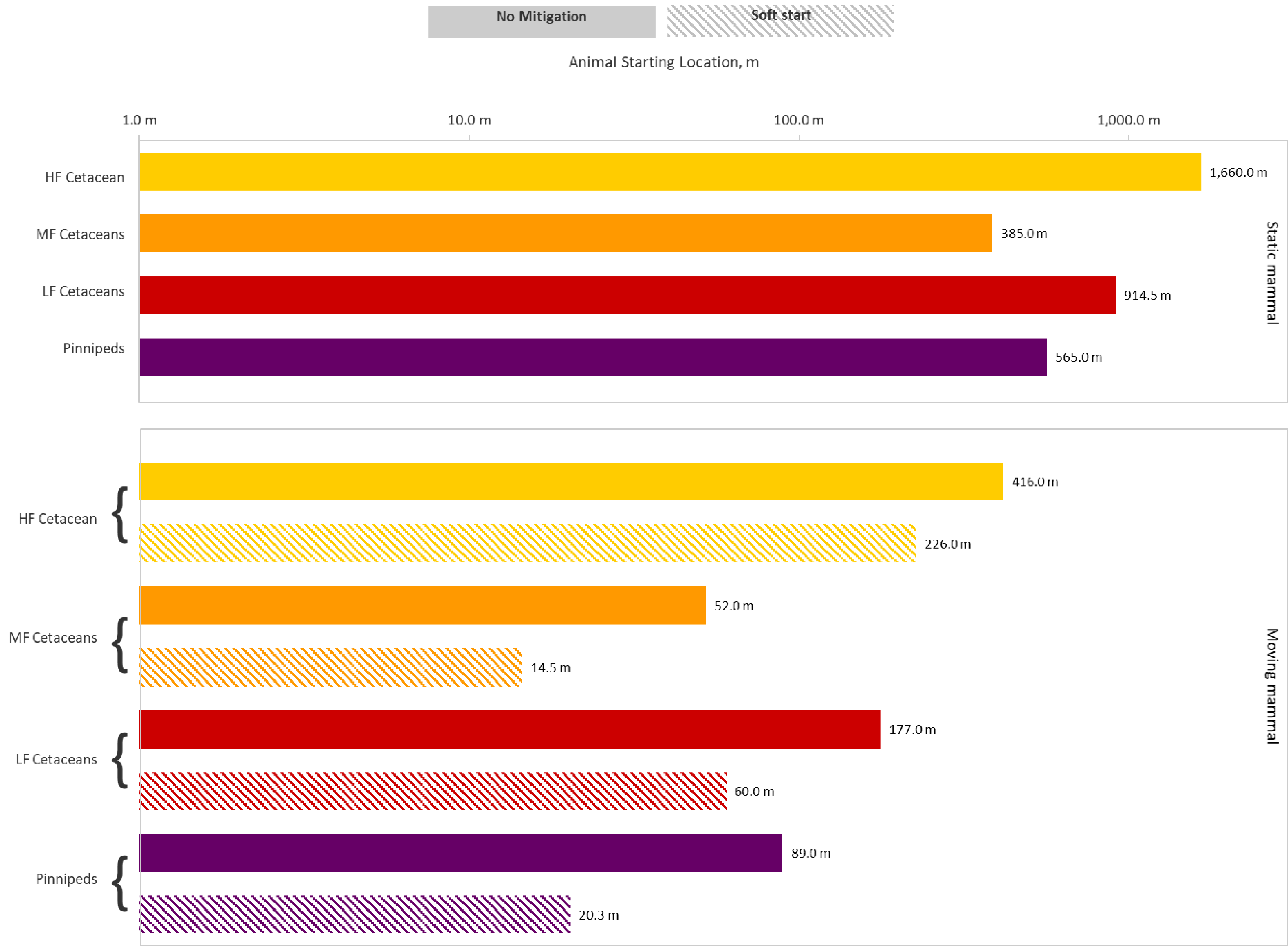


Figure 8-3 – Start Distances Resulting in Exceedance of Guideline SEL Criteria for Onset of Injury to Marine Mammals (Static Array)

The benefit of the soft start operations will be greater at shorter ranges from the source than if the mammal starts further away from the source array. This is because at short distances the sound level is higher and falls away at a faster rate, so an animal swimming at a constant speed will see a larger relative reduction in sound if it starts closer to the source.

The mitigation measures outlined in the JNCC guidelines (JNCC 2017) aim to protect marine mammals from the injury due to survey activities by encouraging vessels to be aware of animals that might be in the area and by increasing sound emissions gradually to give animals the opportunity to move away. With a soft start procedure implemented, the overall radius of potential injury in terms of PTS has been reduced significantly as illustrated in the figures above. For example, Figure 8-3 suggests that the predicted impact distance during the use of the Sercel G-Guns in a static array for HF cetaceans (e.g. harbour porpoise the most sensitive hearing category) is reduced from 416 m to 226 m under soft start conditions for a mammal swimming away from the static source. For a static HF cetacean, the distances would be 1,660 m without the use of a soft start although the condition that the animal would be stationary is considered unrealistic.

Behavioural Effects

The behavioural impact assessment was conducted using the Level B harassment threshold of 160 Db re 1 µPa (rms) proposed by NMFS (2005). As a worst-case the results presented corresponds to a static marine mammal. This resulted in a predicted radial distance of approximately 568 m for all marine mammal hearing groups which equate to areas of 1.01 km^2.

Behavioural changes such as moving away from an area for short periods, reduced surfacing time or echolocation clicks, vocalisation changes and separation of mothers from offspring for short periods, do not necessarily imply that detrimental effects will result for the animals involved. Similarly, the masking of communication signals may also occur without any detrimental effects for the animals involved. In addition, the pulses will be intermittent rather than a continuous sound, which will reduce the period over which sound is experienced and allow animals to echolocate and communicate between pulses. Some whales are known to continue calling in the presence of pulses since the vocalisations can be heard between pulses (e.g. Greene & McLennan, 2000, Madsen *et al*., 2002). It is therefore considered that the zone of behavioural change will not be a zone from which animals are necessarily excluded, but rather one in which normal behaviour might be affected across a range of potential responses, from a simple noticing of the sound to a startle response and return to normal behaviour, through to exclusion from an area. The fact that an animal is within this area does not necessarily mean that disturbance will occur. Mitigation of the potential impacts of anthropogenic sound on cetaceans focuses on reducing near field injuries, and risk assessments assume that the animals move away from loud sources of sound. While this is supported by various studies, observations also show a decline in response to airgun sound during the seismic survey. The findings of Thompson *et al*. (2013) suggest that broader-scale exclusion from preferred habitats is unlikely. Instead, individual's fitness and demographic consequences are likely to be subtle and indirect, highlighting the need to develop frameworks to assess the population consequences of sub-lethal changes in foraging energetics of animals occurring within affected sites.

To determine the likelihood of impact in terms of actual number of animals, it is possible to calculate the number of animals likely to experience some sort of behavioural impact using local density and population estimates. Density estimates from the area covering the North Sea are not well understood for many cetacean species but estimates from SCANS-III (detailed in Hammond *et al*., 2021) provide regional density estimates for some of the species most regularly found in vicinity of the survey.

To assess how the number of animals that could potentially be affected might constitute a non-trivial disturbance offence, it is important to understand what proportion of the population this number represents and what the duration of an effect may be. Temporarily affecting a small proportion of a population would be highly unlikely to result in population level effects, thus not considered as qualifying as a non-trivial disturbance. In contrast, affecting a large proportion of a population may be considered non-trivial disturbance. Determining this proportion is not a simple task since it is not clear how northeast Atlantic marine mammal populations act at a local level. For example, minke whales are likely to make use of the entire northeast Atlantic, so the population can be viewed as one, whilst other species, such as bottlenose dolphins, may display more local fidelity and be viewed as a series of sub-populations.

The Statutory Nature Conservation Bodies (SNCBs) (Hammond *et al.,* 2021; JNCC, 2010; IAMMWG, 2021) note that marine mammals of almost all species found in UK waters are part of larger biological populations whose range extends into the waters of other States and/or the High Seas. To obtain the best conservation outcomes for many species, it is necessary to consider the division of populations into smaller management units. This requires an understanding of the geographical range of populations and sub-populations, to provide advice on impacts at the most appropriate spatial scale. The output of the SNCB exercise investigating how marine mammal populations may act is the determination of Marine Mammal Management Units (MMMU) for species including harbour porpoise, bottlenose dolphin, Atlantic white-sided dolphin, minke whale and white-beaked dolphin. These MMMUs and associated population estimates can be interpreted in the context of the potential disturbance zones to consider the potential for a significant impact to occur.

Bottlenose dolphin *Tursiops truncates*, harbour porpoise *Phocoena phocoena*, minke whale *Balaenoptera acutorostrata,* white-beaked dolphin *Lagenorhynchus albirostris* and Atlantic white-sided dolphin *Lagenorhyncus acutus* have been recorded within the Development area. The number of individual cetaceans potentially affected by the proposed operations are detailed in Table 8-6 and all of insignificant quantities.

The percentage of populations that may be affected are very small/low. Therefore, the proposed operations would be largely undetectable against natural variation and would have no significant effect at the population level.

Two species of seals inhabit UK waters: grey seal *Halichoerus grypus* and harbour seal *Phoca vitulina*. According to the seal density maps provided in NMPi (2022), harbour and grey seal densities in the proposed survey area are 0-1 individuals per 25 km^2. As with cetaceans, the number of individuals likely to be impacted is very small and, therefore, would be largely undetectable against natural variation and would have no significant effect at the population level. Due to the low densities, an assessment was not undertaken for seals within the development area. The information provided indicates that there is a very low likelihood of injury or non-trivial disturbance as a result of the proposed survey operations.

The information provided indicates that there is a very low likelihood of injury or non-trivial disturbance as a result of the proposed survey (Table 8-6). These values are based on a single pulse of the Sercel G-Guns (i.e disturbance within 568 m) and not for the entire survey area. Whilst the latter will provide larger predicted numbers of animals impacted, the sound emitted from the source will dissipate relatively very quickly and there will be no accumulation of the sound levels. Therefore, whilst animals may move away from the sound source, they are likely to be able to return to the area following the passing of the survey vessel. Hence, it was considered that the single pulse approach represented a realistic case.

Table 8-6 – Estimated Number of Cetaceans Experiencing Behavioural Changes Based on a Single Pulse of the Sercel G-Guns source (Hammond et al., 2021; IAMMWGG, 2021)

Species	SCANS-III Density Estimates per km^2	Maximum number of animals predicted to be in the behavioural change impact zone at any one time (density x behavioural change area) **	Management unit (MU) / biogeographical population estimate	Percentage of reference population potentially affected (%)
Bottlenose Dolphin	0.0298	0.03	2,022	< 0.01
Harbour Porpoise	0.599	0.605	346,601	< 0.01
Minke Whale	0.0387	0.039	20,118	< 0.01
White-beaked Dolphin	0.243	0.245	43,951	< 0.01
Atlantic white-sided Dolphin	0.01	0.01	18,128	< 0.01

**Note:* Density estimates have been reported for SCANS-III Survey Block R
**The worst-case predicted behavioural change impact zone is 0.09 km^2 for a single pulse from the Innomar source

Fish

For fish, the most relevant criteria are considered to be those contained in the Sound Exposure Guidelines for Fishes and Sea Turtles (Popper *et al.*, 2014). The guidelines set out criteria for injury due to different sources of noise including those from seismic survey activities. The criteria for the different types of sources include a range of indices including SEL, rms and peak sound pressure levels. 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 criteria presented for seismic surveys using airguns are reproduced in Table **8-7**.

Table 8-7 – Criteria for onset of injury to fish due to seismic activities (Popper et al., 2014)

Type of Animal	**Parameter**	**Mortality and Potential Mortal Injury**	**Impairment**		**Behavioural Response**
			Recoverable Injury	**TTS**	
Fish: no swim bladder (particle motion detection)	Peak, Db re 1 µPa	>213	>213	-	(*Near*) High (*Intermediate*) Mod (*Far*) Low
	SEL$_{cum}$ Db re 1 µPa ^{2}·s	>219	>216	>186	
Fish: where swim bladder is not involved in hearing (particle motion detection)	Peak, Db re 1 µPa	>207	>207	-	(*Near*) High (*Intermediate*) Mod (*Far*) Low
	SEL$_{cum}$ Db re 1 µPa ^{2}·s	>210	>203	>186	
Fish: where swim bladder is involved in hearing (primarily pressure detection)	Peak, Db re 1 µPa	>207	>207	-	(*Near*) High (*Intermediate*) Mod (*Far*) Low
	SEL$_{cum}$ Db re 1 µPa ^{2}·s.	207	203	>186	
Eggs and larvae	Peak, Db re 1 µPa	>207	(*Near*) Mod (Intermediate) Low (*Far*) Low	(*Near*) Mod (*Intermediate*) Low (Far) Low	(*Near*) Mod (*Intermediate*) Low (*Far*) Low
	SEL$_{cum}$ Db re 1 µPa ^{2}·s.	>210			

While detailed modelling of fish has not been carried out, the radius of injury for the different types of fish due to seismic survey and piling operations are presented in Table 8-8 and Table 8-9, respectively. The assessment does not include the effect of soft start partly due to the fact that eggs and larvae cannot move away from the source once the source has started up and therefore the benefit cannot be realised.

Table 8-8 – Impact assessment on fish from Sercel G-Guns

Type of Animal	**Parameter**	**Mortality and Potential Mortal Injury**	**Impairment**		**Behavioural Response**
			Recoverable Injury	**TTS**	
	Peak, Db re 1 µPa	30 m	30 m	-	(*Near*) High

Type of Animal	Parameter	Mortality and Potential Mortal Injury	Impairment		Behavioural Response
			Recoverable Injury	TTS	
Fish: no swim bladder (particle motion detection)	SEL$_{cum}$ Db re 1 µPa^{2}·s	1 m	2 m	181 m	(*Intermediate*) Mod (*Far*) Low
Fish: where swim bladder is not involved in hearing (particle motion detection)	Peak, Db re 1 µPa	57 m	57 m	-	(*Near*) High (*Intermediate*) Mod (*Far*) Low
	SEL$_{cum}$ Db re 1 µPa^{2}·s	5 m	18 m	181 m	
Fish: where swim bladder is involved in hearing (primarily pressure detection)	Peak, Db re 1 µPa	57 m	57 m	-	(*Near*) High (*Intermediate*) High (*Far*) Mod
	SEL$_{cum}$ Db re 1 µPa^{2}·s.	9 m	18 m	181 m	
Eggs and larvae	Peak, Db re 1 µPa	57 m	(*Near*) Mod (Intermediate) Low (*Far*) Low	(*Near*) Mod (*Intermediate*) Low (Far) Low	(*Near*) Mod (*Intermediate*) Low (*Far*) Low
	SEL$_{cum}$ Db re 1 µPa^{2}·s.	5 m			

Table 8-9 – Impact Assessment on Fish from Impact Piling

Type of Animal	Parameter	Mortality and Potential Mortal Injury	Impairment		Behavioural Response
			Recoverable Injury	TTS	
Fish: no swim bladder (particle motion detection)	Peak, Db re 1 µPa	5 m	3 m	-	(*Near*) High (*Intermediate*) Mod (*Far*) Low
	SEL$_{cum}$ Db re 1 µPa^{2}·s	-	-	4 m	
Fish: where swim bladder is not involved in hearing (particle motion detection)	Peak, Db re 1 µPa	5 m	5 m	-	(*Near*) High (*Intermediate*) Mod (*Far*) Low
	SEL$_{cum}$ Db re 1 µPa^{2}·s	-	-	4 m	
Fish: where swim bladder is involved in hearing (primarily pressure detection)	Peak, Db re 1 µPa	5 m	5 m	-	(*Near*) High (*Intermediate*) High (*Far*) Mod
	SEL$_{cum}$ Db re 1 µPa^{2}·s.	-	-	4 m	
Eggs and larvae	Peak, Db re 1 µPa	5 m	(*Near*) Mod (Intermediate) Low (*Far*) Low	(*Near*) Mod (*Intermediate*) Low (Far) Low	(*Near*) High (*Intermediate*) Mod (*Far*) Low
	SEL$_{cum}$ Db re 1 µPa^{2}·s.	-			

The radius of potential injury from 750 in^3 Sercel G-Gun Array source using the Popper *et al.* (2014) criteria is relatively small and range between 1 m for mortal injury to 181 m for temporary threshold shifts depending on the type of hearing mechanism of the fish. For piling this is even smaller and peaks at 5 m for mortal and recoverable injury

Adult fish not in the immediate vicinity of the sound generating activity are generally able to move away and avoid the likelihood of physical injury. However, larvae are not highly mobile and are therefore more likely to incur injuries from the sound energy, including damage to their hearing, kidneys, hearts and swim bladders. Damage from shock to eggs and developing embryos consist of deformation and compression of the membrane, spiral curling of the embryo, displacement of the embryo, and disruption of the vitelline membrane. Although, such effects are unlikely to happen outside of the immediate vicinity of the geophysical survey (> 10 m). Popper *et al.* (2014) recognises the need for more data to help determine the effects of anthropogenic sound on eggs and larvae.

In terms of disturbance (or behavioural response) the impacts from geophysical survey operations are presented in qualitative terms rather than quantitatively. Based on these qualitative criteria, there is a high level of risk of disturbance up to ‘tens of metres’ from the moving device, moderate at distances of 100s of metres (except for fish with swim bladders were the risk remains high) and low beyond this (i.e. ‘far’). For eggs and larvae, the risk is moderate close to the centre of activity (tens of metres) and low beyond this point.

Wardle *et al.* (2001), Mosbech *et al.* (2000) and Wardle *et al.* (1998) state that the potential disturbance zone for fish from intermittent sources like seismic survey sound sources may extend to hundreds of metres or a few kilometres, although these references relate to airgun sources. Whilst estimates of fish populations are generally not available, it is likely that many millions of individuals make up most species’ populations (e.g. Mood & Brooke, 2010). The movement of fish tens or hundreds of metres away from the potential injury or disturbance impact zones would not constitute a large-scale movement by individuals of a species and is unlikely to result in population level impacts. Similarly, the potential impact of fish outside the impact area finding the sound levels too high to enter would be unlikely to result in population level impacts.

In summary, using the approach adopted by Popper *et al.* (2014), the area of behavioural change will extend beyond 10 m from the source, but the risk of disturbance will be moderate and is unlikely to be significant beyond 1 km. Given the fact that the operations will be constantly moving and the relatively short period of activity no habituation to the sound is likely.

8.6. Management and Mitigation

8.6.1. Overview

The underwater sound assessment and calculations has predicted that the use of soft start procedures will reduce the overall impact of the survey operations on marine mammals. It should also be considered that the survey equipment is designed to produce a downward focused sound source; with sound levels reducing with horizontal distance. Therefore, marine mammals or fish within the wider survey area would be subject to varying sound levels over time as the source moves around the survey area, rather than being subject immediately to the levels considered in the assessment and will have the opportunity to vacate the area.

The JNCC guidelines for minimising the risk of disturbance and injury to marine mammals from geophysical surveys (JNCC, 2017) are summarised below. Compliance with these guidelines is considered to constitute best practice and will in most cases, reduce the risk of deliberate injury to marine mammals to negligible levels. Whilst the guidelines don't deal with disturbance directly it is considered that the mitigation measures as recommended will also assist in reducing the potential for disturbance.

8.6.2. Marine Mammal Observer (MMO) and Passive Acoustic Monitoring (PAM)

MMOs on board the vessel from which the VSP will be deployed (in this case, the drilling rig) will monitor for the presence of marine mammals, during the pre-source start search, soft-start and survey, and will recommend delays in the commencement of source activity should any marine mammals be detected within the 500 m mitigation zone. Dedicated PAM operators may also be required to cover the hours of darkness and during periods when day-time conditions are not conducive for visual surveys (e.g. fog or increased sea states). The survey contractor will be providing a team to cover 24-hour observations / PAM during the survey.

8.6.3. Pre-Source Start Search & Mitigation Zone

All observations (MMO or PAM) will be undertaken during a pre-shooting search of 30 minutes i.e. prior to the commencement of the seismic sources in waters < 200 m. This will involve a visual (during daylight hours) and/or acoustic assessment (during hours of darkness / reduced visibility) to determine if any marine mammals are present within the 500 m mitigation zone from the centre of the device deployed. If marine mammals are detected in the mitigation zone during the pre-shooting search, then operations must be delayed until their passage. Either way there should be a minimum of a 20-minute delay from the time of the last sighting within the mitigation zone and the commencement of the soft-start and / or start of operations, to allow animals unavailable for detection to leave the area.

8.6.4. Soft-Start

There should be a soft start conducted every time prior to survey operations. Regardless of duration, where possible power should be built up gradually, in uniform stages from a low energy start-up. Surveys should be planned to avoid unnecessary firing at operational power before commencement of an acquisition line and to time operations to commence data collection as soon as possible once full operational power is achieved.

Survey operations should be planned to avoid unnecessary time at operational power before the commencement of an acquisition line and to time operations to commence data collection as soon as possible once full operational power has been achieved.

8.6.5. Reporting

All recordings of marine mammals will be made using JNCC Standard Forms. At the end of the survey, a monitoring report detailing the marine mammals recorded, methods used to detect them, and details of any problems encountered will be submitted to the JNCC. The report will also include feedback on how successful the mitigation measures were. This requirement will be communicated to the MMO at survey start up meetings and at crew change. If the MMO has any queries on the application of the guidelines during the survey they will contact the JNCC for advice.

8.7. Cumulative and Transboundary Impacts

In theory, any activity that regularly emits underwater noise has the potential to act cumulatively with the Teal West Development to negatively impact marine mammals and fish in the CNS area. The CNS is well-developed in terms of the oil and gas industry and the Teal West development area is within an area already used for oil and gas development (DECC, 2016). Surface infrastructure within 25 km of the Teal West development includes the Anasuria FPSO, Triton FPSO and Gannet A platform, approximately 3 km, 20 km and 14 km east or south-east of the Development, respectively. There are also several pipelines in the vicinity of the Teal West Development associated with nearby oil and gas assets. However, given that the most significant noise impacts has been determined to be from rig deployed seismic surveys, the possibility of a cumulative impact from pre-existing infrastructure and vessels is considered to be negligible.

However, cetacean and fish populations are free-ranging and long-distance movement is likely to be frequent. Any animal experiencing a significant impact from one activity is likely to belong to a much wider ranging population and there is the potential for that same animal to subsequently come into contact with noise from other activities. Potential injury and disturbance impacts resulting from the Teal West Development are not expected to be significant, and significant cumulative impact from the unlikely scenario of an animal encountering noise emissions from multiple activities within a short period of time is therefore considered highly unlikely. As a result, the potential cumulative impact is considered to be not significant.

The restricted areas of potential impact mean that, considering the Teal West field is 84 km from the UK/Norway median line, sound emissions capable of potentially causing injury or disturbance (which are 2.2 km maximum) are unlikely to be received directly by marine mammals or fish across median lines. However, an animal experiencing an impact in UK waters would likely belong to a much wider ranging population and such potential impact could qualify as a transboundary impact. Despite this, any injury or disturbance resulting from the Teal West Development is expected to be not significant and potential transboundary impacts are therefore considered unlikely.

8.8. Decommissioning

Any potential impact that decommissioning operations may have through sound emissions will occur in an area that experienced noise emissions during the Development operations. In general, activities are likely to be similar in nature to those required for installation (e.g. vessel use) and will generate similar noise emissions. However, should wells be abandoned, it is likely that wellheads will be cut off below the seabed; these cutting activities would result in sound emissions. Such sound emissions would be of short-term duration only and would be conducted in line with any relevant mitigation measures. Given the residual impact from the installation and operation are considered to be insignificant, the potential impact from decommissioning is also considered to be insignificant.

It is worth noting that if all the Development infrastructure is not removed at decommissioning, then there are likely to be less activities / vessels which could potentially generate underwater noise, compared to the drilling and installation phases of the Development.

8.9. Protected Sites

The assessment of potential impacts presented in this chapter has, where appropriate, taken account of protected sites. This section provides specific information on the potential impacts on conservation objectives and site integrity of relevant sites.

As described in Chapter 4.3.5 Environmental Baseline, there are four species of marine mammal listed on Annex II of the Habitats Directive that are known to occur in UK waters, all of which are qualifying features of SACs or candidate SACs (cSACs). **Table 8-10** identifies whether any of the pinnipeds, harbour porpoise or bottlenose dolphin recorded in the development area have the potential to be part of an SAC population on the basis of the foraging distances of each of the qualifying features, and actual distance of the SACs designated for these species from the Development area. An assessment of the potential for a likely significant effect (LSE) on a protected site is then made. As can be seen, the assessment considers there to be no potential for underwater noise emissions to interact with species listed as protected features of an SAC. Given no LSE on any SAC, it is not necessary to consider the conservation objectives or integrity of any sites in further detail. Some SACs that have been designated for marine mammals have also been designated as Sites of Special Scientific Interest (SSSI) for the same feature. These are indicated in **Table 8-10**, however since no LSE are expected on the SACs it is also considered that there will be no potential for damage to the protected features of the SSSI.

This assessment considers there to be very limited potential for underwater noise emissions to interact with marine mammal species listed as protected features of any NCMPA due to the distance of these from the Development area. Whilst some Risso's dolphins from the proposed Northeast Lewis NCMPA may be found within the Development area, they are likely to be in shallower waters on the continental shelf where the pipeline installation is the main activity. As this is planned to take place over one summer window and the vessels will be moving along the pipeline route rather than being in one location for the whole duration, it is considered that the interaction with this species will be limited. As such, there is no significant risk to the conservation objectives of the NCMPAs being achieved (either directly from the Teal West Development or cumulatively with other projects).

Table 8-10 shows the distances from the Teal West Development to the nearest protected sites.

Table 8-10 – Conclusions on the potential for LSE from the Teal West Development

Species	Identified As Present in Area?	Closest Sites to Development Area and Designation	Foraging Range of Qualifying Features	Distance From Development Area	Potential For Likely Significant Effect?
Bottlenose Dolphin	No	Moray Firth SAC	Mainly coastal distribution (east coast Scotland)	230 km from Teal West Development	No – Development area beyond foraging range for bottlenose dolphin from Moray Firth SAC (especially since this population is restricted largely to within the 20 m depth contour and to the Scottish east coast). The Development is not expected to injure any bottlenose dolphins or exclude any of this species from the Development area, so there is no cumulative impact expected with other projects.
Harbour Porpoise	No	Southern North Sea SAC	Mainly coastal distribution	200 km from Teal West Development	No – despite being in water depth within their foraging ability, the temporally restricted nature of noise means it has a highly limited potential for interaction between the Development and animals from this site. The Teal West Development is not expected to injure any harbour porpoises or exclude any of this species from the Development area, so there is no cumulative impact expected with other projects.
Harbour Seal	No	Sanday SAC	Approximately 50 km from haul outs	400 km from Teal West Development	No – outwith the foraging range and the temporally restricted nature of the noise emissions means highly limited potential for interaction between the Development and animals from this site. The

Species	Identified As Present in Area?	Closest Sites to Development Area and Designation	Foraging Range of Qualifying Features	Distance From Development Area	Potential For Likely Significant Effect?
					Development is not expected to injure any harbour seals or exclude any of this species from the Development area, so there is no cumulative impact expected with other projects.
Grey Seal	No	Berwickshire and North Northumberland Coast SAC	Up to 200 km from haul outs	300 km from Teal West Development	No – the Development area is considered outwith their foraging extent and there is very limited scope for interaction. The Development is not expected to injure any grey seals or exclude any of this species from the Development area, so there is no cumulative impact expected with other projects.

8.10. EPS Risk Assessment

For any EPS, the Offshore Marine Conservation (Natural habitats &c.) Regulations 2007 (as amended) make it an offence to deliberately or recklessly capture, kill, injure, harass or disturb any such animal. Whilst the injury offence is related to acts against one or more animals, the disturbance offence is related to disturbance of a significant group of EPS. An EPS licence is required for any activity that might result in injury to, or disturbance of, an EPS. There is not considered to any potential for significant impact to EPS in terms of injury or disturbance during the proposed Development. As such, an EPS licence is considered unnecessary.

8.11. Residual Impacts

The information below presents the anticipated residual impacts as a result of the underwater noise generated as part of the Development following the implementation of mitigation measures outlined in Section 8.6.

Receptor	Sensitivity	Vulnerability	Value	Magnitude
Cetaceans – mid and high frequency	**Low**	**Low**	**High**	**Minor**
Cetaceans – low frequency	**Low**	**Low**	**High**	**Minor**
Pinnipeds	**Low**	**Low**	**High**	**Minor**
Fish	**Low**	**Low**	**Low**	**Minor**

Rationale

Considering the information available on the species and species groups that will use the wider deep water and shelf areas in which the Development will see activity, it is considered that there is some tolerance to accommodate the anticipated noise emissions, with an ability to adapt or recover. As such, sensitivity is defined as **low**. It is recognised that whilst there may be temporary effects on behaviours of these species groups (as demonstrated by the modelling and subsequent assessment of impact above), there is not expected to be a change as a result of the proposed activities in the long-term functioning or status of any populations to which they belong. As such, vulnerability is defined for all groups as **low**. Value is defined as **high** for cetacean and pinniped species, on the basis they are designated a degree of protection through the EU Habitats Directive. For fish species, value is defined as **low** from an ecological perspective, as designated protection is not the same as for cetaceans and pinnipeds. Finally, as demonstrated by the noise modelling, the extent of change will be localised in scale and time, and in many cases of very limited frequency. Consequently, magnitude is defined as **minor** for all species.

Considering all of the above, including that there will be no discernible impacts on protected sites with marine mammal features and that mitigation has been adopted to address any potential concerns, the consequence of underwater noise emissions is ranked as **low**. As such, the residual impact of the noise emitted by the Development will be **not significant**.

Consequence	Impact Significance
Low consequence	Not significant

9. PHYSICAL PRESENCE

9.1. Introduction

This chapter addresses relevant impacts to other sea users in the vicinity of the Teal West Development as a result of the additional development above existing activity. The activities associated with the Development, including use of vessels, have the potential to interfere with the activities of other marine users and receptors, including:

- Commercial fisheries;
- Oil and gas activities; and
- Commercial shipping.

According to the latest fisheries statistics, the fishing activity in ICES rectangle 43F0 primarily targets demersal and pelagic fish. The VMS data indicate the effort and value levels for UK vessels operating mobile gear within the vicinity of the development between 2016 and 2020 as being low (Figure 3-8). To put the UK landing values in context, in 2020, ICES Rectangle 43F0 represented <1% of the total landing value and landing weight across the UKCS (MMO, 2021a). EU vessels fishing effort in the wider area surrounding the Development is mainly performed by bottom otter trawls and pelagic trawls, however, effort within the Development area itself is low (EMODnet, 2022a).

Oil and Gas installations in the vicinity of the Development (< 40 km away) include five surface installations, the nearest of which is the Anasuria FPSO that the Teal West production flowline and umbilical will tie-back to, located approximately 3 km of the production and water injection wells. Other nearby installations include Triton FPSO (operated by Dana Petroleum) located 20 km SSE, the Gannet A platform (operated by Shell) located 14 km ESE, the Kittiwake platform (operated by Enquest Heather) located 26 km NNW, and the Arbroath platform (operated by Repsol Sinopec) located 37 km ENE. There are also several pipelines in the vicinity of the Development, including those associated with the Anasuria FPSO. The Teal West production flowline and umbilical will cross the gas lift pipeline from the Guillemot A manifold to the Anasuria FPSO (PL1954), operated by Anasuria, and the water injection pipeline will cross the Production and gas lift pipelines from Anasuria to the Cook manifold (PL1719) (the gas lift pipeline is piggybacked on the production pipeline), operated by Ithaca, and will tie into a spool within the existing Cook Water Injection pipeline (PL4603), also operated by Ithaca.

Shipping activity within Blocks 21/24 and 21/25 is categorised as very low. Vessel tracks within the Development area are patchy and assumed to be associated with port service craft tracking directly across the Development area, with a cluster of non-port service craft activity in the southeast corner of Block 21/25 (Oil and Gas Authority, 2016; EMODnet, 2022b). The density of tanker vessels is relatively high around Anasuria FPSO, which is associated with the transport of crude oil.

There are no known military practice areas or activities within UKCS Blocks 21/24 and 21/25 (Oil and Gas Authority, 2019). Furthermore, as described in Section 4.6.4, there are no offshore wind farms in the vicinity of the Teal West field, and no telecommunications cables or power cables within 40 km, and therefore, these marine users are considered to be beyond a distance at which an interaction with the Development activities is likely.

There are a number of wrecks within 40 kilometres radius of the Development (Table 4-9 -), all of which are classified as non-dangerous. The closest wreck of unknown identity is located 2.9 km south-southeast, and the Zephyus wreck is approximately 5.2 km west-southwest of the Teal West area. As all vessels and the jack-up rig will be positioned using a DP / GPS system, and no anchoring planned, the risk of damage to these wrecks is considered negligible and not assessed further.

The Teal West Development activities have the potential of impacting upon marine users through the following pathways:

- By increasing the vessel collision risks associated with increasing vessel traffic in the area.
- By precluding their use of 500 m radius safety exclusion zone that will be established around the drilling rig during drilling operations and maintained permanently around the Teal West DC and each wellhead during the life of field; and
- By obstructing or excluding other sea users from areas where structures are laid / fixed on the seabed, including the new production flowline, electrohydraulic umbilical, water injection line, riser base manifold, risers, drill centre valve skid, and associated protection materials.

Any obstruction and/or exclusion impacts associated with the existing safety zone around the Anasuria FPSO will not be considered.

9.2. Regulatory Controls

The regulatory framework which guides the management of impacts to other sea users from the proposed Development consists of the following legislation:

- Marine and Coastal Access Act (MCAA) 2009; and
- Energy Act 2008.

The MCAA 2009 provides for navigational safety and risk management in UK waters. Section 77 of the MCAA 2009 excludes oil and gas activities that relate to oil and gas exploration and production for which a licence under Part 4 of the Energy Act 2008 is required. The provisions for “consent to locate” fall under the Energy Act 2008 Part 4A. Granting of consent to locate permits the installation of offshore infrastructure in line with consent conditions.

9.3. Assumptions and Data Gaps

To ensure that the assessment of physical presence reflects the worst-case scenario, a number of assumptions are made regarding Development activities. Primarily, these relate to vessel use and safety zones (see Section 9.4):

- A temporary 500 m safety zone will be established around the jack-up rig during drilling operations;
- A permanent 500 m safety zone around the Teal West DC and each of the three wellheads will be in place throughout installation and operations, within which the pipeline and umbilical tie-in structure will be located;
- The Teal West umbilical, pipeline and water injection line will be installed in separate trenches at 30 meters separation distance;
- Up to 100 concrete mattresses (18 m^2 each) and 200 sandbags (0.18 m^2 each) for external protection at the trench transitions at either end of the route, at crossing points with existing pipelines, at the tie-in spools and for upheaval mitigation (can be used). There is no plan to use rock placement although a contingency of up to 3,000 tonnes is considered for mitigating against upheaval buckling if necessary;
- No moored or anchored vessels will be used; and

- The existing 500 m safety zone around the Anasuria FPSO to which Teal West production flowline and umbilical will tie-back is excluded from the assessment.

It is considered that the information available to inform this assessment has been sufficient to undertake a thorough and accurate assessment of the potential impacts as a result of the physical presence of the Development. Therefore, there are no data gaps identified.

9.4. Description of Potential Impacts

9.4.1. Increased Vessel Traffic and Collision Risk

The temporary physical presence of Development vessels has the potential to interfere with other sea users and may increase the risk of vessel collision.

The Teal West Development is in the open sea (approximately 143 km from the east coast of Scotland and England) where shipping and fishing are of low intensity. The planned activities are expected to be a temporary and short-term, including drilling and pipeline/ umbilical installation (Section 3.5)

Six vessel types (excluding contingency rock placement vessel) will be physically present within the Development area, with duration ranging from 10 to 45 days. The Phase 1 of the Development is expected to be constructed during a 4-5 months period over which these vessels will be present and it is unlikely that the vessels will all be on site at the same time. No anchored or moored vessels are anticipated to be used.

9.4.2. Temporary and Permanent Exclusion

There will be a 500 m exclusion zone encompassing an area of approximately 0.8 km^2 around the drill rig in which activities by other sea users will be restricted for the duration of its deployment, amounting to approximately 100 days. When the VP5 well is installed and producing, a permanent 500 m exclusion zone will be in place. The water injector well will be drilled approximately 150 m to the West of VP5 and VP6 will be drilled 150m to the West of water injector well. A 500 m exclusion zone will be in place around each of these wells; note that the exclusion zones for each well will overlap. As described in Section 4.6.1, the Development area is of low importance to the fishing industry and has low shipping traffic. Given the spatial constraint of the exclusion zone, the presence of guard vessels and the moderate wider area usage by other sea users (including commercial fisheries), no significant impacts are anticipated from the permanent exclusion.

It is acknowledged that the installation works, including the presence of installation vessels, which may be restricted in their manoeuvrability, may temporarily obstruct access for other sea users and require vessels to use route diversions. Additionally, there will be a delay between the pipeline, umbilical, as well as water injection flowline laying and subsequent trenching / backfill activities, during which access by other sea users may also be restricted. Long term exclusion will not occur as there will be no permanent exclusion zone applied around the trench, except in the areas that overlap with the 500 m safety zones associated with the Teal West DC and Anasuria FPSO to which the production flowline and umbilical will tie-back. As such, for the majority of the pipeline and umbilical trenches, there will be no statutory restrictions on fishing or other activities.

It is expected that the pipelines and umbilical will be buried for the majority of the routes, with a target depth of 1 meter cover. External protection, including concrete mattresses and sand bags (rock maybe used as a contingency) will be required at the following locations:

- Trench transitions;
- At three crossing points along the pipelines and umbilical (outside the 500 m safety zones); and
- Spot locations for upheaval buckling mitigation, identified during post-installation surveys.

In areas where external protection is used, the pipeline and/or umbilical will be above the seabed, and therefore, may present a risk to vessels engaging in fishing activity in contact with the seabed (e.g. demersal trawls). Demersal trawling is expected to occur in the vicinity of the Development; however, the protection will be designed to be overtrawlable, and therefore, no permanent exclusion is expected to occur. It is also expected that the majority of external protection at the tie- structures will be within the 500 m safety zones of the Anasuria FPSO and the Teal West DC.

9.4.3. Snagging Risk and Dropped Objects

Drilling operations have the potential to introduce seabed anomalies which can increase the potential risk of snagging associated with commercial fishing activities which make contact with the seafloor. Fishing activity in ICES Rectangle 43F0 is predominantly pelagic and demersal (variable from year to year), although the level of fishing effort and value are low (Section 4.6.1).

The water depth in the area is ~ 90 m, hence subsea infrastructure is highly unlikely to pose a risk of interaction for pelagic fishing gear. Demersal gear involves towing nets along the seabed and this type of fishing may penetrate the seabed and pose a risk to subsea infrastructure, and in extreme cases, a potential risk to life, if snagging occurs. In the installation phase, during the delay between the pipelay and umbilical lay and subsequent trenching, these assets will be unburied and may present a potential snagging risk. It is expected that the pipeline and umbilical will first be laid by a reel-lay vessel and that trenching and backfill will then be performed by a dedicated trenching support vessel.

Trenching berms may form following pipeline and umbilical trenching and backfill. Fisheries interactions with berms can result in damage to fishing nets and gears, potentially contaminate or displace catches with sediment, or, in extreme instances, generate snags which pose a safety threat to fishing vessels and their onboard personnel. The degree of snagging risk caused by seabed disturbance depends partly on the consistency of the sediment. Cohesive clay sediment is likely to generate more resistance to gear than the sediments observed in the Development area which are sand and non-cohesive muddy sand. Berms formed in clay sediments are likely to persist for longer, while features formed in sand are likely to be re-worked by the currents fairly rapidly. The sandy sediment observed in the Development area is expected to provide a little resistance to demersal towed gear and therefore, the gear is likely to be able to pull through the sediment and wash out.

With regards to snagging risks during operation, it is expected that the pipeline and umbilical will be trenched and buried for the majority of the routes, with a target depth of cover of 0.5 – 1 m. External protection, including concrete mattresses and sand bags will be required in some areas which may present a potential snagging risk to demersal towed gears. External protection will be designed to be overtrawlable to reduce this risk. A requirement for rock placement is not anticipated, however, if necessary, it will only be placed in spot locations within a limited footprint. Rock berms will be designed to be overtrawlable. In addition, regular inspection surveys will be undertaken to assess pipeline conditions, including free spans, which will subsequently be rectified.

The tie-in structures and spools will be located within the 500 m safety zones, therefore not presenting a snagging risk as fishing vessels will be prohibited from these areas. Nevertheless, FFS will be installed at the subsea trees as an additional protection measure.

There is also the possibility for objects to be accidentally lost overboard during installation activities and as part of normal operation and maintenance. If large enough, such objects can provide an uncharted obstacle that has the potential to damage fishing nets or fishing catch. The potential for dropped objects will be minimised through the implementation of standard mitigation measures as described in Section 9.6.3.

9.5. Assessment of Impacts to Other Sea Users

9.5.1. Increased Vessel Traffic and Collision Risk

A minor increase in vessel traffic during the Teal West Development installation activities is expected due to the presence of the rig and six installation and support vessels. The drilling campaign will be completed prior to hook up and commissioning activities and hence reduces the potential further for any risks of collision. Blocks 21/24 and 21/25 are characterised by a very low shipping traffic, although shuttle tankers regularly transport oil from the Anasuria FPSO.

Management and mitigation measures outlined in Section 9.6.1 are aimed at reducing the risk of collision, including communication and notification procedures to ensure that all vessels operating in the area are aware of drilling and installation activities and project-associated vessels. Given the mitigation measures, and the limited vessel requirement during development, the overall interference with other vessels and potential for collision risk is considered to be minimal.

9.5.2. Temporary and Permanent Exclusion

There will be an exclusion zone encompassing an area of approximately 0.8 km^2 around the drilling rig in which activities by other sea users will be restricted for the duration of its deployment; this will amount to approximately 100 days, with an additional 12 days for mobilisation and demobilisation activities. This exclusion zone will be maintained around the DC and VP5 wellhead for the life of the Development. Drilling of the water injection well and 2nd production well (VP6) over later development phases will be undertaken within similar timescales and under their own safety zone requirements.

During pipelines and umbilical installation, activities by other sea users may be obstructed and require vessels to use route diversions, this will be for a short duration. As the installation vessels will be moving along the pipeline / umbilical routes, this obstruction of access will be on a rolling basis, meaning any impacts will be temporary and transient.

The area of the Teal West Development is of low importance to the fishing and shipping industries in the greater regional context. Given the limited spatial and temporal extent of any obstructed access to fishing grounds, and the limited spatial extent of any external protection, no significant impacts to other sea users are anticipated from either temporary or permanent exclusion.

9.5.3. Snagging Risk and Dropped Objects

As described in Section 9.4.3 the main sources of snagging from the Development during the installation phase include any unburied sections of pipelines or umbilical awaiting burial and potential trenching berms. The snagging risk associated with unburied sections of the pipeline will be minimised by the presence of guard vessels that will reduce any potential interactions between fishing vessels and unprotected assets. Furthermore, the non-cohesive nature of the sediment in the Development area also limits any potential snagging in relation to trenching berms. Where other potential snag risks are identified during the installation phase, they will be remediated as appropriate.

The snagging risks during operations relate to the presence of the infrastructure on the seabed, including any external protection, as well as potential free spans that may form over time. The tie-in points at the drill centre manifold and riser base manifold are not expected to present a snagging risk as these will be located within existing permanent 500 m safety zones. Fishing Friendly Structures will be installed at the subsea trees to reduce the snagging risk if any boats were to accidently breach the 500 m safety zone. However, this is unlikely to occur.

The pipelines are expected to be trenched and buried along the majority of the route except at crossings, at trench transitions, and in spot locations for upheaval mitigation. Any external protection will be designed to be overtrawlable to reduce the potential for snagging. The footprint of external protection will also remain limited, thus reducing the snagging risk.

Considering the above, and the implementation of the management and mitigation measures it is considered that the snagging risk will be minimal.

With regards to dropped objects, the mitigation measures outlined in Section 9.6 below will ensure the potential for such occurrences will be minimised and dealt with appropriately.

9.6. Management and Mitigation

9.6.1. Increased Vessel Traffic and Collision Risk

A number of mitigation measures will be employed to reduce the impact of increased vessel traffic and collision risk on other sea users:

- A Consent to Locate will be in place for the drilling rig, and AHUK will consult with relevant authorities, licensees of adjacent licences and organisations to minimise interference impacts resulting from the proposed drilling activities;
- A safety exclusion zone of 500 m in radius will be established around the drilling rig during drilling and around the Teal West wells and DC for the life of the Development;
- Information on the location of subsea infrastructure, safety zones and vessel operations will be communicated to other sea users (via the UK Hydrographic Office) through the standard communication channels including Kingfisher, Notice to Mariners and Radio Navigation Warnings;
- Infrastructure and safety zones will be marked as hazards on admiralty charts and entered into the FishSafe system so that it may be avoided by fishing vessels;
- During installation, the number of vessels and length of time they are required on site will be reduced as far as practicable through careful planning of the installation activities;
- A guard vessel will be present on site in the interim period between the laying of the pipeline and umbilical and arrival of the trenching support vessel to ensure that other sea users are aware of the surface laid pipeline and umbilical;
- Consultation will be undertaken with relevant authorities and organisations;
- Environmental awareness training will be given to all relevant crew members to reduce the risk of collisions between vessels and animals; and
- Development and implementation of a fisheries liaison strategy.

9.6.2. Temporary and Permanent Exclusion

With regard to temporary exclusion during installation, AHUK has reduced vessel numbers and vessel days as far as practicable whilst adhering to safety and emergency response requirements.

9.6.3. Snagging Risk

A number of mitigation measures will be employed to reduce the impact of snagging on other sea users:

- The location of subsea infrastructure will be communicated to other sea users through standard communication channels, including Notices to Mariners and Kingfisher bulletins.
- A fishing-friendly integrated XT will be installed, reducing the potential for snagging risks;
- Should it be required, the spread of contingency rock will be minimised through the use of a fall pipe vessel; and
- A post-installation survey will be performed once activities are completed to identify any hazards to fishing and shipping and navigation; and
- Regular maintenance inspection surveys will be undertaken throughout the Development's lifetime to ensure structures remain in a favourable condition.

9.6.4. Dropped Objects

The potential for dropped objects will be minimised during drilling, installation and operation through the following measures:

- Personnel will be suitably trained as to minimise the potential for dropped objects:
- Lift planning will be undertaken to manage risk during lifting activities, and all lifting equipment will be tested and certified;
- All deck items will be securely stowed;
- All equipment and material on installation vessels will be adequately stowed or sea fastened;
- Transfers of objects will use specialist equipment and consider environmental conditions; and
- Procedures will be put in place to ensure that the location of any lost material is recorded and that significant objects are recovered where practicable.
- The contractor will have a dropped objects procedure which will be used for the proposed installation operations to minimise any issues with dropped objects;
- Compliance to Lifting Operations and Lifting Equipment Regulations (LOLER) including inspection/testing; and
- A post-installation survey will be performed once activities are completed to identify any significant dropped objects and seabed anomalies.

9.7. Cumulative and Transboundary Impacts

The CNS is well-developed in terms of the oil and gas industry and the Teal West Development a is within an area extensively used for hydrocarbon production (DECC, 2016). Oil and gas installations in the vicinity of the Development (< 40 km away) include five surface installations, the nearest of which is the Anasuria FPSO (operated by Anasuria), located 3 km of the production and water injection wells and adjacent to the riser manifold. Other nearby installations include Triton FPSO (operated by Dana Petroleum) located 20 km SSE, the Gannet A platform (operated by Shell) located 14 km ESE, the Kittiwake platform (operated by Enquest Heather) located 26 km NNW, and the Arbroath platform (operated by Repsol Sinopec) located 37 km ENE (shown in Figure 4-12). There are also several pipelines in the vicinity of the Development, including those associated with the Anasuria FPSO. There are no oil and gas projects currently under construction near the Development; however, in the future, decommissioning of nearby installations could generate increased vessel presence. With regards to immediate activities, which are temporally limited, there are not likely to be any cumulative impacts associated with the Development. Given the small potential for snagging risks to arise and dropped objects to occur, it is considered that the chance for cumulative impact relating to these hazards is negligible.

Other developments will utilise vessels which have the potential to act cumulatively in increasing vessel collision risk. This is particularly relevant to the operation of shuttle tankers to and from the Anasuria FPSO. As mentioned in Section 4.6.7, shipping and general vessel traffic is considered very low in the area. The increased vessel traffic will be temporary, limited to installation, maintenance and decommissioning activities, it should not act in combination with any other existing projects to increase collision risk.

The Development is located in the area of low fishing effort. A total of 107 and 206 days of fishing effort were recorded within ICES Rectangle 43F0 in the years 2019 and 2020 respectively (Scottish Government, 2021). The 0.8 km^2 of area which will be lost to fisheries represents a small fraction of the total sea available for both fisheries and shipping. On this basis it is considered that the potential for cumulative impacts related to exclusion of other sea users is negligible.

Given the distance to the UK/Norway median line, it is unlikely that the Development will affect other sea users in Norwegian waters, therefore transboundary impacts are considered not significant.

9.8. Decommissioning

It is anticipated that the decommissioning activities associated with the Development will in the main be a reversal of the installation activities. The majority of the potential impacts and the suggested mitigation and management relating to physical presence of the Development will be the same as has been described for installation. Any potential impacts that decommissioning operations may have on other sea users will occur in an area that experienced an impact during the installation operations. The current philosophy is for the pin piles to be cut below the seabed with the remainder left in situ. Removal of all non-buried infrastructure would reduce any risks to other sea users to a negligible level and negate any requirement for long-term inspection and monitoring.

Any infrastructure left *in situ* or rock placement made, will be surveyed for potential snagging risks and mitigated accordingly. The well will be killed with kill weight fluid and cement plugs set to re-establish cap rock integrity both inside and outside the casing. This will be done in accordance with OEUK abandonment guidelines for offshore wells. The cement plugs will be tested as per requirements and casing strings retrieved. The surface casing and conductor will be cut at least 1.5m below seabed with cement plug spotted to seabed. There will not be any permanent steel structures protruding above the seabed for any snagging risks to occur. Prior to the end of field life, there may be changes to the statutory decommissioning requirements as well as advances in technology and knowledge. AHUK will aim to utilise recognised industry standard environmental practice during all decommissioning operations in line with the legislation and guidance in place at the time of decommissioning.

9.9. Residual Impacts

The information below presents the anticipated residual impacts as a result of the physical presence of the Development following the implementation of mitigation measures outlined in Section 9.6.

Receptor	Sensitivity	Vulnerability	Value	Magnitude
Oil and Gas activities	Medium	Low	Low	Minor
Shipping	Medium	Low	Negligible	Minor
Fisheries	Low	Low	Low	Minor

Rationale

Oil and Gas activities

Although the Development will be located within relatively close proximity to a number of oil and gas developments, these should be able to tolerate the small area of exclusion associated with the drilling rig and increased vessel activity. However, the nature of oil and gas developments is considered relatively sensitive thus he overall sensitivity is considered **medium**. There are not thought to be any long-term impacts on oil and gas developments in the area, beyond the 500 m safety zone around the Teal West DC and wellheads, therefore the vulnerability is considered **low**. The value of the receptor is considered **low** given the distance between the existing oil and gas activities and the Development will not impact the operational functionality of the industry. The magnitude of the impact to oil and gas developments from the Development is **minor** given the temporary and short-term nature of the disruption. Consequence is therefore **low**.

Shipping

The area experiences low vessel traffic so the risk of collision due to Development vessel presence is minimal. Shipping is also capable of accommodating short-term interference therefore sensitivity is **low**. Vulnerability is also considered **low** as even though behaviour may have to change short-term, it is considered the Development will not cause any long-term changes to shipping within the area. The value of shipping is considered **low** given the level of activity in the area. The magnitude is also considered to be **minor** as the Development activities are temporary in duration and so limited in extent. The operational phase of the Development will be much less likely to impact shipping in the region. Consequence is therefore **low**.

Fisheries

Fishing effort within the Development area is low with the majority of vessels targeting pelagic and demersal species and to a lesser extent shellfish. The sensitivity of fisheries to potential impacts as a result of the physical presence of the Project is considered to be **low** as the fishing industry has the ability to tolerate the impact and is also capable of adapting to exclusion. In addition, the obstruction to fishing during pipeline and umbilical installation activities will be temporary. Furthermore, ICES Rectangle 43F0 is not considered to be as productive in terms of landings by weight and catch value as the surrounding region (<1%). Therefore, the vulnerability is considered to be **low** as the area of obstruction is small in the context of available fishing area. The value of the receptor is considered to be low as the effort in the area is considered to be low. The magnitude of the impact is considered to be **minor** as any impact will be localised and largely of a short-term nature. Consequence is therefore **low.**

Consequence	Impact Significance
Low consequence	Not significant

10. ATMOSPHERIC EMISSIONS AND CLIMATE

10.1. Introduction

Atmospheric emissions from the Development will arise during all phases of the lifecycle including:

- Fabrication of new pipelines and seabed infrastructure (including emissions associated with materials used in fabrication).
- Vessel fuel combustion during installation, commissioning, drilling of wells and operations.
- Operational emissions from the Anasuria FPSO for processing the produced fluids from Teal West; and
- Decommissioning of the Development's infrastructure.

Atmospheric emissions from the Development, which will primarily result from complete or in-complete combustion of fuels, will contribute to impacts at a local, regional, national, transboundary, and global scale. The quantification of emissions anticipated to result from the Development and assessment of the potential impacts of the Development on local air quality (Section 10.6.1) and global climate change (Section 10.10) are presented in this chapter. Global climate change will have an impact on the Development and vice versa due to the change in the future marine climate e.g., increasing extreme weather events. The change in the marine climate also has the potential to act in combination with the impacts of the Development. The two areas of potential impacts related to climate change have been assessed and are presented in Section 10.10.

GHGs are the gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere and clouds. These substances prevent energy from leaving the atmosphere and thus cause a heating of the atmosphere.

On a global scale, concern regarding atmospheric emission of GHGs (including water vapour, CO_2, methane (CH_4), nitrous oxides (N_2O), ozone (O_3) and chlorofluorocarbons) is focused on the impact they have on global climate change. The Intergovernmental Panel on Climate Change (IPCC) in its sixth assessment report (AR6) states:

'it is unequivocal that the increase of CO_2, CH_4 and N_2O in the atmosphere over the industrial era is the result of human activities and that human influence is the principal driver of many changes observed across the atmosphere, ocean, cryosphere and biosphere.'

Climate change estimates in the AR6 report state that each of the last four decades have been successively warmer than any decade that preceded it since 1850. IPCC (2021) reports a 47% increase in CO_2 concentrations since 1750 which far exceeds the natural multi-millennial changes between glacial and interglacial periods over at least the past 800,000 years, and states that fossil fuel combustion is the primary contributor to the observed climate change.

The effect GHGs have on the heating of the atmosphere is quantified in the global warming potential (GWP) of the substance, a value describing the radiative forcing impact of one mass-based unit of a given greenhouse gas relative to an equivalent unit of CO_2 over a given period. Thus, it is possible to calculate a value for the GWP of all GHGs emitted in terms of an equivalent mass of CO_2. This value is called the carbon dioxide equivalent (CO_2e). The use of the CO_2e value allows comparison of the emissions from the Development with UK shipping emissions and the UK carbon budget, which are also described in CO_2e.

All emissions will have the potential to contribute to impacts at a local, regional, national, transboundary and global scale. On a local-scale project emissions such as NOx and SOx and carbon monoxide (CO) may affect air quality.

It is important to quantify and assess the impact of all emissions planned to be released from the development of the Teal West field. The quantification will facilitate the assessment of the environmental impact of activities. The information on the quantification and impact assessment of the emissions is presented in this chapter of the ES for the:

- Atmospheric emissions associated with the embodied carbon of the material, drilling, installation and commissioning, operation and decommissioning of the Teal West Development.
- The operational emissions associated with the processing of the Teal West production at the Anasuria FPSO facility where they will be emitted.

10.2. Regulatory Controls

10.2.1. Legislation

In the UK, there are several atmospheric regulatory controls which apply to offshore developments and require the provision of atmospheric emissions inventories and management. Following the UK's departure from the EU, the atmospherics legislation that is derived from EU regulations was transcribed into UK law.

Relevant legislation for offshore combustion equipment includes:

- Climate Change Act 2008 (as amended)
- The National Emission Ceilings Regulations 2002
- The Greenhouse Gas Emissions Trading Scheme Order 2020
- Directive 96/61 on Integrated Pollution Prevention and Control
- Pollution Prevention and Control Act 1999
- The Offshore Combustion Installations (Pollution Prevention and Control) Regulations 2013 as amended by The Offshore Combustion Installations (Pollution Prevention and Control) (Amendment) Regulations 2018
- The Pollution Prevention and Control (Designation of Medium Combustion Plant Directive) (Scotland) Order 2017
- The Pollution Prevention and Control (Scotland) Amendment Regulations 2017
- The Pollution Prevention and Control (Designation of the Medium Combustion Plant Directive) (Offshore) Order 2018

In addition, any flaring and venting is consented through the Petroleum Act 1998.

10.2.1. F-gases

If any of the F-gases (hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) or sulphur hexafluoride (SF6)) are present, the following regulations apply:

- Regulation (EC) No. 517/2014 of the European Parliament and of the Council on fluorinated greenhouse gases.
- The Fluorinated Greenhouse Gases Regulations 2015 (As Amended)
- The Ozone-Depleting Substances and Fluorinated Greenhouse Gases (Amendment etc.) (EU Exit) Regulations 2019.

10.2.2. Vessels

The Merchant Shipping (Prevention of Air Pollution from Ships) Regulations 2008 implement MARPOL Annex VI in the UK and establish controls on marine engines and marine fuel in order to limit emissions, in particular NOx and SOx. All vessels used during the proposed project will have the appropriate UK Air Pollution Prevention Certificate (UKAPP) or International Air Pollution Prevention Certificate (IAPP) in place, as required.

- Regulation 14 designated the North Sea for the purposes of Sox and particulate matter control Sulphur Oxides Emission Control (SECA).
- Regulation 13 requires Nitrogen Oxides emissions (NECA) to be included within Emission Control Areas (ECA) as evidenced by the issue of Engine International Air Pollution Prevention Certifications (EIAPP)
- Directive 2005/33/EC amending Directive 1999/32/EC as regards the sulphur content of marine fuels
    - The Sulphur Content of Liquid Fuels (England and Wales) Regulations 2000
    - The Sulphur Content of Liquid Fuels (Scotland) Regulations 2014

10.2.3. Guidance

The North Sea Transition Authority (NSTA), (formerly the Oil and Gas Authority), issued (June 2021) consolidated and updated guidance on flaring and venting, which sets out their approach to driving reductions in the emissions, through clear principles, using the NSTA consenting regime and stewardship activity. The consent requirements to conduct flaring and venting are set out in the Energy Act 1976, as well as the applicable offshore production license (granted under the Petroleum Act (1998)).

In March 2021, the NSTA issued Net Zero Stewardship Expectation 11, (NSTA 2021). The Stewardship Expectations are designed to give operators and licensees clarity on expected behaviours and good practices. Expectation 11 focuses on the following areas:

- Creating a culture of GHG emissions reduction within the UKCS.
- Ensuring that GHG emissions reduction is considered throughout the entire oil and gas lifecycle.
- Collaboration between all relevant parties to support and progress potential energy integration developments (such as electrification).

The North Sea Transition Deal (2021) requires the sector to follow Stewardship Expectation 11, encouraging emissions reductions from both existing and new developments. This Chapter quantifies the emissions anticipated as a result the Development across the entire oil and gas lifecycle and assesses the potential impacts of CO_2e and climate change (as well as other atmospheric pollutants). Any significant environmental risks and impacts are managed in line with regulatory requirements and the AHUK Petroleum Sustainability Policy.

10.3. Assumptions

The concept select assessment identified a tie back to Anasuria FPSO as the best environmentally, economically, and technically feasible option for the Teal West Development (Section 4).

The following assumptions have been made when calculating and presenting the atmospheric emissions for the Teal West Development:

- All vessels required for the Teal West Development will use low sulphur diesel (<0.1% sulphur content).
- The life of the field is planned to be from 2024 to 2034.
- In terms of gas compression systems, water injection and offloading pumps, the addition of Teal West processing is expected to cause an increase in power demand on the FPSO. Associated fuel gas demand and the associated emissions from combusting fuel gas are calculated and assessed within this chapter.
- Current FPSO flaring levels are considered sufficient to account for any non-routine start up and shut down, safety issues plus full platform shutdown. Studies have also been carried out and no upset of the process is expected due to Teal West production and therefore no increase of flaring is planned.
- FPSO shutdown requirements will not alter with the Teal West fluids and therefore there will be no additional flaring or diesel use.
- There are no anticipated changes to FPSO topside inventory which would drive a change to leaks of vapours from pressurized containment (fugitive emissions) other than the additional venting from the cargo tanks.
- Decommissioning activities are assumed to be of the same order of magnitude as vessel emissions for the installation. Decommissioning is predicted to be conducted in 2035. It has been assumed that decommissioning will include vessel activity associated with the plugging and abandonment of wells, the removal of the pipelines, umbilical and umbilical riser and subsea structures. However, for the purposes of emissions calculations, the removal of the gas export pipeline has not been assumed. All calculations for emissions associated with vessel activity during decommissioning have applied the same fuel assumptions made for the installation and commissioning phase. This assumes no decarbonization of the decommissioning fleet by 2035.

10.4. Potential Emissions Inventory and Assessment

A list of the activities at the Development that will result in emissions to atmosphere is presented Table 10-1.

There is not expected to be increases in helicopter flights or supply vessel transits to Anasuria due to Teal West, although space may be taken up on these trips by staff and equipment for Teal West specific work scopes. The emissions from the cargo tanks and offloading from the FPSO have been included as they are expected to increase with Teal West production.

Table 10-1 List of the planned activities at the Development contributing to atmospheric emissions

Operation	Activity	Source of emissions
Obtaining raw materials and fabrication for new infrastructure	Embodied carbon from new subsea infrastructure materials.	Embodied[10] emissions
Drilling and completions	Power generation for drilling rig operation	Combustion of diesel
	Power generation for support vessels i.e., supply and emergency response and rescue vessel (ERRV), and helicopters	Combustion of transport fuels
	Clean-up of the well after drilling	Flare combustion
Installation and commissioning of subsea infrastructure	Power generation for anchor handling vessel, pipelay vessel, heavy lift vessel, construction support vessel and ROV support vessels.	Combustion of transport fuels
	Power generation for support vessels i.e. emergency response and rescue vessel (ERRV), supply vessels and helicopters	Combustion of transport fuels
FPSO operations	Power Generation for production operations and water injection	Combustion of fuel gas in turbines.
	Hydrocarbon storage and offloading	Incremental increase in diesel use for offloading pump. Incremental vapour release (Venting of methane and nmVOCs) from the FPSO storage tanks and during crude oil transfer from the Anasuria FPSO to shuttle tankers
	Power generation for support vessels - i.e., ERRV, supply, maintenance, well intervention vessels and helicopters	Combustion of transport fuels

[10] Embodied carbon means all the CO_2 emitted in producing materials. It's estimated from the energy used to extract and transport raw materials as well as emissions from manufacturing them to become the material e.g. transforming iron into steel.

Decommissioning	Power generation for anchor handling vessel, heavy lift Support Vessels i.e., supply emergency response and rescue vessel (ERRV) and helicopters	Combustion of transport fuels

Quantification of gaseous emissions used for the impact assessment was based on engineering estimates of fuel consumption and generic emission factors (UK Environmental and Emissions Monitoring System (EEMS)[11]. For the climate change impact assessment, the global warming potentials (GWP) used to convert gaseous emissions to their CO_2e were those defined in the IPCC Sixth Assessment Report, AR6 and AR5[12] (based on a 100-year horizon).

The estimated atmospheric emissions as a result of the Teal West Development are presented and the impact assessed in this chapter. In alignment with the NSTA Net Zero Stewardship Expectation 11, (NSTA 2021), a complete forecast of the field's energy consumption and GHG emissions is presented below, considering all applicable lifecycle phases.

10.4.1. Embodied carbon in new infrastructure

In alignment with the NSTA Net Zero Stewardship Expectation 11, (NSTA 2021), the Development will take advantage of existing infrastructure and facilities by producing through the Anasuria FPSO. Embodied carbon[13] in the context of the Teal West Development therefore only refers to new infrastructure, i.e., the wells, tie-in structure, flowlines, umbilical, spools, concrete mattresses, and rock protection. All details of the construction basis for these are listed in the Project Description in Section 3. No additional embodied carbon is associated with the Anasuria FPSO as very minimal new equipment will be installed on the Anasuria FPSO due to the Teal West Development (Project Description Section 3).

The quantities of materials for each item of Teal West infrastructure were calculated based on the available design data with expert engineering knowledge. Carbon conversion factors (ICE, 2022) were applied to obtain the values for the embodied carbon in the materials.

The embodied carbon estimated in the new Teal West infrastructure is presented in Table 10-2. The total embodied carbon for the Development was determined to be 16,487 tCO_2e. The main contribution to embodied carbon is from the flexibles at 80% that includes the riser, jumpers, production flowline and water injection. 12.4% of the embodied CO_2 is attributed to the subsea structures, including the subsea valve skid with UTA, FFS, XTs and wells, the RBM/clump weight and the spools. The remaining infrastructure represents 7.8% (see Figure 10-1).

As Teal West is a small subsea development tieback, the embodied carbon in the design is relatively low when compared to developments that require new topside facilities. As the majority of infrastructure may be recycled at the end of field-life, overall carbon impact may be further reduced.

[11] EEMS Atmospheric Emissions Calculations (OGUK, 2008).

[12] The GWPs wer not updated in AR6 therefore the GWPs in AR5 are used in the calculations.

[13] The carbon calculations have been carried out in accordance with the international standards PAS 2050:2011 Specification for the assessment of life cycle greenhouse gas emissions of goods and services, and ISO 14064: 2018 Greenhouse gases - Parts 1 to 3.

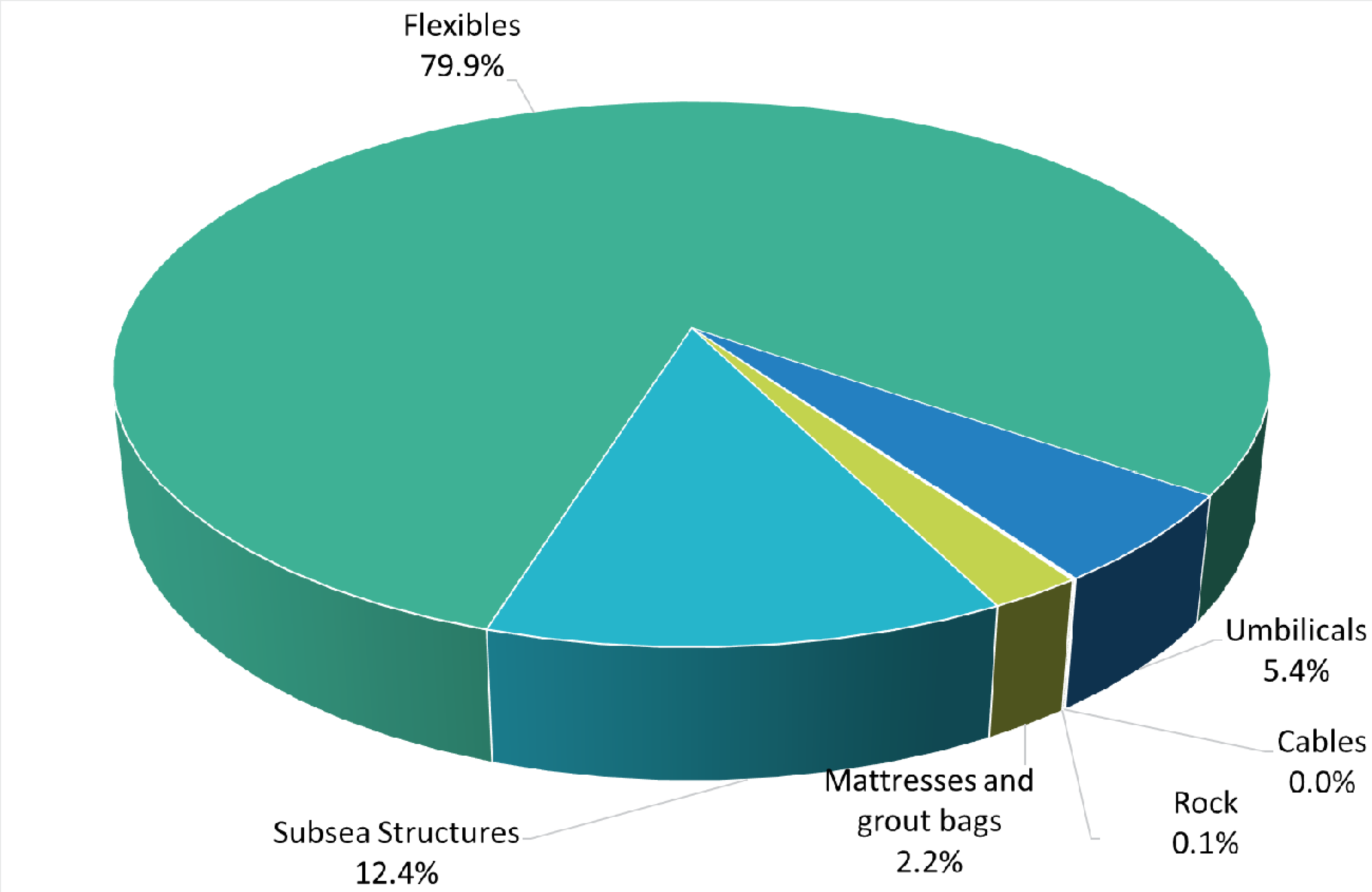


Figure 10-1 Proportion of Embodied Carbon in the Subsea Infrastructure for Teal West

Table 10-2 Embodied carbon associated with the new infrastructure for the Teal West Development

Infrastructure	CO_2e (tonnes)
Subsea Structures	2,037
Flexibles – Riser, jumpers, production flowline and water injection flowline	13,170
Umbilicals	896
Cables	8
Mattresses and grout bags - Concrete mattresses for pipeline protection and sandbags	366
Rock for protection	10
Total	**16,487**

10.4.2. Drilling and vessel activities

Emissions are expected to result from vessel and drilling activity, plus helicopters that will be necessary as part of the Teal West Development. The Project Description (Section 3) provides further details but in summary:

- Well operations will require a drilling rig and the assistance of support vessels such as supply vessels and ERRVs plus a helicopter service for crew transport. There will be some flaring during well clean up to ensure the well bores are cleaned to an acceptable level.
- The subsea installation and decommissioning phases will require a fleet of specialist vessels (pipelay vessel, heavy lift vessel, anchor handling vessel and diving support vessel), as well as general support vessels.
- The inspection and maintenance of the wells and subsea infrastructure will require routine vessel activities throughout the life of the field.

Rigs, vessels and helicopters

Rigs and vessels will be powered by diesel engines resulting in emissions of CO_2 plus CO, NO_x, N_2O, SO_x, CH_4, and non-methane volatile organic compounds (nmVOC) as a result of incomplete combustion, plus particulate emissions. The helicopter will be powered by an aviation kerosene engine, with similar combustion emissions.

The emissions have been calculated from the estimated duration of use and the total amount of daily fuel that will be required. The conversion factors used to estimate the equivalent CO_2 from fuel use is taken from different sources such as the Institute of Petroleum (IP) (2000), The Environmental and Emissions Monitoring System (EEMS), Atmospheric Emissions Calculations (OGUK, 2008) and IPCC (2014). Emissions for combustion gases other than CO_2 were converted into an overall carbon dioxide equivalent (CO_2e) using their GWP as defined by the IPCC, (Table 10-3).

Table 10-3 Potential environmental impact and global warming potential (100-year horizon (AR5 / AR6)) of relevant GHGs – CO_2e (te)

Combustion Gas	Environmental Impact	Global Warming Potential
CO_2	Contribute to climate change	1
CH_4	Regional-level air quality deterioration through low-level ozone production, which can be detrimental to health and can potentially impact vegetation, crops and ecosystems. Also contributes to the global GHG emission load and climate change	29.7
N_2O	Contribute to climate change	273
CO	Has an indirect effect on climate change	1.6
NMVOC	Reacts with NOx in the atmosphere to form ozone in the lower atmosphere, further contributing to the global GHG emission load and climate change	5.6

Table 10-4 below shows the expected duration of activities (in days) for the power generation requirements during the survey, drilling and installation activities. The decommissioning phase will require a fleet of specialist vessels (construction support vessel and diving support vessel) and it has been assumed that the number of days needed from the decommissioning vessels will be the same as installation minus the pipeline vessels, rock dump and survey vessels.

Table 10-4 Rig and vessel activity during the Teal West Development

Vessel Type	Duration (Days)	Operations to be undertaken
Surveys		
Survey vessel	50	Site surveys and installation preparation
Drilling Activities		
Drill rig (on site)	300	100 days drilling x 3 wells
Drill Rig (Transit)	36	12 days transit (return trip) x 3 mobilisations
Rig Tow Vessel	126	14 days for each tow vessel. 3 required per rig mobilisation (3 rig mobilisations).
Supply vessel	300	Supply vessel to rig
Emergency Response and Rescue Vessel (ERRV)	300	ERRV on site for duration of drilling up to 3 wells.
Subsea Installation		
Reel Lay Vessel	45	Pipeline installation Vessel
TSV [14]	45	Trenching
CSV/Dive support Vessel (DSV)[5]	45	installation of Risers, RBM, DCVS, spools, jumpers and mattresses.
Seabed preparation and crossings preparation[5]	10	
Rock Placement Vessel	10	Contingency rock placement
Helicopter		
Helicopters during drilling and subsea installation	300	Transfer of personnel. Up to 7 trips per week during drilling.
Operations		
DSV	660	13 Well workover (Scale Squeezes) on production wells each for 20 days each). 3 Workovers (1 every 3 years) on water injector well
Tanker export of oil	22	Additional offloads of oil as a result of Teal West Production
Inspection and maintenance	50	5 days per year for visual inspection activities.
Decommissioning		
Vessels considered as DSV	100	

The atmospheric emissions (in tonnes) from rigs and vessels during the full life cycle of Development have been calculated using the information in Table 10-3, Table 10-4 and presented in Table 10-5.

[14] Vessels also considered to be used for Decommissioning

Table 10-5 Atmospheric emissions (tonnes) from the Teal West Development rigs and vessels for the lifecycle of the Development

Rigs and Vessel activities	CO_2	CO	NOx	CH_4	VOC	Total CO_2e[15]	N_2O	SOx
Survey	5,611	27	99	0	4	5,752	0	0
Drilling rigs	57,708	283	1,023	1	42	59,161	3	0
Subsea Installation	10,772	53	191	0	8	11,043	1	0
Helicopters	10,895	29	0	0	8	11,204	1	2
Inspection and maintenance per year	1,901	9	34	0	1	1,949	0	0
Well workover every 3 years	1,731	8	31	0	1	1,775	0	0
Total Operations	26,106	128	463	0	19	26,764	1	0
Decommissioning	5,771	28	102	0	4	5,916	0	0
LoF to 2034	**116,862**	**565**	**1,944**	**2**	**88**	**123,563**	**6**	**2**

As illustrated in Figure 10-2, emissions associated with drilling rigs and vessels for life of field operations represent the highest percentage of overall Development drilling rig and vessel CO_2e emissions at 49.4% and 22.3% (assuming a maximum LOF of 11 years) respectively. The highest NOx and SOx emissions will be from the drilling rigs and the helicopters respectively.

Environmental receptors such as flora and fauna present in the vicinity of the Development are expected to be mobile and/or sparsely distributed and therefore not highly sensitive to rig, vessel and helicopter emissions. Air quality impacts from rigs, vessels, helicopter emissions are further mitigated by the open and dispersive nature of the local environment with average wind speed at the Development area over a 30-year long-term period of approximately 10 – 11 m/s (DECC, 2016). All releases from these activities will be transitory and likely to disperse rapidly. Local air quality is not expected to be adversely affected by emissions occurring as part of the Development.

The total CO_2e emissions estimated to be emitted from the drilling rigs, vessels and helicopters is 121,614 tonnes (Table 10-5) which is 41 % of the life of field emissions. The majority of the rig, vessel and helicopter emissions will occur in 2024 at the drilling and installation phase.

In 2019[16] the commercial fishing in UK waters emitted 782 kt CO_2e, coastal shipping[17] 4,521 kt CO_2e, and leisure craft 186 kt CO_2e on one year. The maximum annual emissions from Teal West would occur during the subsea installation phase of approximately 76 kt CO_2e would occur in one year. The installation emissions would represent about 1.38% of the sum of the emissions from the sources described above for

[15] The sum of the CO_2e of CO_2, CO, NOx, CH_4 and nmVOCs

[16] NAEI dataset. These figures are from the NAEI dataset and do not include international shipping passing through UK waters

[17] Includes local project traffic movements near to the Teal West field area in 2019.

shipping in 2019. During operations Teal West related vessel emissions will be around 20 kt CO_2e per annum which represents 0.36% of the 2019 UK shipping emissions.

The increase in emissions to the maritime inventory as a result of the Teal West Development is not expected to be significant and expected to decline with the decarbonisation of the shipping industry.

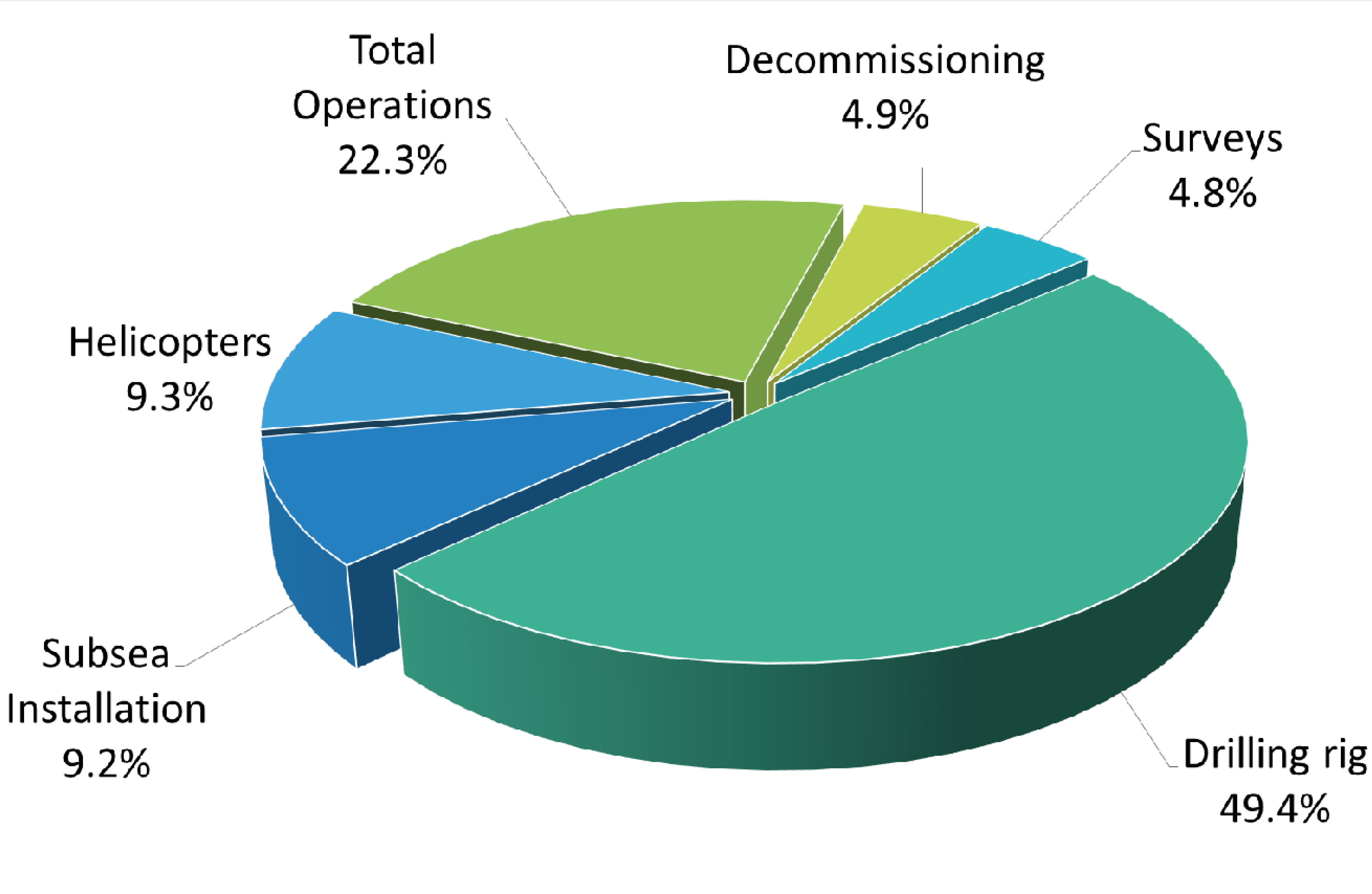


Figure 10-2 Percentage of CO2e emitted by rigs and vessels activities for Teal West assuming 11 years life of field

As with all other sectors of UK industry, shipping is identifying opportunities to decarbonize and therefore the atmospheric emissions from the decommissioning vessels may be less than those predicted for installation and commissioning.

Well clean up flaring

Wells cannot be cleaned up to the Anasuria FPSO due to the potential for damage to the swivel seals, therefore they will be cleaned up with a clean-up equipment package rigged up on the drilling rig. A 24-hour flow period will be required to obtain the required cleanliness prior to finishing the well activities and producing hydrocarbons to the FPSO. The two development wells will flow at controlled choke sizes to separators and burners and surge tanks will be in place to ensure zero oil spill overboard. A filtration system will also be in place to ensure aqueous discharges are filtered to required levels prior to discharge.

The hydrocarbon flow has been estimated to result in a maximum of 398 t of oil and 65 t of gas will be combusted per development well. This will result in 1,562 t CO_2e being emitted per well. As there will be 2 development wells, there will be a total of 3,124 t CO_2e being emitted from well-clean-up for the life of the field.

10.4.3. Operational emissions

The incremental operational emissions inventory for the processing of Teal West fluids on the Anasuria facility was calculated based on the additional production in relation to the:

- Additional power demand for gas compression, water injection and cargo offloads.
- There is additional venting from the FPSO's cargo oil tanks and diesel usage / emissions from the inert gas generator, used to blanket the cargo oil tanks.

There is not expected to be an incremental increase in diesel use for power generation.

Electrical power in the Anasuria FPSO is supplied by 3 x 50% 8.7MW (limited by the power management system) dual fuel (gas and diesel) aero derivative power generation turbines. Two out of the three turbines are fitted with waste heat recovery units (2 x 100%) to supply heat to the process and utility systems.

There is an emergency generator package unit feeding the emergency switchboard and is rated at 750kW. The main inert gas generator is designed to burn a stoichiometric mixture of diesel fuel oil and fresh air and in so doing produce a supply of inert gas. During offloading operations or tank emptying (e.g. for maintenance) the inert gas is used to maintain a positive pressure in the cargo tanks preventing oxygen ingress and the formation of a flammable atmosphere.

Power generation

The tieback of Teal West to the Anasuria FPSO only requires the following minor modifications to accommodate the Teal West production:

- Installation of inlet facilities to tie-in the Teal West Production Riser to the existing topsides production manifold and riser pull in.
- Installation of chemical injection facilities for Teal West.
- Tie-in of the Teal West subsea control system to existing platform systems.

Due to the minor nature of these modification the emissions from these activities have not been included in this inventory.

The addition of Teal West production at the Anasuria FPSO, will result in additional power generation demand which will increase total CO_2e emissions from the installation. The estimate of the incremental emissions which will be required at the Anasuria FPSO to process and offload the Teal West high case of production is shown in Table 10-6.

Total power demand for Teal West was modelled and is shown in Table 10-6 for 2024 to 2034 which is the life of the field. The incremental fuel gas demand was subsequently calculated using the conversion 0.259 MMSCFD/MW and then converted into tonnes. From these emissions were calculated as follows

- EEMS factor 2.86 kg CO_2/kg of gas
- Anasuria-specific Fuel Gas Ratio of 0.00034 t CH_4/t CO_2
- Anasuria-specific Fuel Gas Ratio 0.00187 t CO_2e/t CO_2

The increase in fuel gas demand is higher at the early life of field and decreases towards the end of the Teal West life of field with the reduction in production.

Table 10-6 – Incremental fuel gas demand and GHG emissions at Anasuria FPSO for the life of Teal West field

Year	Total Power Demand (MWh)	Anasuria extra fuel gas demand required to process Teal West production (MMscfd)	CO_2 (tonnes)	CH_4 (tonnes)	Other GHGs (tonnes CO_2e)	Total Teal West Incremental (tonnes CO_2e)
2024	10,775	0.48	9,560	3.2	17.9	9,673
2025	23,994	0.71	21,289	7.2	39.8	21,543
2026	21,562	0.64	19,131	6.4	35.8	19,358
2027	21,276	0.63	18,877	6.4	35.3	19,104
2028	15,683	0.46	13,915	4.7	26.0	14,081
2029	13,361	0.40	11,855	4.0	22.2	11,996
2030	12,401	0.37	11,003	3.7	21.2	11,134
2031	11,954	0.35	10,606	3.6	19.8	10,733
2032	11,696	0.35	10,377	3.5	19.4	10,501
2033	11,452	0.34	10,161	3.4	19.0	10,281
2034	11,348	0.34	10,069	3.4	18.8	10,189
Total	**165,502**	**5.07**	**146,844**	**49.5**	**275**	**148,594**

An incremental 182 t of diesel to fuel the inert gas generator will also be required through the life of the field as shown in Table 10-7.

Table 10-7 – Incremental diesel demand and GHG emissions for the inert gas generator at Anasuria FPSO for the life of Teal West field

Year	Diesel consumption (tonnes)	CO_2 (tonnes)	CH_4 (tonnes)	Other GHGs (tonnes CO_2e)	Total Teal West Incremental (tonnes CO_2e)
2024	38.3	123	1.3.E-03	2.2	125
2025	35.1	112	1.2.E-03	2.0	114
2026	27.1	87	8.9.E-04	1.6	88.6
2027	35.1	112	1.2.E-03	2.0	114
2028	16.0	51	5.2.E-04	0.9	51.9
2029	9.6	31	3.1.E-04	0.6	31.6
2030	6.4	20	2.1.E-04	0.4	20.4
2031	4.8	15	1.6.E-04	0.3	15.3
2032	4.8	15	1.6.E-04	0.3	15.3
2033	1.6	5	5.2.E-05	0.1	5.10
2034	3.2	10	1.0.E-04	0.2	10.2
Total	**181.9**	**581**	**0.006**	**10.6**	**592**

Vapour from the cargo tanks

Venting of vapour (methane and non-methane volatile organic carbons) occurs during offload operations. The additional venting of methane and nmVOCs from the Anasuria FPSO cargo oil tanks as a result of the additional oil production from Teal West is presented in Table 10-8. The incremental venting emissions are expected to be a total of 32 t CH_4 and 1,894 t nmVOCs throughout the life of the field.

Table 10-8 – Incremental methane, VOC and CO_2e emissions from the cargo storage tanks at Anasuria FPSO for the life of Teal West field

Year	CH_4 (tonnes)	VOC (tonnes)	Total Teal West Incremental (tonnes CO_2e)
2024	6.7	394.2	2,407
2025	6.3	371.4	2,268
2026	4.8	285.0	1,739
2027	6.0	352.8	2,154
2028	3.0	174.8	1,068
2029	1.7	98.8	604
2030	1.1	65.9	402
2031	0.8	49.7	302
2032	0.6	38.0	231
2033	0.5	29.5	180
2034	0.4	24.8	151
Total	**32**	**1,885**	**11,506**

10.4.4. Total emissions

The total GHG emissions for the Teal West field are summarised in Table 10-9 below. The operational emissions are the largest annual contribution to the Development emissions with ca167 kt CO_2e.

Table 10-9 – Annual Teal West CO_2e Emissions (kilotonnes) for the life of the field

YEAR	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Embodied Carbon	16	0	0	0	0	0	0	0	0	0	0
Rig, Vessel and Helicopter Activity	87	2	4	2	2	4	2	2	4	2	2
Well clean up flaring	1.6	1.6	0	0	0	0	0	0	0	0	0
Operational (incremental power generation and vapour release)	12	26	21	21	15	13	12	11	11	10	10
Decommissioning	0	0	0	0	0	0	0	0	0	0	0
Total	117	29	25	23	17	16	14	13	14	12	12

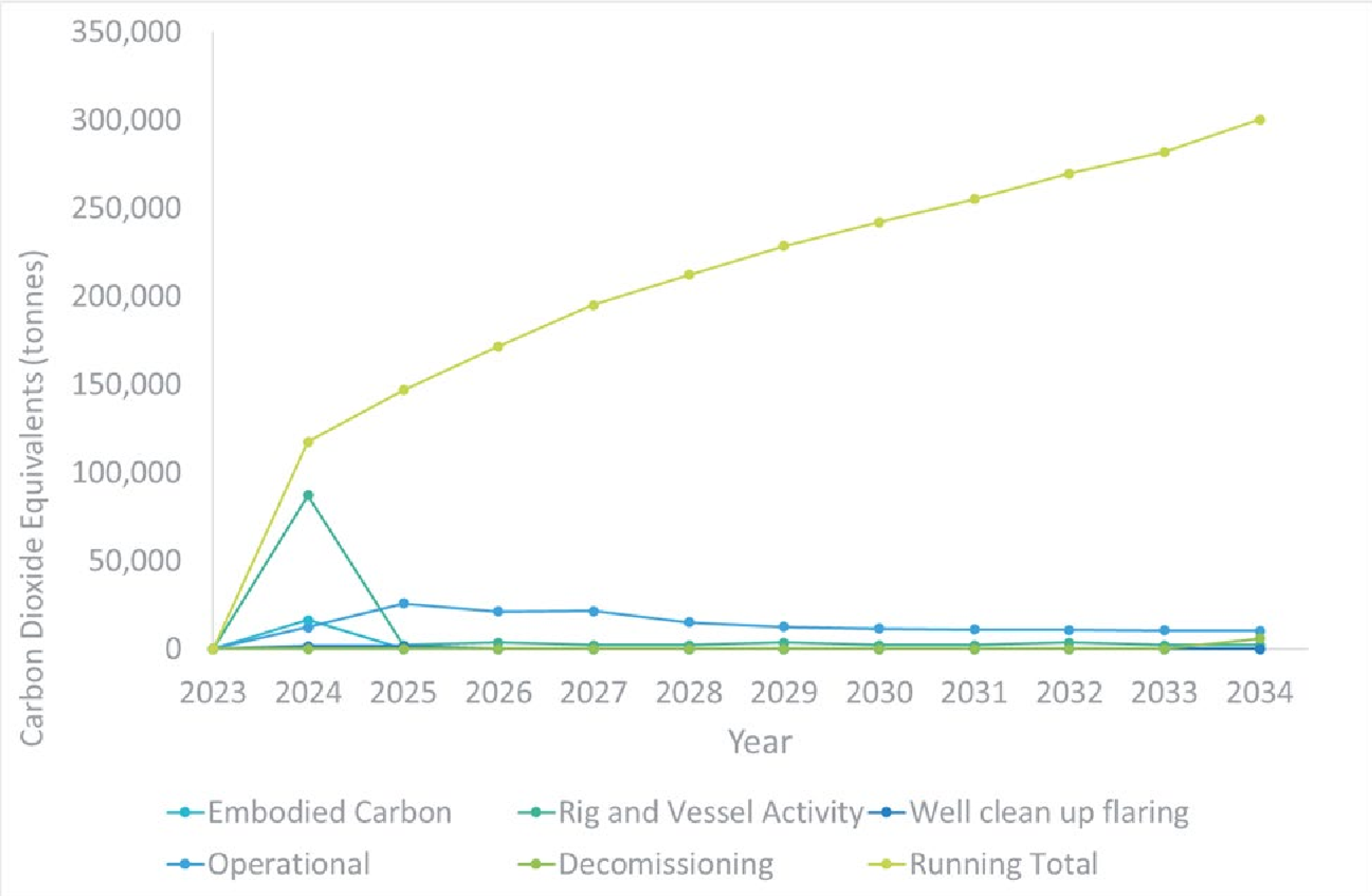


Figure 10-3 Life of field emissions for Teal West

The total life of field incremental emissions for production of the Teal West through the Anasuria FPSO is estimated as 162,645 tonnes CO2e. The majority of the emissions will be due to the incremental increase in fuel gas combustion for processing of the hydrocarbons and the carbon intensity of the Teal West will be 14.1 kg CO2e/boe for the life of the field. The incremental diesel use for the inert gas generator will be approximately 11.6 tonnes of CO2e during the life of the Teal West field equating to less than 0.01 % of the emissions due to Teal West. It is anticipated that the Anasuria FPSO will not require to be operated out with the Best Available Technology currently in use to accommodate the Teal West production.

The only flaring that is anticipated to occur as a result of the Teal West Development is from the drilling rig for well clean-up which will be at most 1.05% of the total CO_2e emissions for the life of field. No process upsets resulting in increased flaring emissions are expected when processing the Teal West hydrocarbons.

It is anticipated that the addition of the Teal West production to the Anasuria FPSO process will reduce the Anasuria FPSO carbon intensity as the proportional increase in production is higher than the proportional increase in emissions i.e. the processing plant will run at a higher efficiency. The following abatement opportunities have been identified by AOC for the operational emissions of the Anasuria FPSO (Table 10-10). AOC view the projects in Table 10-10 as commercially feasible and they are planned to be implemented before Teal West first.

Table 10-10 Estimated CO_2e reduction impact

Project description	Estimated CO_2e savings (tonnes/year)
Installation of HEPA filters on the turbine	5,671
Conduct control loop tuning equipment	5,246
Monitor performance of compressor loads	340
Nitrogen purge on Flare	7,089
Total	18,346

10.5. Management and Mitigation

AHUK have a Net Zero Policy in support of the UK Net Zero Target and of industry delivery of net zero through the NSTA Strategy and the Stewardship Expectations (NSTA,2021) and initiatives. The policy, an integral part of AHUK's management system, is embedded in the company way of working and will support delivery of the NSTA expectations.

For the lifecycle of the Development, AHUK has embedded minimisation of GHG emissions via identification and assessment in the design conducted to date. Opportunities for further reduction of emissions and improvements in energy efficiency will be sought during emissions reduction reviews in subsequent design phases. During the Teal West operational phase, AHUK will support AOC in operation, maintenance and modification of the Anasuria installation to seek and realise emissions reductions, which may include the timely deployment of appropriate new abatement technologies. The management system framework will ensure that the reduction of emissions is embedded in late life/pre-cessation of production phase.

Reviews of opportunities for emissions reduction will include third party contractors as appropriate and emissions management will be an integral part of supply chain selection criteria and management. For example:

- Net Zero considerations are included in tender questionnaires and evaluation criteria e.g., The project procurement strategy described in the Supply Chain Action Plan (SCAP) is to give preference to companies that attempt to mitigate emissions in their manufacturing processes and AHUK evaluation criteria in awarding contracts considers the emissions reduction plans of the contractors.
- The Commissioning plan will be developed with the appropriate contractors and will provide for evaluation of the GHG emission profiles of different commissioning strategies.

AHUK will support third parties' emission reduction plans e.g., rigs/vessels abatement plans which may incorporate appropriate new abatement technologies. AHUK will implement emissions performance reporting which will include the reporting of power/energy consumption and GHG emissions and the undertaking of regular energy surveys.

10.5.1. Drilling and vessel activities

Rigs, vessels and helicopters will be owned by a third party and the activities are therefore subject to supply chain processes of contractor selection and management. In alignment with the NSTA Net Zero Stewardship Expectation 11, (NSTA 2021), minimisation of emissions from rigs and vessels will form part of the selection criteria for the installation vessels through the tendering and selection process. Opportunities for emissions reductions have included or will include:

- Streamlining of activities through planning to reduce the time required for vessels and helicopters. This may include scheduling of the subsea installation programme to minimise the number of mobilisations, demobilisations and length of vessel transit.
- All vessels and rigs employed during installation and drilling activities will comply with the Merchant Shipping (Prevention of Air Pollution from Ships) (Amendment) Regulations 2014.
- Any Fluorinated-gases (F-gases) in rig and vessel refrigeration and cooling systems will be managed in accordance with applicable legislation
- Vessel specific
  - Vessel Common Marine Inspection Documents (CMID), offshore vessel inspection database (OVID) and HSE assurance audits conducted to ensure that contracted vessels meet International Maritime Organisation (IMO)/ The International Convention for the Prevention of Pollution from Ships (MARPOL) and BP marine and HSE standards.
  - Each vessel will have a Shipboard Energy Efficiency Management Plan (SEEMP) which contains information for minimising fuel consumptions e.g., economical speeds when operationally appropriate.
  - Green dynamic positioning or economical speeds will be encouraged when operationally appropriate.
  - Use of low sulphur fuels (as per UK regulatory requirements).
  - The opportunity for use of shoreside power for supply vessels has been considered and will form part of the selection criteria.
  - Selection of hybrid vessels, which are more common in the Norwegian sector, may be possible from 2023 in the UK sector. If possible, hybrid vessel options will be included in tenders; and
  - Shared site survey vessels with other operators working in the area.
- Drilling specific
  - The opportunity to share helicopters, boats and ERRV with the Anasuria FPSO when the rig is in the field for 3 months per well has been considered. If all the three wells are drilled, then this amounts to 9 months of potential shared resources which will reduce the emissions from the installation phase of the Development.
  - An 'option well' has been included in the drilling rig tender which may enable the campaign to be shared with another operator thus reducing mobilisation and demobilisation emissions.
  - Use of excess wellheads and subsea xmas trees surplus to requirements, purchased from another NS Operator.
  - A cuttings dryer system is being considered on the rig (space allowing) which will reduce the oil on cuttings before transport ashore. A dryer will reduce the emissions required for transport ashore and treatment of cuttings. The oil will be returned for reuse in the drilling mud; and
  - The duration of the well clean-up flaring will be limited as far as is practicable to reduce the requirement to flare but attain the goal of a clean well for production. The latest 'green burner' technology will be used on the selected rig.

During operation and maintenance of the Teal West field, AOC will be responsible for logistics, including vessel selection and management. In alignment with NSTA Net Zero Stewardship Expectation 11, (NSTA 2021), AOC´s logistics operations strategy seeks to minimise GHG emissions through collaboration with other operators, and to the extent practicable, AOC shares Anasuria supply vessel operations with wider area operations.

10.5.2. Operational GHG Emissions

The incremental emissions from the Anasuria FPSO due to the processing of the Teal West fluids was determined from the additional power demand for gas compression, water injection and cargo offloading, diesel for the inert gas generator, used to blanket the cargo oil tanks and additional vapour release from the FPSO's cargo oil tanks. The additional production will enable the the Anasuria FPSO process plant to run more efficiently.

Approximately 90% of the emissions from the Anasuria FPSO fall under the UK Emissions Trading Scheme (UKETS) regulations and are measured and quantified under the AOC permit in place, i.e. the process for emissions measurement and estimation is in place for UKETS compliance. AOC routinely use an FLIR camera to identify and quantify fugitive emissions. AHUK will support AOC should there be an opportunity to invest in and deploy technological advances in GHG emissions measurement. As part of the assurance process, AHUK will carry out due diligence on operational processes (i.e., maintenance planning and execution, ongoing monitoring, competent personnel, internal/external auditing) to ensure emissions reduction via efficient operation of equipment and routine energy efficiency studies. Applicable performance metrics e.g., carbon intensity, will form part of the routine monitoring data AOC will provide to AHUK.

In alignment with the NSTA Net Zero Stewardship Expectation 11, (NSTA 2021), AOC (as Operator of the Anasuria FPSO) will seek to deliver continuous improvement across all areas of GHG emissions reduction during the operational phase of the Teal West Development. AHUK will support AOC in emission reduction activities which include the utilisation of digital twin technology to predict and mitigate potential process upsets which can result in increased emissions.

AOC has applied a robust and systematic approach to the identification and assessment of GHG emission reduction opportunities covering energy generation, energy demand intensity, and flaring. A series of potential emissions reduction projects that are under investigation for Anasuria are detailed in Table 10-10. Currently all flare purge gas and other sources of low-pressure gas on the Anasuria FPSO (e.g., compressor dry gas seal vents, glycol regeneration column vapour outlet) are flared. AOC are investigating opportunities to reduce the amount of flared gas and associated emissions: AHUK will support AOC initiatives to reduce flare emissions. All opportunities to reduce GHG emissions will inform the Anasuria FPSO Emissions Reduction Action Plan (ERAP) which will be reviewed, and investment commitments made by AHUK prior to submission to NSTA as a demonstration of commitment by AHUK. AHUK will contribute to the SCAP supporting delivery of identified and approved emission reductions within the AOC ERAP. AOC will monitor the delivery of the initiatives in the ERAP through asset management of Teal West.

10.6. Cumulative and Transboundary Impacts

10.6.1. Air quality

As noted in Section 4.6.3, the closest active oil and gas activities to the Teal West development are the Anasuria FPSO, the Triton platform (approximately 23 km from Teal West), the Kittiwake platform (approximately 26 km from Teal West) and the Gannet platform (approximately 18 km). There are no offshore windfarms in the vicinity.

The limited duration of activities and the associated vessel emissions are not expected to cumulatively result in any discernible impact on local air quality above the baseline levels. The cumulative local air quality impact at Anasuria resulting from existing fields and the addition of Teal West are expected to be negligible. The ongoing CO_2 reduction work scopes will also improve energy efficiency and therefore reduce all emissions due to fuel combustion.

The proposed activities and associated emissions arising from the Teal West Development will be approximately 150 km from the east coast of the UK and approximately 85 km from the UK/Norway transboundary line. The emissions are expected to be localised to the Development activities and are not expected to result in any discernible impact on local air quality above the baseline levels or onshore, therefore a significant transboundary impact is not expected.

10.6.2. Global climate change

The potential impact of GHG emissions from developments on global climate change is not geographically constrained. This means all developments with GHG emissions have the potential to result in a cumulative effect on the global climate.

The sensitivity of the climate to GHG emissions is considered to be ‘high’, recognising:

- Any additional GHG impacts could affect the UK’s ability to limit its GHG emissions and achieve its future carbon budgets, (as per the Climate Change Act 2008, which commits the UK to reducing GHG emissions by at least 100% of 1990 levels by 2050); and
- The importance of meeting the Paris Agreement goal and of limiting global warming below 1.5°C (IPCC, 2021).

The current assessment is aligned with Institute of Environmental Management and Assessment (2022)[18] which states that:

“The crux of significance is not whether a project emits GHG emissions, nor even the magnitude of GHG emissions alone, but whether it contributes to reducing GHG emissions relative to a comparable baseline consistent with a trajectory towards net zero by 2050.”

Where no sector-based or local emissions budgets exist, comparison can be made with the UK Carbon Budgets. Table 10-11 presents the Offshore Development’s net CO_2e emissions against UK carbon budgets. During the 2023 - 2027 carbon accounting period, emissions associated with embodied carbon, rig and vessels and beginning of operation are assumed to occur from the Development. It is clear that the Development will contribute only a very small percentage of the UK’s available carbon budget regardless of the accounting period being considered.

Table 10-11 Development net CO_2e emissions against UK carbon budget (Committee on Climate Change, 2020) [19]

Emission Item	Carbon Accounting Period		
	2023 to 2027	**2028 to 2032**	**2033 to 2037**
UK carbon budget for period (tonnes CO_2e)	1,950,000,000	1,765,000,000	965,000,000

[18] Environmental Impact Assessment Guide to: Assessing Greenhouse Gas Emissions and Evaluating their Significance
[19] All emissions from the development were considered

Offshore Development emissions for period (tonnes CO_2e)	195,032	74,482	30,632
Development CO_2e emissions as a % of UK budget	0.01%	0.004%	0.003%

In this assessment the impact on the NSTA sector-based area emission values is available and are therefore used as a proxy for the impact of the Development on the global climate (Table 10-12). On this basis, where GHG emissions from a development would be greater than 30%, the magnitude of the emissions would be considered large.

Table 10-13).

Table 10-12 NSTA UKCS offshore CO_2 emissions and estimated impact of Teal West (NSTA, 2020).[20]

Period	CO_2 (Mt)
2017	12.6
2018	12.7
2019	13.1
2020	11.9
Average	12.6
Approximate Annual average operational emissions due to Teal West	0.014
Estimate of the % change in annual emissions for the offshore oil and gas sector that could result from Teal West	0.11%

Table 10-13 – Magnitude criteria used for impact assessment

Magnitude	Magnitude criteria description
Beneficial change	> 3 % decrease in the most recent 4-year average of the offshore oil and gas sector emission value
Negligible change	+/- 3 % change to the most recent 4-year average of the offshore oil and gas sector emission value
Small increase	Between 3 and 30% increase in the most recent 4-year average of the offshore oil and gas sector emission value
Large increase	Greater than 30% increase in the most recent 4-year average of the offshore oil and gas sector emission value

The average offshore CO_2e emissions from the offshore oil and gas sector from the last 4 years of data is 12.6 Mt CO_2. The annual operational emissions of Teal West alone are expected to be in the order of 0.014 Mt CO_2e per year over the life of field. This equates to approximately 0.1% of the annual sector emissions. The magnitude of the Development emissions is therefore considered to have a negligible cumulative impact on global climate change.

Given the high sensitivity of the receptor and the negligible magnitude of the impact the overall significance is assessed to be minor and not significant (Table 10-14). The Development is therefore likely to have a limited cumulative effect in the context of the release of GHGs into the environment i.e., they will have negligible cumulative or transboundary impact.

[20] Only operational emissions have been considered to align with the scope of the NSTA data

Table 10-14 Significance of effects matrix for GHG emissions impact assessment

Magnitude of GHG emissions	Sensitivity of Receptor – High
Beneficial change	Beneficial
Negligible change	Minor – Not Significant
Small increase	Moderate – Significant
Large increase	Major – Significant

10.7. Decommissioning

At the end of field life, the Development will be decommissioned. The decommissioning process will generate atmospheric emissions both directly from late-life management of the asset, cessation of operation activities and associated vessel traffic, and indirectly through the reuse and recycling of materials (e.g., steel).

Management of the emissions in the late-life and cessation of production of the Teal West asset will be in line with AHUK's decommissioning plans. In alignment with the NSTA Net Zero Stewardship Expectation 11, (NSTA 2021), the decommissioning plan will seek to minimise GHG emissions by assessing the latest technology at the time. As with all other sectors of UK industry, shipping is identifying opportunities to decarbonize and therefore the atmospheric emissions from the decommissioning vessels may be less than those predicted for installation and commissioning. AHUK´s procurement process will ensure GHG emissions reduction is part of the selection criteria to deliver the decommissioning plan when developed.

10.8. Protected Sites

The Scottish Marine Plan seeks to ensure that oil and gas developments consider key environmental risks including the impacts of releases to atmosphere. Atmospheric emissions associated with the Development will not occur within any SAC or SPA. However, the Anasuria FPSO is on the edge of the East of Gannet and Montrose NCMPA.

As discussed in Section 4.5, the East of Gannet and Montrose NMPCA is designated for benthic habitat features and ocean quahogs. As the qualifying features of the NMPCA are situated at depth on the seabed and given that atmospheric emissions are expected to represent at most a negligible increase in the baseline for the area, there are no significant effects expected within the NMPCA, and no expected risk to its conservation objectives or integrity.

The next closest NMPCA is the Norwegian Boundary Sediment Plain approximately 90 km northeast and the next closest SAC to the Development is the Scanner Pockmark, located 110 km to the north. Any elevated levels of emissions offshore due to the Development will be short-lived and hardly detectable beyond a short distance from their source, (due to the dispersive nature of the offshore environment). Since atmospheric emissions are localised and transitory, the Development does not present a risk to the conservation objectives or integrity of any other protected sites.

10.9. Residual Impacts

With respect to air quality, the atmospheric emissions from the Development will mostly be temporary and limited in nature during the installation and decommissioning phase. It is not anticipated that there will be any significant changes to flaring, fuel gas demand or combustion. Taking into account the distance from any potentially sensitive receptors, it is not expected that atmospheric emissions will negatively impact local air quality or result in significant local cumulative impacts.

In terms of global climate change (i.e., cumulative and transboundary impacts), the Development will add a relatively small increment to the overall offshore emissions of the UK. Its contribution to global warming will be negligible.

Table 10-15 Air quality residual impact

Receptor	Sensitivity	Vulnerability	Value	Magnitude
Local Air Quality	Low	Low	Low	Negligible
Rationale				
Information regarding emissions has been used to assign the sensitivity, vulnerability and value of the receptor as follows. On the basis that the activity will occur in the highly dispersive marine environment, the receptor sensitivity and vulnerability is ranked as Low. A ranking of low has been assigned to the vulnerability of the receptor as there are no air quality issues identified in the vicinity and any impact will occur in the immediate vicinity of the Development. Magnitude is ranked as negligible as the emissions are short term in duration, intermittent and distributed and therefore unlikely to be discernible or measurable. On this basis, the consequence is negligible and the impact not significant.				
Consequence		**Impact Significance**		
Negligible		Not significant		

Table 10-16 Contribution to Global Climate change residual impact

Receptor	Sensitivity	Vulnerability	Value	Magnitude
Contribution to Global Climate change	High	High	High	Negligible
Rationale				
Information regarding CO_2e emissions has been used to assign the sensitivity, vulnerability and value of the receptor as follows: On a global scale, the IPCC in its sixth assessment report (AR6) states that it is unequivocal that the increase of CO_2, CH_4 and N_2O in the atmosphere over the industrial era is the result of human activities and that human influence is the principal driver of many changes observed across the atmosphere, ocean, cryosphere and biosphere, (IPCC, 2021). Climate change estimates in the AR6 report that each of the last four decades have been successively warmer than any decade that preceded it since 1850. IPCC (2021) reports a 47% increase in CO_2 concentrations since 1750, which far exceeds the natural multi-millennial changes between glacial and interglacial periods over at least the past 800,000 years, and states that fossil fuel combustion is the primary contributor to the observed climate change. On this basis, the receptor sensitivity, vulnerability and value are all ranked as high. The magnitude of the impact is ranked as negligible due to the low level of additional emissions of CO_2e resulting from the Development relative to the UK carbon budget. On this basis, the consequence is minor and the impact not significant.				
Consequence		**Impact Significance**		
Negligible		Not significant		

10.10. Climate Change Assessment

10.10.1. Introduction

The climate change impact assessment for the Development differs from other impacts assessed and presented within this ES, as it does not consider the potential impact of the Development on specific receptors. The impact of the climate (i.e., an external factor) on the Development itself and the in-combination impacts of the Development and climate change (In-Combination Climate Impact, ICCI) are assessed in a climate change impact assessment.

As the construction phase is much shorter than the operational phase and will be undertaken from 2023 future climate change for the construction phase is less relevant and not considered further. Detailed information on the decommissioning of the Development infrastructure is also limited at this time, and therefore, a meaningful assessment of the Development and climate change during the decommissioning phase is not possible. For these reasons, this section focuses on the potential impacts posed by climate change on the Development during the 11 year operational phase, including operations and maintenance as well as the infrastructure itself.

10.10.2. Data gaps and uncertainties

The key uncertainties / difficulties associated with predicting the impact on the Development and the impacts assessed within this ES include:

- Uncertainty in the modelled predictions – based on the uncertainty around the future emissions scenario as well as an uncertainty in other model inputs (e.g., current conditions, parameters etc.);
- Uncertainty around the response of the physical, biological, and socio-economic environment to changes in climate variables; and
- Difficulties in attributing changes in the physical, biological, and socio-economic environment to climate change.

The climate change resilience review and the ICCI assessment are also limited by the data availability at the time of the assessment.

10.10.3. Climate Change Resilience

This section looks at the ability of the Development to withstand, respond to and recover from the projected changes in climate.

Climate change resilience is defined as the indication of a project's ability to withstand, respond to, and recover rapidly from disruptions caused by changing climate variables (IEMA, 2020).

The projected change in climate variables were considered and assessed for potential impact on the Development infrastructure, facilities, or activities.

The potential impacts on the Development during the operation phase associated with projected changes for the climate variables listed above are listed in Table 10-17 below.

Table 10-17 – Potential impact of changing climate variables on the Development (during the operations and maintenance phase)

Climate Variable		Potential Impact on Project Design	Significance On Project Design
Extreme weather events	Increased frequency of high wind events	Disruption or increased safety risk to operation and maintenance procedures or equipment / vessels as a result of high wind events.	Not significant
	Increased mean maximum wave heights	Disruption or increased safety risk to operation and maintenance procedures or equipment / vessels as a result of high waves.	Not significant
Changing sea conditions	Increased sea temperature	Potential damage, loss or reduced structural integrity of the Development's infrastructure (e.g., thermal expansion).	Not significant
	Increased near-bed temperature	Potential damage, loss or reduced structural integrity of the Development's infrastructure (e.g., thermal expansion).	Not significant
	Reduced mean wave height.	None identified / within current conditions.	Not significant
Sea level rise	Sea level rise	Potential damage, loss or reduced structural integrity of Development infrastructure (e.g., impact on FPSO).	Not significant

It has been determined that, based on the table above and the Development planned, no significant impact is expected from climate change on the Development.

10.10.4. In-combination Climate Impact Assessment

An ICCI is defined as an interaction between a) a projected future climate change and b) an effect identified as a result of the Development, which exacerbates the scale of the impact (IEMA, 2020). This section considers how the impacts assessed within this ES could be exacerbated or reduced by any predicted future changes in the physical environment.

Following review of the relevant potential impacts assessed within this ES, as outlined in Chapter 6 to Chapter 11, it has been concluded that the consequences of any potential ICCI would be negligible and would not change the potential significance assessed through this ES.

11. ACCIDENTAL EVENTS

11.1. Introduction

All marine activities carry with them some risk of accidents. Accidents caused by human error, equipment failure or by extreme natural conditions may result in environmental impacts. The risk of accidental hydrocarbon releases is inherent in all offshore oil and gas activities, and an area of public concern as they may have potentially significant impacts on water quality, flora, fauna and other users of the sea.

The potential impact of any accidental hydrocarbon or chemical release will be determined by the location of the release, characteristics and weathering properties of the released material, the direction of travel and whether environmental sensitivities lie in the path of the release. These environmental sensitivities will have spatial and temporal variations. Therefore, the likelihood of any accidental release having a potential impact on the environment must consider the likelihood of occurrence against the probability of that hydrocarbon or chemical reaching a sensitive area and the environmental sensitivities present at that time.

In light of major accidental events in recent years, this chapter incorporates relevant information in assessing and mitigating the impacts of potential accidental events resulting from the proposed operations at the Teal West Development.

11.2. Regulatory Controls

The key regulatory drivers associated with the prevention and response to spill risks are summarised as follows:

- The International Convention on Oil Pollution, Preparedness, Response and Cooperation (OPRC), which has been ratified by the UK, requires the UK Government to ensure that operators have a formally approved Oil Pollution Emergency Plan (OPEP) in place for each offshore operation or agreed grouping of facilities. This is enacted through The Merchant Shipping (OPRC) Regulations 1998;
- The Offshore Installations (Emergency Pollution Control) Regulations 2002 give the Government power to intervene in the event of an incident involving an offshore installation where there is, or may be, a risk of significant pollution, or where an operator has failed to implement proper control and preventative measures. These regulations apply to accidental hydrocarbon releases;
- The Offshore Petroleum Licensing (Offshore Safety Directive) Regulations 2015 implement Directive 2013/30/EU. The objectives of the Directive are to reduce as far as possible the occurrence of major accidents relating to offshore oil and gas operations and limit their consequences., thus increasing the protection of the marine environment and coastal economies against pollution. The Directive aims to achieve this objective by establishing minimum conditions for safe hydrocarbon exploration and exploitation offshore as well as improving the response mechanisms in case of an accident; thereby limiting possible disruptions to the EU's indigenous energy production;
- The Offshore Installations (Offshore Safety Directive) (Safety Case) Regulations 2015 objective is to understand how a major accident (MA) may impact the environment and to identify safety and environmental critical elements (SECEs) in the design and operation of an offshore installation. As part of that commitment, operators are required to identify in their safety cases where any major accident hazards (MAHs) have the potential to cause a major environmental incident (MEI) and where applicable, ensure there are robust safeguards in place to prevent MEIs from occurring;

- Assessment may also be required to determine if there could be any LSE from spill risk on any SACs or SPAs designated under the European Directives listed below, which are transcribed into UK legislation by the Conservation Regulations 1994 (as amended) (inshore out to 12 NM) and the Offshore Marine Conservation Regulations 2007 (as amended) (beyond 12 NM). These regulations require the project developer to provide the information required by the competent authority (BEIS) to undertake such an assessment;

11.3. Description of Risks and Potential Impacts

The following is a list of accident scenarios with the potential to result in losses of containment from the Development leading to large oil releases. The relevant scenarios selected as part of this review for further discussion included:

- Blowouts and well releases;
- Pipeline / Riser Release;
- Dropped Objects and Swinging Loads; and
- Loss of diesel inventory.

Note that some scenarios, such as structural failure, combine further causes such as extreme weather, corrosion and seismic events.

Major loss of containment events in offshore facilities are typically low frequency, high consequence scenarios. These differ from minor leaks which are more common to occur, however with lesser consequences. As such, the relative number of such large-scale events reported in any historical dataset for a given location, such as the UKCS, is naturally expected to be very low.

The source of UKCS oil release data from offshore installations is the Petroleum Operations Notices 1 (PON1) database (BEIS, 2019a). PON1 data is collated by OPRED. Under the OPPC Regulations, the offshore environmental regulator requires operators to submit details of all non-permitted chemical and oil releases to sea as a PON1 report, regardless of quantity. Discharges that are permitted sometimes do not meet the permit limit e.g. oil in produced water, and these are also submitted as a non-compliance of the OPPC regulations in the PON1 system.

Table 11-1 and Figure 11-1 presents a summary of the accidental oil releases reported per year from 2008 to 2018. It also includes the total quantities of oil released (in tonnes) for each year. Overall, the number of reported releases increased considerably over the years since 1975, potentially associated with improvements in reporting behaviours, although a decrease between 1990 and 1995 was observed. The total quantities of oil released had a significant spike between 1985 and 1990, with an overall average decrease afterward (despite a spike in 1997, with over 800 tonnes of oil being released in that year (UKOOA, 2006)). Since the early 2000's (more specifically after 2002) the average number of reported oil releases remained approximately constant (fluctuating between 250 – 375 releases per year) (UKOOA, 2006). The peaks in released amounts observed between 2010 – 2012 are a consequence of the three largest releases in the reported period – one release of 131 tonnes in 2010, one release of 218 tonnes in 2011, and one release of 405 tonnes in 2012. In the 11-year period between 2008-2018 approximately 1,246 tonnes of oil was released, while in the preceding 11 years (1997-2007) this amount was approximately 1,700 tonnes.

Table 11-1 – Summary of reported accidental oil releases and released amounts, 2008-2018

Year	Number of Accidental Oil Releases	Released Amount (tonnes)
2008	266	31.5
2009	290	52.2
2010	265	19.2
2011	280	265.4
2012	246	521.9
2013	298	102.5
2014	307	30.4
2015	287	34.9
2016	282	20.6
2017	297	26.8
2018	314	13.0
Total in period	**3,034**	**1,246**

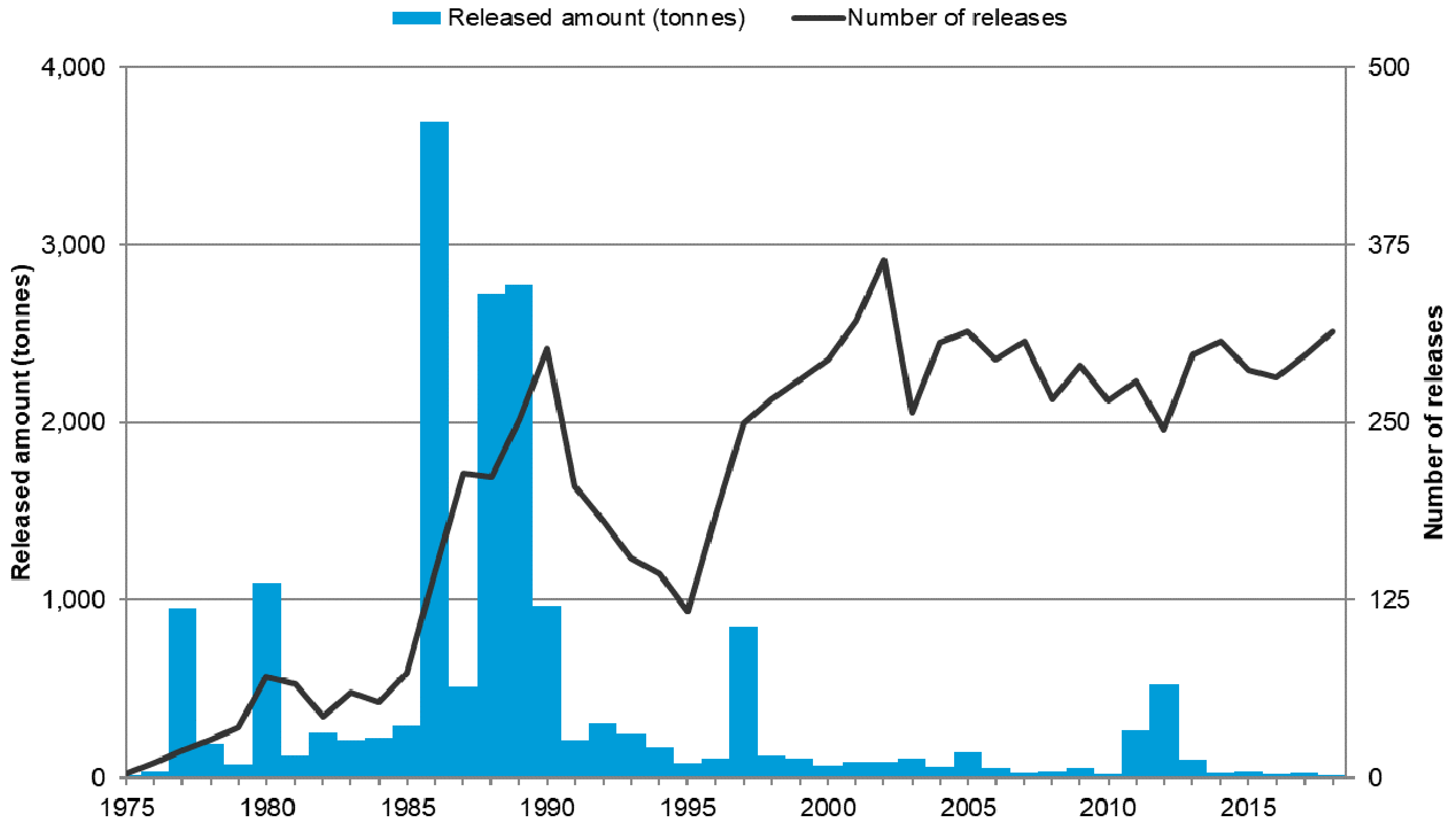


Figure 11-1 – Time series of the number of accidental oil releases and the associated released amount from 1975 to 2018

It was also seen that out of the 3034 oil releases reported in the 11 years between 2008-2018, 1146 releases (~38%) were of less than 0.001 tonnes (i.e. approximately less than 1 kg), and 2959 (~97%) were releases of less than a single tonne. Only two events were of a magnitude greater than 100 tonnes and no event exceeded 1,000 tonnes.

11.3.1. Blowout and Well Releases

A surface blowout is defined as an uncontrolled flow of formation hydrocarbons from the reservoir to the surface which occurs because of loss of the primary and secondary well controls, i.e. oil flowing from a well from some point that was not intended. A blowout beneath the seabed may occur if the downhole pressure exceeds the fracture pressure of a formation and hydrocarbons flow into the weaker formation.

Primary well control is the process which maintains the hydrostatic pressure in the wellbore which is greater than the pressure of the hydrocarbons in the formation being drilled, but less than the formation fracture pressure. If the formation pressure is greater than the pressure of the drilling fluid in the wellbore (i.e. mud hydrostatic) the well will flow and the hydrocarbons will enter into the wellbore. If the primary well control fails this flow may be stopped by closing the BOP, which is the initial stage of secondary well control. Secondary well control is completed by circulating out and displacing the wellbore with a high-density fluid to shut in the well. If the primary and secondary well controls fail, then a blowout may occur.

Based on International Association of Oil and Gas Producers analysis (IOGP, 2010), the likelihood of a blowout is remote. Nevertheless, as the consequence of a hydrocarbon release of any nature is potentially significant, AHUK will implement rigorous measures to reduce the potential for a failure of well control and ensure effective response should an incident occur.

The estimated frequency of releases larger than 100 tonnes were calculated based on an 11-year (2008 – 2018) UKCS oil release profile (Table 11-2).

Table 11-2 – Estimated Frequencies of Large Releases

Year	≥ 100 tonnes (/year)	≥ 1,000 tonnes (/year)	≥ 10,000 tonnes (/year)	≥ 100,000 tonnes (/year)
All releases – estimated frequencies from F-Q linear equation	2.8E-01	6.3E-02	1.5E-02	3.3E-03

In the period between 2000 – 2015 there were 26 well control incidents in the UK (ExproSoft, 2017). The Elgin incident in 2012 was the only well control related incident resulting in significant loss of oil to the sea in the history of UKCS offshore activity.

From these, 10 were related to completion and workover activities, 4 to wireline, 3 to production wells, 1 to an abandoned well, 1 unknown, with the remaining 7 related to exploration and development drilling (Table 11-3). These figures result in approximately 1.4 well control incidents per year in average. Based on this analysis, the likelihood of a blowout or well release is considered remote to extremely remote. Nevertheless, as the consequence of a hydrocarbon release of any nature is potentially significant, AHUK will implement rigorous measures to reduce the potential for a failure of well control and will respond should an incident occur (these are detailed in Section 11.6).

Table 11-3 – Overview of the number of loss of well control events that occurred during different operational phases 2000 – 2015 (ExproSoft, 2017)

Description	Drilling		Completion	Workover	Production Causes		Wireline	Abandoned Well	Unknown	Total
	Development Drilling	Exploration			External*	Internal				
Number of well blowouts	4	3	5	5	-	3	4	1	1	26
Percentage (%)	15.4	11.5	19.2	19.2	-	11.5	15.4	3.8	3.8	
*External causes include storm, military and ship collision										

11.3.2. Pipeline/Riser Release

From analysis of the PON1 dataset, releases from risers and pipelines were one of the main contributors to oil releases. The worst pipeline release within the dataset was the 2011 incident at the Gannet pipeline, in which 218 tonnes of released oil were reported. More recently, a release of about 500 barrels (~70 tonnes) occurred in February 2022 from a pipeline between the Conwy and Douglas platforms in the Irish Sea, a relatively new pipeline which is also much larger than the proposed production flowline for the Teal West Project. The importance of ensuring a robust pipeline design and extensive management controls (see Section 11.6) to effectively manage corrosion and minimize free spans is key to mitigating pipeline integrity issues.

The quantities released from a pipeline failure scenario can vary significantly, and these will depend on many factors:

- pipeline diameter;
- topography of the pipeline;
- pipeline pressurization;
- hole size for the leak;
- flow rates; and
- oil type and specific gravity.

The potential release in a worst-case pipeline release could be in the range of several thousand tonnes, although a release of such magnitude would likely result from severe failures on large pipelines, such as the Norpipe pipeline which connects Ekofisk to the UK coast. The pipeline at the Teal West Development is a small in-field production pipeline and will contain a much smaller volume (approximately 65 tonnes maximum). After identification of a pipeline leak by reduction in receiving pressure or oil on the sea surface, the pipeline will be isolated from the wells (via the well controls on the XT). The release of oil from the isolated pipeline will only continue until the internal pressure reduces and it is hydrostatically locked.

11.3.3. Dropped Objects

There exists the possibility that during drilling, installation and operational activities associated with the Teal West Development, dropped objects to sea may occur. If the dropped object damages the integrity of any live infrastructure a release of hydrocarbons may be a consequence. Any objects dropped during these activities will be removed from the seabed where appropriate. Dropped object procedures are industry standard and there is only a very remote probability of any interaction with any live infrastructure.

11.3.4. Loss of Diesel Inventory

There are a number of diesel releases within the PON1s for the reported period. 17 of the diesel releases were greater or equal to 1 tonne in size, with one event greater than 10 tonnes. These events include releases from general diesel system, with causes including overfilling of tanks and incorrect line-up of valves, as well as diesel releases during bunkering commonly resulting from hose failure. The worst-case diesel release within the reported period was of approximately 14 tonnes during bunkering. A release of diesel resulting from a failure of a process equipment, such as the overflow of a tank, the failure of a transfer line, or a hydraulic leak could be treated as a process release.

A significant loss of diesel inventory, for example onboard the drilling rig, could result in releases in excess of 1,000 tonnes. In extreme cases, the loss of the whole diesel inventory of a rig could result in a release exceeding 10,000 tonnes, although this is a very low likelihood scenario which would, more likely, be associated with a severe loss of integrity e.g. from a collision or a structural failure.

11.3.5. Other Support Vessels

Potential sources of accidental releases from installation operations include:

- Upsets in bilge treatment systems;
- Storage tank failure of lube oils, fuel oil, oil-based mud, base oil and chemicals;
- Accidental release during maintenance activities, including equipment removal and lubrication; and
- Damage sustained during a collision, grounding, fire or explosions.

The most frequently reported accidental releases from vessel traffic are associated with upsets in bilge treatment systems and are usually small (<1 tonne). The most recent Advisory Committee on Protection of the Sea (ACOPS) report on discharges to sea states that approximately 85% of accidental chemical releases in 2016 were considered under the OSPAR list of substances used and discharged offshore as PLONOR to the environment; that none of the chemicals were included in the OSPAR list of chemicals for priority action (which are considered to pose the greatest potential impact). None of the releases resulted in a significant environment impact (ACOPS, 2017).

Behaviour of Hydrocarbons at Sea

The potential environmental impact of an accidental hydrocarbon release depends on a wide variety of factors, which include:

- Accidental release volume;
- Type of hydrocarbon release;
- Direction of travel of the surface slick;
- Weathering properties of the hydrocarbon;
- Any environmental sensitivities present in the path of the slick (these may change with time); and
- Sensitivity of the sea and beaching locations.

The Oil Spill Contingency and Response (OSCAR) model has been developed by Sintef to model the fate of accidentally released hydrocarbons at sea. To understand the specific behaviour of releases from the Teal West Development, oil spill modelling was conducted in accordance with BEIS guidance (2021) using this model. The worst-case scenario modelled was:

- Well blowout at Teal West using the highest unconstrained well flowrate for 120 days (time taken to drill a relief well).

Details of the scenario modelled are shown in the following table. This model was run on the basis that there was no intervention by any third-party to respond to the released oil. The accidental release scenarios for the development are detailed below in Table 11-4.

Table 11-4 – Accidental release scenarios

Scenario Description	Hydrocarbon Type	Release Volume (m^3)	Modelled depth of release	Model Type
Well blowout at Teal West using the highest unconstrained well flowrate for 120 days (time taken to drill a relief well).	Teal West Crude	280,000	Seabed	Stochastic

The probability plots for surface oiling are displayed in Figure 11-2. Modelling indicated that oil is predicted to cross the Norwegian, Danish, Swedish, German, Dutch, Faroese, Svalbard, Icelandic and Jan Mayen median lines; the worst-case probability of contamination and arrival times for these crossings are listed below:

- Norwegian waters – maximum probability of 100% in all seasons and a minimum arrival time of 1 day 3 hours in winter;
- Danish waters – maximum probability of 100% in all seasons and a minimum arrival time of 9 days 7 hours in autumn;
- Swedish waters – maximum probability of 100% and a minimum arrival time of 17 days 5 hours in summer;
- German waters – maximum probability of 85.5% in spring and a minimum arrival time of 16 days 5 hours in winter;
- Netherlands waters– maximum probability of 71.8% in winter and spring and a minimum arrival time of 15 days 7 hours in winter;
- Faroese waters- maximum probability of 14.5% in spring and a minimum arrival time of 67 days 21 hours in summer;
- Svalbard waters – maximum probability of 5.5% and a minimum arrival time of 117 days 21 hours in summer;
- Icelandic waters – maximum probability of 0.9% in winter, spring and summer and a minimum arrival time of 129 days 3 hours in summer; and
- Jan Mayen waters – maximum probability of 5.5% and a minimum arrival time of 95 days 18 hours in summer.

In addition, beaching was predicted to occur on the east coast of the UK from Kent to Shetland and on European coastlines including Norway, Denmark, Sweden, Germany, Netherlands, Faroe Islands, Belgium, France and Jan Mayen. The worst-case probability of contamination and arrival times for the beached oil at different locations is as follows:

- UK – the region with the worst-case oiling is Shetland with a maximum probability of 70% in autumn and a minimum arrival time of 17 days 13 hours in winter. However, beaching is also predicted at Orkney (maximum probability of 39.1% and a minimum arrival time of 18 days 9 hours), Highlands (maximum probability of 32.7% and a minimum arrival time of 7 days 7 hours), Grampian region (maximum probability of 67.3% and a minimum arrival time of 4 days 17 hours), North-east England (maximum probability of 45.5% and a minimum arrival time of 11 days 10 hours), Yorkshire (maximum probability of 40% and a minimum arrival time of 30 days 2 hours), East Midlands (maximum probability of 24.5% and a minimum arrival time of 59 days 18 hours), East Anglia (maximum probability of 23.6% and a minimum arrival time of 63 days 10 hours) and South-east England (maximum probability of 0.9% and a minimum arrival time of 142 days 15 hours);

- Norway – maximum probability of 100% in summer and a minimum arrival time of 12 days 19 hours in autumn;
- Denmark – maximum probability of 100% in winter, spring and summer and a minimum arrival time of 13 days 7 hours in winter;
- Sweden – maximum probability of 97.3% in summer and a minimum arrival time of 18 days 17 hours in winter;
- Germany – maximum probability of 65.5% and a minimum arrival time of 19 days 18 hours in winter;
- Netherlands – maximum probability of 20.9% in winter and a minimum arrival time of 54 days 12 hours in autumn;
- Faroe Islands – maximum probability of 3.6% in winter and autumn and a minimum arrival time of 80 days 6 hours in winter;
- Iceland – maximum probability of 8.2% and a minimum arrival time of 82 days 11 hours in autumn;
- Jan Mayen – maximum probability of 2.7% and a minimum arrival time of 77 days 15 hours in autumn;
- France- maximum probability of 0.9% in winter and autumn and a minimum arrival time of 142 days 22 hours in autumn; and
- Belgium – maximum probability of 0.9% and a minimum arrival time of 113 days 6 hours in spring.

The maximum mass of beached oil in any single run was predicted to be 5,415 tonnes in spring (or 18,848 tonnes of beached emulsion), which would be distributed across North Sea coasts.

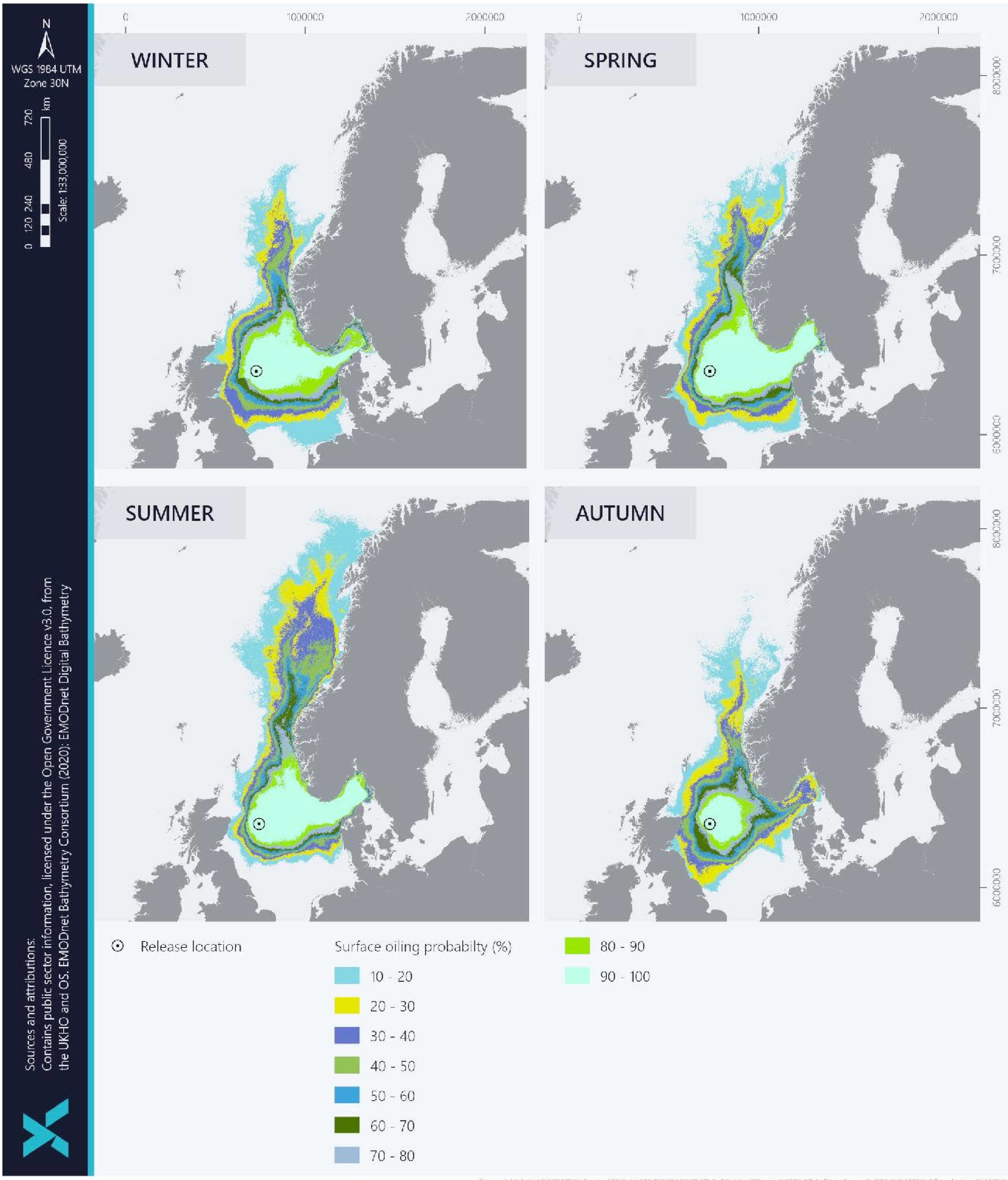


Figure 11-2 – Scenario 1: Well blowout – Probability of surface oiling (above 0.3 µm) above 10%

11.4. Potential Receptors

Vulnerability of the environment is a function of the exposure routes of the environment to a stressor and has both a temporal and spatial variability. The severity or consequence of a hydrocarbon release is a function of the vulnerability of the receptor and the exposure of the receptors to the hydrocarbon and this is in turn dependent on the quantity and duration of the hydrocarbons release (its source term) and its physical properties which determine its behaviour (persistence and distribution) in the environment. Risk is the product of the probability of exposure to a hazard and consequence of that hazard on a particular receptor. Uncertainty in the environmental risk is difficult to quantify and accounted for by assuming worst-case outcomes to assess high consequence, low probability events. The following assessment therefore considers a low probability unmitigated blowout event, for which worst-case source control predictions are used to determine the duration of the release and a stand-off approach is adopted with respect to the released hydrocarbons i.e. no response or clean-up activities are considered to mitigate the released hydrocarbons. This is therefore the largest theoretical release that could occur from the Teal West Development.

11.4.1. Coastal Environments

The likelihood of a hydrocarbon spill reaching the coastal environment is a function of the likelihood of a hydrocarbon spill occurring and the probability of the released hydrocarbons beaching. The level of impact on the shoreline is related to the volume of hydrocarbon beaching, the composition of the beached hydrocarbons, and the type of beach.

Coastal environmental sensitivities to spills include nearshore breeding seabird populations, shore birds, over wintering diver and duck species, marine mammals, aquaculture operations and sub-littoral and coastal habitats many of which are designated as SACs and SPAs.

Intertidal areas of the coast show varying degrees of sensitivity to spills; this variability is a function of both actual effects on specific organisms and the physical fate of the released substances within the habitat concerned. For example, high energy rock, boulder or cliff coastlines tend to have lower sensitivity to hydrocarbon pollution because oil is rapidly broken up and dispersed by wave action, whilst beached oil remains on the surface of rocks and is exposed to weathering. In contrast, sheltered, low energy shorelines tend to have moderate to high sensitivity because oil is not broken up by wave action and it can be mixed into the sediment, shingle or cobbles where it is not exposed to weathering and therefore persists for longer.

11.4.2. Protected Sites

Sea surface and shoreline probability of contamination data exported from the stochastic oil spill modelling (see Section 11.5.2) were examined to identify protected sites which are at risk of hydrocarbon contamination and require further assessment. For the purposes of this assessment it was concluded through an expert elicitation process that a protected site required further assessment if the probability of shoreline or surface contamination within the site was equal to or above 40% in any of the release scenarios.

The qualifying features in most coastal sites identified as having the potential to be impacted because of oiling are estuaries, mud and sandflats and dune features, although dunes are unlikely to be oiled. These habitats are also more likely to be negatively affected by hydrocarbon contamination than sea cliff habitats.

Habitats most likely to be negatively affected by hydrocarbon contamination are exposed reefs and species that forage in the contaminated areas. Various seal haul-out locations are present in the Shetland and Northumberland areas which are regions likely to be significantly contaminated with oil should a well blowout occur. The animals most at risk from oil coming ashore on seal haul-out sites and breeding colonies are neonatal pups. These animals are born without any blubber and reply on their prenatal fur and metabolic activity for thermal balance. They are therefore more susceptible than adults to external oil contamination (Ekker *et al.*, 1992). The pups remain on the breeding colonies until they are weaned and unlike adults or juveniles, would be unable to leave the contaminated areas.

As the blowout represents the worst-case scenario, the potential of contamination at protected sites was assessed for the blowout scenario only. The protected sites included in the assessment were SACs (including Candidate Special Area of Conservation (cSACs)), SPAs (including Potential Special Protection Areas (pSPAs)) and NCMPAS. There were 22 sites with at least a 40% probability of receiving oil, although this does not necessarily mean that the qualifying features of the sites will be impacted. A number of sites are designated for features that would be unlikely to receive any oil such as those in the benthic environment. The sites likely to be most significantly impacted are those designated for seabird species or marine mammals as they are most likely to be present at the sea surface where the oil would be found at the highest quantities. These are presented in Table 11-5. The impact of contamination on the designation features are discussed below in the relevant sections.

Table 11-5 – Protected sites and features for sites where hydrocarbon from a well blowout at Teal West is predicted to enter the site at a probability sufficient to dictate further assessment (>40% probability of surface contamination) (JNCC, 2020)

Site	Primary Designation Features
Ythan Estuary, Sands of Forvie and Meikle Loch SPA Maximum probability of oiling (%): 41.8	**Annex I Species that are primary reason for selection** • Common tern *Sterna hirundo* • Little tern *Sternula albifrons*
Buchan Ness to Collieston Coast SPA Maximum probability of oiling (%): 42.7	**Annex I Species that are primary reason for selection** • Guillemot *Uria aalge* • Shag *Phalacrocorax aristotelis*
Bluemull and Colgrave Sounds SPA Maximum probability of oiling (%): 46.4	**Annex I Species that are primary reason for selection:** • Red-throated Diver *Gavia stellata*
East Mainland Coast, Shetland SPA Maximum probability of oiling (%): 70.0	**Annex I Species that are primary reason for selection** • Great northern diver *Gavia immer* • Red-throated diver *Gavia stellata* • Slavonian grebe *Podiceps auritus*
Lindisfarne SPA Maximum probability of oiling (%): 41.8	**Annex I Species that are primary reason for selection** • Roseate tern *Sterna dougallii* • Little tern *Sternula albifrons*
Fetlar SPA Maximum probability of oiling (%): 68.2 **Fetlar to Haroldswick NCMPA** Maximum probability of oiling (%): 68.2	**Annex I Species that are primary reason for selection (Fetlar SPA):** • Arctic tern *Sterna paradisaea* • Red-necked phalarope *Phalaropus lobatus* **Annex I Species that are primary reason for selection (Fetlar to Haroldswick NCMPA):** • Black guillemot *Cepphus grylle*

Site	Primary Designation Features
Firth of Forth SPA Maximum probability of oiling (%): 51.8	**Annex I Species that are primary reason for selection:** • Bar-tailed godwit *Limosa lapponica* • Golden plover *Pluvialis apricaria* • Red-throated diver *Gavia stellata* • Sandwich tern *Sterna sandvicensis* • Slavonian grebe *Podiceps auritus*
Fair Isle SPA Maximum probability of oiling (%): 40.0	**Annex I Species that are primary reason for selection:** • Arctic tern *Sterna paradisaea*
St Abb's Head to Fast Castle SPA Maximum probability of oiling (%): 44.5	**Annex I Species that are primary reason for selection** • Guillemot *Uria aalge* • Shag *Phalacrocorax aristotelis*
Hermaness, Saxa Vord and Valla Field SPA Maximum probability of oiling (%): 55.5	**Annex I Species that are primary reason for selection:** • Red-throated Diver *Gavia stellata*
Outer Firth of Forth and St Andrews Bay Complex SPA Maximum probability of oiling (%): 51.8	**Annex I Species that are primary reason for selection:** • Arctic tern *Sterna paradisaea* • Common tern *Sterna hirundo* • Guillemot *Uria aalge* • Manx shearwater *Puffinus puffinus* • Red-throated diver *Gavia stellata*
Firth of Tay and Eden Estuary SPA Maximum probability of oiling (%): 40.9	**Annex I Species that are primary reason for selection:** • Bar-tailed godwit *Limosa lapponica* • Little tern *Sternula albifrons* • Marsh harrier *Circus aeruginosus* • Roseate tern *Sterna dougallii* • Sandwich tern *Sterna sandvicensis* • Shag *Phalacrocorax aristotelis*
Northumberland Marine SPA Maximum probability of oiling (%): 42.7	**Annex I Species that are primary reason for selection:** • Arctic tern *Sterna paradisaea* • Common tern *Sterna hirundo* • Roseate tern *Sterna dougallii* • Little tern *Sternula albifrons* • Guillemot *Uria aalge*
Forth Islands SPA Maximum probability of oiling (%): 42.7	**Annex I Species that are primary reason for selection:** • Arctic tern *Sterna paradisaea* • Common tern *Sterna hirundo* • Guillemot *Uria aalge*
Northumbria Coast SPA Maximum probability of oiling (%): 43.6	**Annex I Species that are primary reason for selection:** • Arctic tern *Sterna paradisaea*
Southern Trench NCMPA Maximum probability of oiling (%): 49.1	**No Annex I/II habitats or species are designated for protection at this site**

Site	Primary Designation Features
Tweed Estuary SAC Maximum probability of oiling (%): 49.1	**Annex I habitats that are a primary reason for selection of this site** • Estuaries • Mudflats and sandflats not covered by seawater at low tide
Mousa SAC Maximum probability of oiling (%): 49.1	**Annex II species that are a primary reason for selection:** • Harbour seal *Phoca vitulina*
Firth of Tay and Eden Estuary SAC Maximum probability of oiling (%): 49.1	**Annex II species that are a primary reason for selection:** • Harbour seal *Phoca vitulina* **Annex I habitats that are a primary reason for selection of this site** • Estuaries • Intertidal mudflats and sandflats
Berwickshire and North Northumberland Coast SAC Maximum probability of oiling (%): 49.1	**Annex II species that are a primary reason for selection:** • Grey seal *Halichoerus grypus* **Annex I habitats that are a primary reason for selection of this site** • Intertidal mudflats and sandflats
Southern North Sea SAC Maximum probability of oiling (%): 49.1	**Annex II species that are a primary reason for selection:** • Harbour porpoise *Phocoena phocoena*

In addition to the sites listed in Table 11-7 there are an additional 13 protected sites that could receive oil under a worst-cast well blowout (>40% probability) which are designated for features that are less sensitive to oil on the sea surface such as those of benthic or geological nature. These are listed below in Table 11-6.

Table 11-6 – Protected sites with features that will not likely be impacted because of hydrocarbon contamination from a well blowout at Teal West (>40% probability of surface contamination) (JNCC, 2020)

Site	Primary Designation Features
Mousa to Boddam NCMPA Maximum probability of oiling (%): 55.5	**Protected geomorphological features:** • Marine Geomorphology of the Scottish Shelf Seabed **Protected species:** • Sandeels
Firth of Forth Banks Complex NCMPA Maximum probability of oiling (%): 53.6	**Protected habitats and geomorphological features:** • Ocean quahog aggregations • Offshore subtidal sands and gravels
Norwegian Boundary Sediment Plain NCMPA Maximum probability of oiling (%): 100	**Protected habitats and geomorphological features:** • Ocean quahog aggregations
East of Gannet and Montrose Fields NCMPA Maximum probability of oiling (%): 100	**Protected habitats and geomorphological features:** • Ocean quahog aggregations • Offshore deep sea muds

Site	Primary Designation Features
Turbot Bank NCMPA Maximum probability of oiling (%): 43.6	**Protected species:** • Sandeels
Central Fladen NCMPA Maximum probability of oiling (%): 45.5	**Protected habitats and geomorphological features:** • Burrowed mud (seapens and burrowing megafauna and tall seapen components) • Sub-glacial tunnel valley representative of the Fladen Deeps Key Geodiversity Area
Dogger Bank SAC Maximum probability of oiling (%): 58.2	**Protected habitats and geomorphological features:** • Sandbanks which are slightly covered by sea water all the time
Braemar Pockmarks SAC Maximum probability of oiling (%): 82.7	**Annex I habitats that are a primary reason for selection of this site** • Submarine structures made by leaking gases
Scanner Pockmarks SAC Maximum probability of oiling (%): 99.1	**Annex I habitats that are a primary reason for selection of this site** • Submarine structures made by leaking gases
Fulmar MCZ Maximum probability of oiling (%): 100	**Protected habitats and geomorphological features:** • Subtidal muds • Subtidal sand • Subtidal mixed sediment
Swallow Sand MCZ Maximum probability of oiling (%): 63.4	**Protected habitats and geomorphological features:** • Subtidal muds • Subtidal coarse sediment
North East of Farnes Deep MCZ Maximum probability of oiling (%): 46.4	**Protected habitats and geomorphological features:** • Subtidal muds • Subtidal sand • Subtidal mixed sediment
Berwick to St Mary's MCZ Maximum probability of oiling (%): 42.7	**No Annex I/II habitats or species are designated for protection at this site**

11.4.3. Marine Mammals

Marine mammals such as cetaceans and seals are potentially vulnerable to oil on the sea surface and shoreline. These species are highly mobile and are present in temporally and spatially varying densities in the North Sea. As a result, the impact of released oil on these species will depend on the encounter rate of each species with the oil and as such includes a behavioural component (e.g., there is some evidence of some marine mammal species actively avoiding oil on the sea surface).

Cetaceans are present in the vicinity of the Development area (Environment Baseline Chapter 4). In the event of a release, the potential impact will depend on the encounter rate of the species with the oil and their feeding habits; the overall health of individuals before exposure; and the characteristics of the hydrocarbons. Cetaceans are pelagic (move freely in the water column) and migrate. Their strong attraction to specific areas for breeding or feeding may override any tendency cetaceans have to avoid hydrocarbon contaminated areas. It is thought unlikely that a population of cetaceans in the open sea would be affected by a spill in the long-term (Aubin, 1990). In contrast to seabirds, there is relatively little evidence of direct mortality associated with oil spills (Geraci & St. Aubin, 1990; Hammond *et al*. 2002), although the aggregated distribution of some species (especially dolphins) may expose large numbers of individuals to localised oiling.

Whilst it is possible that some marine mammals could encounter surface accumulations of oil and would be susceptible through inhalation or skin absorption, their ability for avoidance would reduce the potential for impact and it is unlikely that any marine mammal listed under the habitats directive would be impacted on a population level. As such, no significant impact is expected on marine mammals at sea.

Seals are widespread in the North Sea and come ashore to breed and pup (see Environment Baseline Chapter 4). There are a number of seal haul-out sites along the north and east coast of Scotland. Any oil which comes ashore will therefore increase the exposure of oil to the seals at these sites; as noted above in the discussion on protected sites, pups remain on the breeding colonies until they are weened and are particularly susceptible to oil. In the event of oil coming ashore, the population could be significantly impacted for at least one breeding season.

11.4.4. Benthic Environments

Although there are a few sites with the potential to be impacted by surface oiling (Table 8.6), it is very unlikely that the hydrocarbons would be mixed with the water column in sufficient quantities and/or depth to interact with the protected seabed features offshore. As such, no significant impact is expected on the benthic environment.

11.4.5. Birds

Impacts of sea surface oiling on seabirds is one of the greatest environmental risks posed by accidental hydrocarbon release events. This is primarily due to the high affinity of oil for seabird plumage. Once oil becomes incorporated into the feathers, there is a very high chance of death due to loss of body heat, starvation, drowning or oil ingestion from preening activity. Plumage is essential to flight, waterproofing and heat insulation and even small effects on any of these functions can result in mortality.

Some groups of seabirds are more vulnerable than others due to their particular behaviours. Guillemots, which spend much of their time on the sea surface and typically dive to avoid danger, are particularly sensitive to oil slicks. Common guillemots are particularly vulnerable in the post-breeding period because the male parents accompany their flightless young in swimming offshore from the breeding colonies. This generally occurs in late spring and early summer. Gannets are also sensitive due to their diving behaviour which causes them to repeatedly pass through any sea surface hydrocarbon layer.

Species that nest on cliffs and cliff tops are unlikely to have their nesting sites directly adversely affected by an accidental hydrocarbon release, although following the Sea Empress incident, gannets were observed collecting contaminated nesting material (Santillo *et al*., 1998).

Sheltered habitats that encourage wading or resting on calm water may suffer significant losses of birds in the event of sea surface oiling due to the greater likelihood that large accumulations of birds will be exposed. Following the Sivand spill in the Humber Estuary, the Royal Society for the Protection of Birds (RSPB) reported 160 dead oiled birds were found and estimated that 4,000 birds may have been oiled in total (NOAA, 1992). In the case of the Braer tanker spill, approximately 1,500 birds were estimated to have been killed, although the stormy weather at the time of the spill limited this number as much of the oil was swept out to sea. Furthermore, the spill was in January and many of the local bird species had flown south for winter. It is likely that most oiled birds in both of these spills would have died due to hypothermia and toxicity; and it is common that only a small proportion of bird carcasses are recovered following hydrocarbon release mortality events.

Sensitivity of species also varies in line with the total biogeographical population, which influences the potential for population recovery following an incident.

The JNCC has stated in a memorandum to the UK Parliament that the greatest risks to nature conservation from oil on the offshore sea surface is to seabirds (JNCC, 2011). The seasonal vulnerability of seabirds to surface pollutants is identified using the Seabird Oil Sensitivity Index (SOSI), derived from JNCC block-specific data. In the immediate vicinity of the Teal West Development, seabird sensitivity to oil releases ranges from low to extremely high, with particular sensitivity in April and May (see Chapter 4.3.4). The magnitude of any impact will depend on the number of birds present, the percentage of the population present, their vulnerability to spilled hydrocarbons, and their recovery rates from oil pollution. The physical impact of a spill is one of plumage damage leading to loss of insulation and waterproofing.

Seabirds that rest and breed within SPA boundaries commonly feed in waters outside the site boundary, meaning that hydrocarbon releases may impact protected site features without entering the site.

There are 16 SPAs listed in Table 11-5 with a > 40% probability of contamination at the mentioned SPAs. As discussed below, the impacts of sea surface oiling on seabirds are one of the greatest environmental risks posed by accidental hydrocarbon release events. However, the contamination is unlikely to be long-term as the population is anticipated to recover even if there was some oiling; potential recovery rates may range from 1 to 10 or more years depending on the species affected and the extent of population loss. Recovery rates depend on numerous factors including:

- The percentage of the breeding population killed (and therefore numbers remaining);
- Number of juveniles lost (affecting recruitment rates in following years);
- Size of the existing pre-breeding pool and rates of recruitment into the colonies;
- Rates of reproduction of individual species;
- Long-term loss of feeding grounds and prey species; and
- Sub-lethal effects which may affect reproductive success.

11.5. Major Pollution Incident Release Assessment

Under the Offshore Safety Directive (2013/30/EC) and the implementing UK regulations, the Offshore Installations (Offshore Safety Directive) (Safety Case) Regulations 2015 (OSCR), operators are required to identify in their well notifications where any MAHs associated with the operations has the potential to cause an MEI. The Teal West Development does not have a safety case associated with it as it is a subsea tie-back and therefore an MEI will not be caused by an MAH. Instead, the Anasuria FPSO safety case will be updated to include the Teal West Development. However, in line with the EIA regulations, an assessment of the worst-case accidental event is required and will therefore be considered to determine if it has the potential to cause a Major Pollution Incident (MPI).

The worst-case accidental event associated with the Development has been determined as a well blowout. The season in this scenario which resulted in the largest volume of onshore oil was investigated further using deterministic modelling to determine the potential for an MPI to occur. Specifically, the potential for a blowout to cause significant adverse change to a protected species or habitat as defined by Annex I of the Birds Directive or Annex I, Annex II and Annex IV of the Habitats Directive was identified and assessed. Although such an incident may have the potential to cause significant impacts, this is under the assumption that it is a worst-case blowout where no response measures have taken place. Therefore, this is very conservative in its assumptions. It should be noted that, the overall worst-case quantity of oil onshore is not equivalent to the worst-case quantity of UKCS oil onshore due to a significant proportion of beaching on European coastlines in the actual worst-case shoreline oiling. As shown by the oil trajectory in the stochastic modelling (Section11.5.8), there is a high probability of oil reaching protected sites on the European coastline and further offshore as it drifts on the surface. The impact on European sites is discussed in more detail in Section 11.5.7. To understand the potential worst-case impact within the jurisdiction of the UK authorities, the deterministic modelling was run with a UKCS-exclusive grid, hence the sharp cut off in model output as it approaches the European coastline in the Figure 11-4 to Figure 11-7. Furthermore, although such an incident may have the potential to cause significant impacts, this is under the assumption that it is a worst-case blowout where no response measures have taken place. Therefore, this is very conservative in its assumptions.

The provision for assessing a major pollution incident will also apply to transitional and coastal waters covered by the Water Framework Directive (WFD) (Directive 2000/60/EC). The guidance states that a major accident relating to offshore oil activities are extremely unlikely to result in significant adverse changes to the water quality status (BEIS, 2017). However, designated shellfish waters should be discussed in detail as Member States are required to ensure implementation of the WFD. Degradation in water quality could impact the shellfish leading to unsafe products for human consumption and the temporary closure of the area to commercial production.

11.5.1. Release Behaviour

The mass balance of oil over the duration of the release is presented in Figure 11-3. The deterministic model predicted that the most common fate of the released oil was through evaporation to the atmosphere (52.9%) by the end of the model (day 150), while approximately 13.1% was predicted to biodegrade. Deposition in the sediment accounted for approximately 10.5% of the remaining oil, with approximately 9.3% being dispersed throughout the water column. Approximately 6.4% and 0.4% accounted for oil stranded onshore and oil present on the sea surface, respectively. As shown in the Figure, there is a large variability in the oil that is registered as dispersed and on the sea surface and the two fates effectively mirror each other throughout the model duration. This is caused by wave action causing particles in the model to be registered at the sea surface in one timestep but then being forced slightly below the surface in the next and are therefore registered in the water column. The remaining 7.3% left the gridded area by the end of the model due to the constrained grid used.

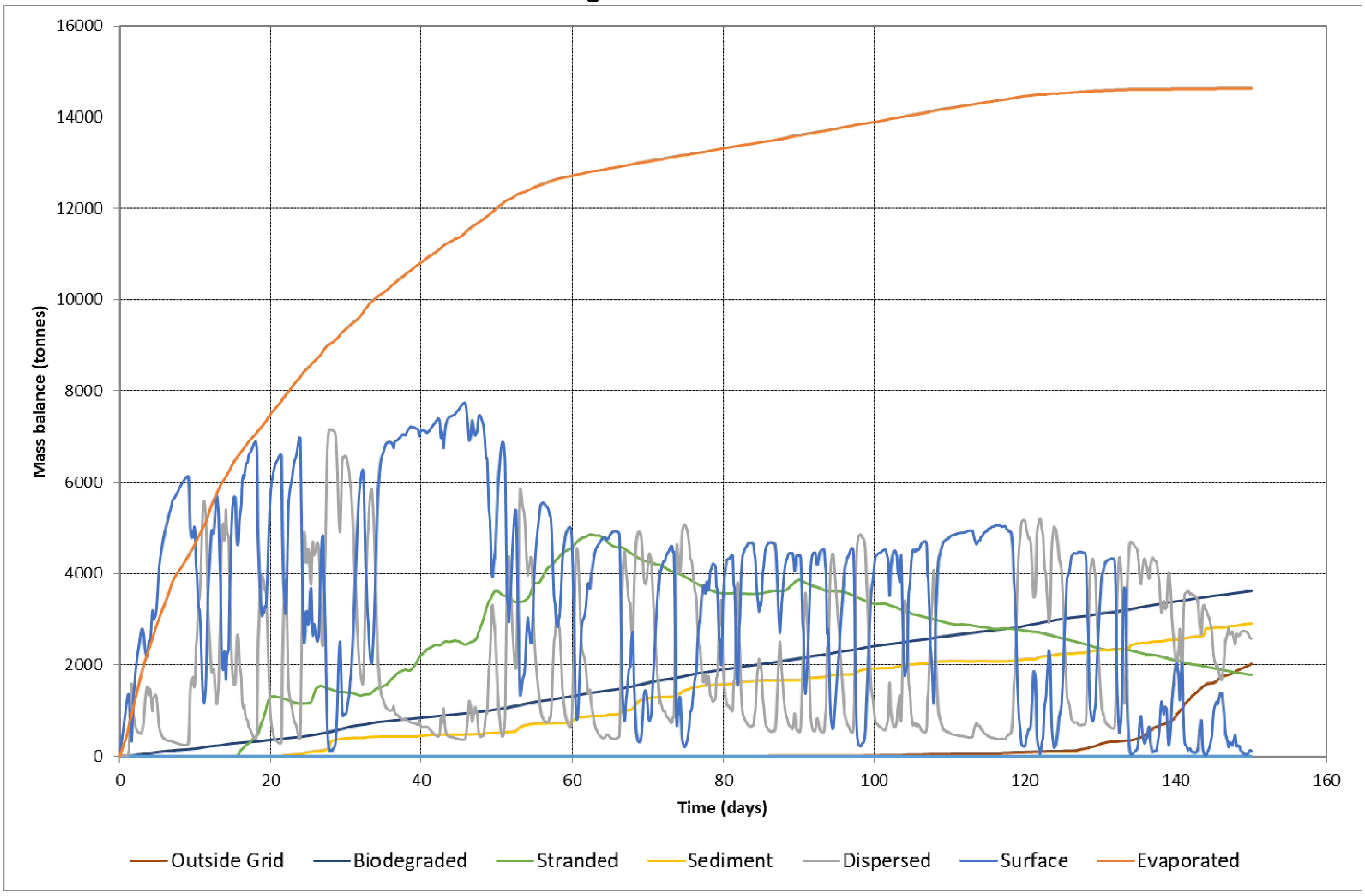


Figure 11-3 – Mass balance of oil from Teal West blow out deterministic scenario

Table 11-7 Mass balance of oil from Teal West well blowout deterministic scenario after 150 days

Fate	Mass (te)	Percentage
Surface	106.3	0.4
Evaporated	14,630	52.9
Water Column	2,582	9.3
Sediment	2,901	10.5
Beached Onshore	1,775	6.4
Biodegraded	3,631	13.1
Outside Gridded Area	2,027	7.3

11.5.2. Assessment Methodology

Environmental vulnerability to oil spills is both a function of the magnitude of the event and the sensitivity of environmental receptors to such events. There is no standard or widely recognised method of determining the environmental impact associated with crude oil spills, therefore the approach undertaken was based on the "Impact Scales and Gradation of Oil Spill Ecological Hazards and Consequences in the Marine Environments" classification guide described by Patin (2004), and provides assessment criteria which is in line with the Offshore Safety Directive [Article 2(37)], as detailed in Table 11-8 to Table 11-11.

The MPI assessment considered the potential impacts to UK protected sites (specifically SACs, SPAs, NC MPAs and species (specifically those listed under Annex I of the Birds Directive Annex II and IV of the Habitats Directive) in terms of surface oiling, shoreline oiling and oil in sediments (Sections 11.5.3 to 11.5.5).

Although separate to an MEI, this assessment utilizes the MEI guidance (BEIS, 2017) which states that impacts on plankton and pelagic species are unlikely to be significant as any hydrocarbons entering the water column will be rapidly and widely dispersed. It should also be noted that the only protected fish species found within the North Sea is the sturgeon *Acipenser sturio* however their sightings are uncommon. Therefore, oil within the water column offshore is only considered in terms of potential effects on shellfish waters (Section 11.5.6).

Table 11-8 – Consequence assessment – spatial scale (Area)

Spatial Scale	Area Under Impact
Point	Less than 100 m^2
Local	Range from 100 m^2 to 1 km^2
Confined	Range from 1 km^2 to 100 km^2
Sub-regional	More than 100 km^2
Regional	Spread over the shelf area

Table 11-9 – Consequence assessment – temporal scale

Temporal Scale	Longevity
Short term	Several minutes to several days
Temporary	Several days to one season
Long-term	One season to one year
Chronic	More than one year

Table 11-10 – Consequence assessment – reversibility of changes

Reversibility of Changes	Longevity of Disturbance
Reversible (acute stress)	Acute disturbances in the state of environment and stresses in biota that can be eliminated either naturally or artificially within a short time span (several days to one season)
Slightly reversible	Disturbances in the state of environment and stresses in biota that can be eliminated either naturally or artificially within a relatively short time span (one season to three years)
Irreversible (chronic stress)	Prolonged disturbances in the state of environment and stresses in biota that exist longer than three years

Table 11-11 – Consequence assessment – general assessment

General Assessment	Disruption
Insignificant	Minimal changes that are either absent or not discernible.
Slight	Slight disturbances to the environment and short-term stresses in biota are discernible (below minimum reaction threshold 0.1% of natural population reaction).

General Assessment	Disruption
Moderate	Moderate disturbances to the environment and stresses in biota are observed (changes up to 1% of natural population reaction are feasible).
Severe	Severe disturbances to the environment and stresses in biota are observed (up to 10% of natural population).
Catastrophic	Catastrophic disturbances to the environment and stresses in biota are observed (up to 50% of natural population). Changes are irreversible and stable structural and functional degradation of a system is evident.

11.5.3. Oil on the Sea Surface

Birds on the sea surface are sensitive to contamination from oil which damages their feathers and causes death via waterlogging and hyperthermia. Canadian research has identified that sheens as thin as 0.1 µm (0.0001 mm) can have a negative impact on feather structure (O'Hara and Morandin, 2010).

The modelling predicts that over the period of the blowout scenario, much of the sea surface throughout the UKCS blocks will experience surface oil above the threshold determined for seabird species, with seabird oil sensitivity being low or medium for most of the year, and high to extremely high in September and October. The trajectory of the blowout slick is such that potentially 34 UK protected sites could be contaminated. Of these potentially contaminated sites, 11 sites were SPAs which support large numbers of seabirds listed on Annex I of the Birds Directive e.g. guillemot, Arctic tern, red-throated diver and guillemot. The predicted maximum thickness at an SPA was 0.037 mm at Outer Firth of Forth and St Andrews Bay Complex SPA. The remaining sites at risk of contamination are made up of 8 SACs and 15 NCMPAs/MCZs.

Many of the SPAs along the east coast of the UK support similar protected bird species and therefore, each population would be expected to be able to recover through recruitments from nearby sites within one breeding season. However, potential recovery rates will vary depending on the species affected and the extent of population loss (see Piatt *et. Al.,* 1990; Boersma *et.al.,* 1995). Recovery rates depend on numerous factors as discussed in Section 11.4.5.

Recovery potential of qualifying species populations varies widely and depends partly on existing population dynamics. For example, the little tern population of Britain declined by approximately 27% between the Seabird Colony Register surveys completed in 1988 and the Seabird 2000 surveys completed in 2002. As such, this species is likely to take longer to recover from population losses due to the existing downward population pressure. In a worst-case scenario, recovery would be expected to occur within 10-years.

However, there is an uncertainty in the determination as to whether the population of birds as qualifying features of these SPAs would recover. Therefore, whilst this would not impact the conservation status of the species as a whole (due to the small proportion of the populations present) it would result in a degradation of a qualifying feature. In adopting a precautionary approach to account for this uncertainty, it is concluded that there is a potential for the blowout to result in significant adverse effects on the environment in accordance with Directive 2004/35/EC of the European Parliament and of the Council on environmental liability with regard to the prevention and remedying of environmental damage.

Marine mammals also have potential to encounter the surface oil, although no specific threshold for impact has been determined. Of the 34 sites that could potentially be reached by surface oil, four sites are areas of importance for marine mammals. The site of these four which is predicted to receive the thickest oil is Berwickshire and North Northumberland Coast SAC which is designated for a large population of grey seal breeding colonies. The north-east England coastal section of the site is representative of 2.5% of annual UK pup production The potential surface thicknesses at this site reaches a maximum of 0.018 mm and therefore the likelihood of these marine mammals being impacted upon encountering a surface slick is high. However, it is expected that marine mammals would actively avoid the surface oil (Geraci and St. Aubin, 1990). It is reasonable to conclude that given the extent of the oil on the sea surface in this area, although likely to be temporary in nature, surface oil is considered to present a significant adverse impact to marine mammals found at these protected sites.

In consideration of the potential impacts to seabirds and marine mammals; surface oil contamination is predicted to have the potential to cause a measurable significant adverse change to protected bird species listed in the EU Birds Directive and Annex II species listed in the EU Habitats Directive due to the number of sites contaminated greater than the 0.0001 mm threshold. Therefore, there is potential for a MPI to occur via oil on the sea surface.

Using the environmental consequence assessment table generated by Patin (2004), the outcome of this scenario revealed the spatial scale was “regional”, the temporal scale “long-term”, the reversibility of changes was “slightly reversible” and the general assessment “severe”, as per Table 11-8 to Table 11-11.

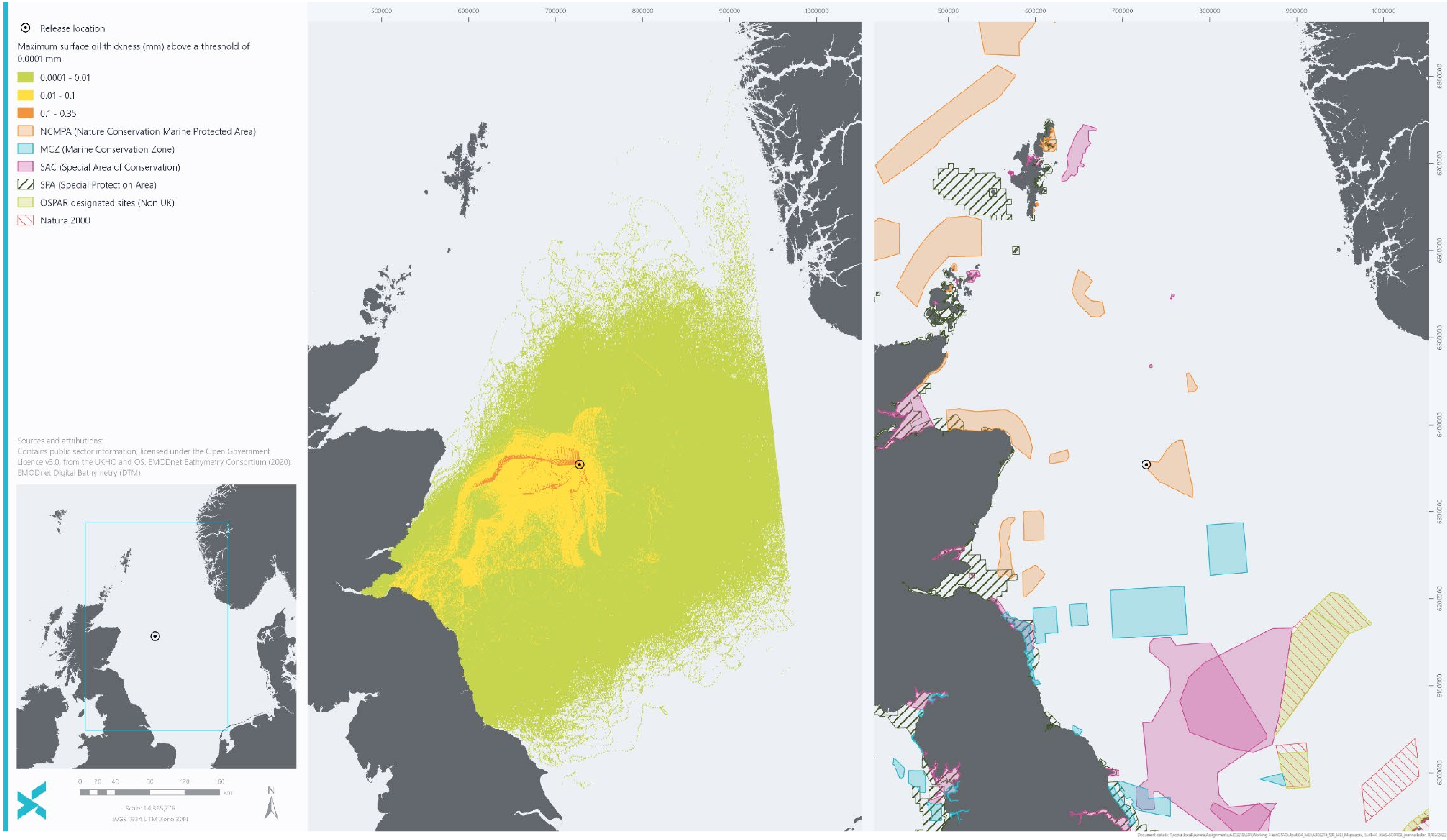


Figure 11-4 – Deterministic modelling: Maximum oil on the sea surface

11.5.4. Shoreline Oil

The International Tankers Owners Pollution Federation (ITOPF) have produced a Technical Information Paper providing guidance on how to estimate the stranded oil volume (ITOPF, 2011). Using this guidance, it was estimated that a light oiling of Teal West Crude equates to a volume of between 0.1 l/m^2 (0.0843 kg/m^2) and 1 l/m^2 (0.843 kg/m^2), moderate oiling equates to volumes between 1 l/m^2 (0.843 kg/m^2) and 10 l/m^2 (8.43 kg/m^2) and heavy oiling equates to volumes greater than 10 l/m^2 (>8.43 kg/m^2).

Within the UKCS, the blowout modelling resulted in beached oil from the east Aberdeenshire coast to the east Yorkshire coast. There was no oiling greater than the heavy oiling threshold predicted at any UK protected sites. However, oiling greater than 0.843 kg/m^2 (moderate oiling threshold) is predicted at 10 protected sites. The sites predicted to receive the highest quantity of oil are Outer Firth of Forth and St Andrews Bay Complex SPA (3.27 kg/m^2), St Abb's Head to Fast Castle SPA (2.85 kg/m^2), and Firth of Forth SPA (2.69 kg/m^2). Many of the SPAs that would be impacted by moderate oiling (including all three listed) support populations of seabirds listed on Annex I of the EU Birds Directive, such as the red-throated diver and guillemot, meaning this is of particular importance. A further 5 protected sites were predicted to receive oil within the light oiling threshold.

When considering oil on the shoreline, it should be considered that a significant amount of the east coast of the UK (particularly Scotland and north-east England) is rocky shoreline and numerous observations in different parts of the world indicate that oil persistence, and consequently its adverse impact, sharply decrease from sheltered gravel and pebble shorelines to open rocky shores (Patin 2004). In addition, a rocky nature of the coastline is likely to mean that most of the birds would be roosting and nesting above the narrow zone where potential oil may reach the shoreline. However, in regions such as Aberdeenshire and Northumberland there are also large stretches of sandy beach which would be more vulnerable to any oil that might beach. Hydrocarbons would be drastically more difficult to clean on such a coastline due and priority would be given to protect these areas.

Many of the SPAs along the Scottish and English coasts support similar protected bird species and therefore, each population depending on numbers may be able to recover via recruitment over a few breeding seasons. However, due to the uncertainty as to whether the population of birds as qualifying features of these SPAs would recover (Piatt *et. Al.,* 1990; Boersma *et.al.,* 1995) and after adopting a precautionary approach to account for this uncertainty, it is concluded that there is a potential for the blowout to result in significant adverse effects on bird species.

In consideration of the potential impacts to the receptors discussed above as well as the uncertainty around population recovery; shoreline oil contamination is considered to have the potential to cause a measurable significant adverse change to a protected species or habitat as defined by Annex I of the Birds Directive or Annex I, II and IV of the Habitats Directive in accordance with the Offshore Safety Directive. Therefore, there is the potential for a MPI to occur via oil on the shoreline.

Using the environmental consequence assessment table generated by Patin (2004), the outcome of this scenario revealed the spatial scale was "regional", the temporal scale "chronic", the reversibility of changes was "slightly reversible" and the general assessment "severe", as per Table 11-8 to Table 11-11

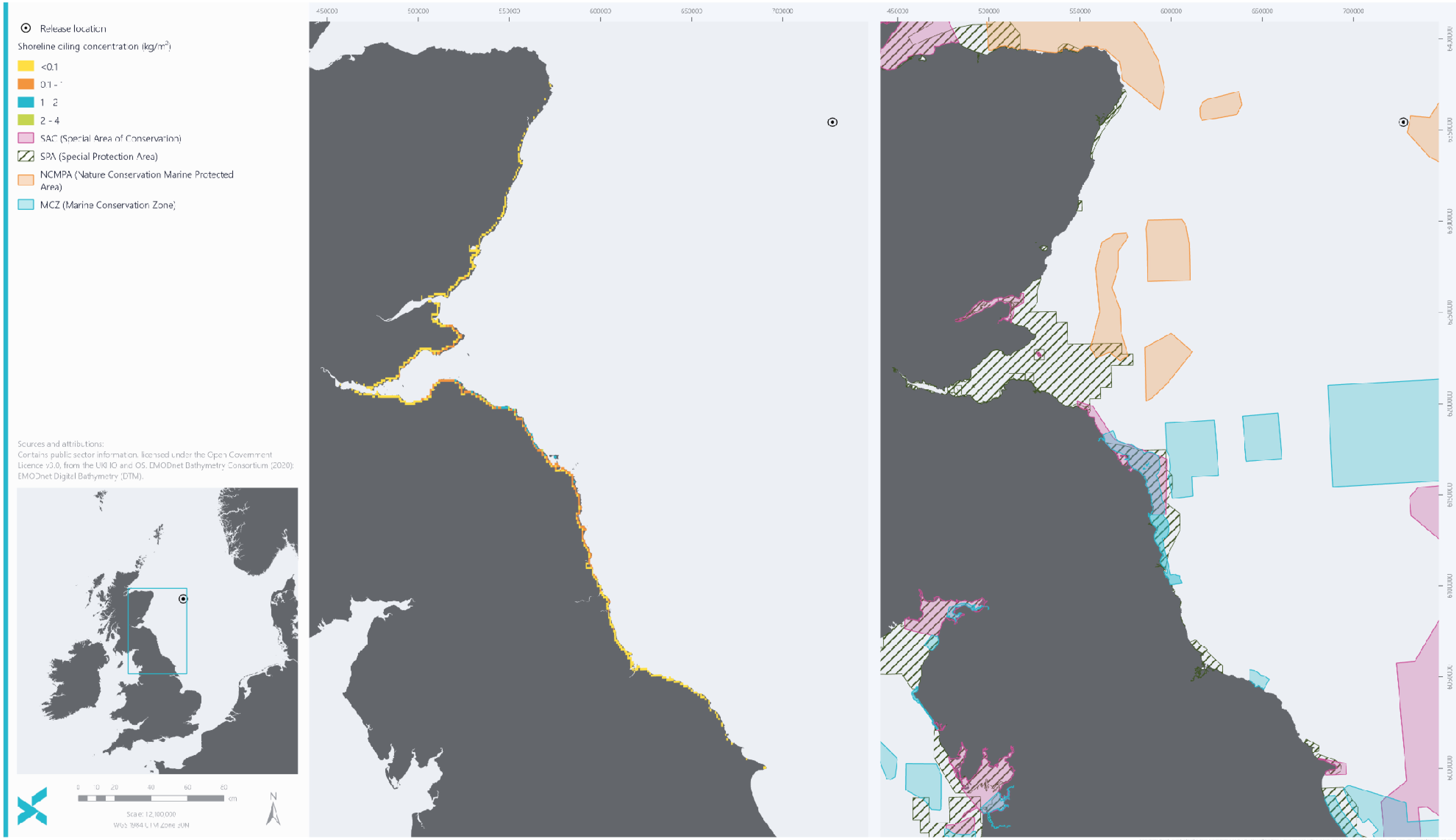


Figure 11-5 – Deterministic modelling: Maximum oil on the shoreline

11.5.5. Oil in Sediment

There are currently no published North Sea thresholds for oil in sediment; however, the Fisheries Research Services (now Marine Scotland) have carried out temporal studies into the levels of hydrocarbons in the sediments from the East Shetland Basin and the Fladden grounds (Marine Scotland, 2008). These studies determined that a hydrocarbon sediment concentration of 50 µg/g is common in North Sea sediments and levels higher than this appears to return to background levels over time. In terms of mass, 50 µg/g equates to 6.88 g/m^2 (assuming a sediment bulk density of 2.75 kg/m^2).

The model predicted sediment contamination to occur over a wide area of the seabed, with 7 protected sites with the potential to have oil in sediment concentrations above the background level (Figure 11-6). Of these potentially contaminated sites, 5 support large numbers of protected birds species. Most of these SPAs are designated for surface-dwelling seabirds which are not likely to be adversely impacted by oil in sediment as the nature of the surface water will not change. However, the Firth of Forth SPA (approximately 107.2 g/m^2 of oiling) supports wading species such as the bar-tailed godwit and dunlin and therefore sediment oil concentrations greater than the background concentration will increase the oil exposure to these wader species and could cause a measurable significant adverse change to these protected species.

Mudflats and sandflat habitats (Annex I habitat) are particularly vulnerable to oil because oil is not broken up by wave action and it can be mixed into the sediment, shingle or cobbles where it is not exposed to weathering and therefore persists for longer. The Berwickshire and North Northumberland Coast SAC is designated for the protection of mudflats and sandflats and large shallow inlets and bays (another Annex I habitat) and is predicted to have an oil in sediment concentration of 10.1 g/m^2. This is a relatively high concentration of oil that has the potential to result in the degradation of the reason for designation.

In consideration of the possible receptors, oil in sediment is considered to have the potential to cause a measurable significant adverse change to a protected species or habitat as defined by Annex I of the Birds Directive or Annex I, II and IV of the Habitats Directive in accordance with the Offshore Safety Directive. Therefore, the potential for a MPI due to oil in sediment is considered likely.

Using the environmental consequence assessment table generated by Patin (2004), the outcome of this scenario revealed the spatial scale was ‘regional’, the temporal scale ‘long-term’, the reversibility of changes was ‘slightly reversible’ and the general assessment ‘severe’, as per Table 11-8 to Table 11-11.

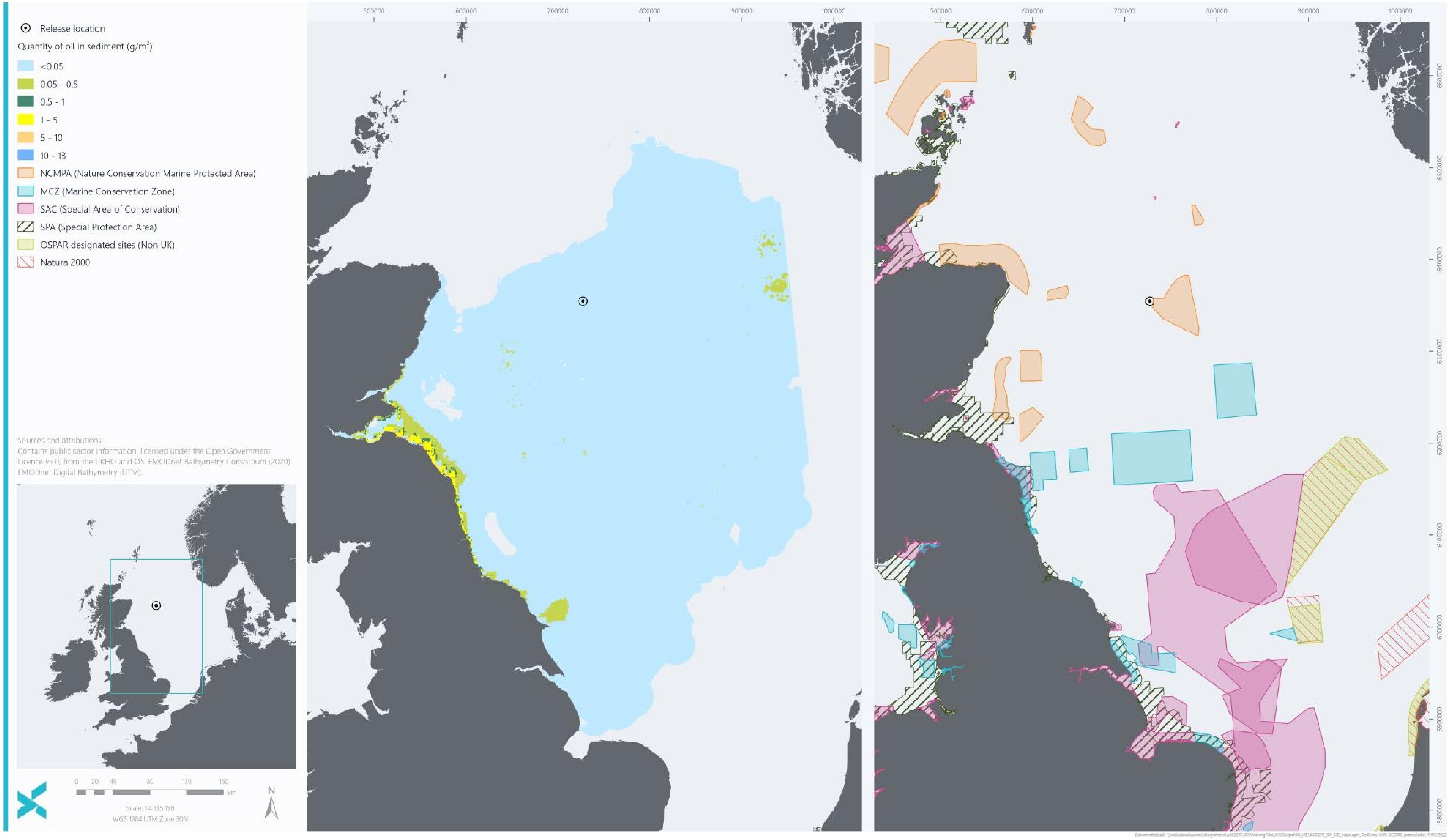


Figure 11-6 – Deterministic modelling: Maximum oil in sediment

11.5.6. Oil in Water Column

Surface oiling which affects the water quality is also of a concern at coastal shellfish protection areas and active aquaculture sites. Shellfish production is an important activity in Scotland, economically, socially and environmentally. The Shellfish Farming Production Survey (Scottish Government, 2020a) states that in 2018, the total value at first sale for all species was calculated at approximately £7.9 million, a decrease of 17% from the £9.5 million estimated in 2018. The industry contributed to approximately 136 full-time jobs and 141 part-time and casual workers during 2019. The number of full-time staff decreased by one and the number of part-time and casual employees decreased by 20 compared with 2018 (Scottish Government, 2020a). Production was dominated by mussel and Pacific oyster in terms of value and tonnage. Mussel production decreased by 3% and Pacific oyster production increased by 14% during 2019, although small quantities of scallop, queen scallop (queen) and native oyster were also produced (Scottish Government, 2020a). An increase for finfish production was also recorded between 2018 and 2019, where total production was 156,025 tonnes in 2018 and 203,881 tonnes in 2019 (Scottish Government, 2020b).

Furthermore, other socio-economic receptors, including coastal tourist and recreational areas, and other coastal industries and activities could interact with oil in the water column.

Fish juveniles and eggs are particularly sensitive life-stages with respect to oil in the water column, with dispersed oil concentrations as low as 1 mg/l having negative effects (Broderson *et al.* 1977). According to the ITOPF technical paper on effects of oil pollution on fisheries and mariculture (2014), 15 ppb is the threshold at which oil is considered to have adverse effects on aquaculture production. In determining the extent to which aquaculture would be affected, areas that include significant aquaculture production were compared against the 15 ppb threshold (Figure 11-7). As stated for shoreline oiling in Section 3.6.5, the worst-case deterministic model predominantly avoids the UKCS, although there is potential for water column contamination on the UKCS based on the stochastic blowout model. If this was to occur, the size of the contaminated UKCS area over the 15 ppb threshold could be significant based on the size of the area over 15 ppb in Figure 3.8. Shetland and Orkney support most of the shellfish protection areas and aquaculture sites on the east coast of the UK. However, oil is unlikely to drift in the water column as far as either region at a concentration > 15 ppb. The east coast of mainland Scotland also supports aquaculture in areas such as Aberdeenshire and Fife which may be vulnerable due to concentrations in the water column remaining high in these areas. .

Using the environmental consequence assessment table generated by Patin (2004), the outcome of this scenario revealed the spatial scale was “regional”, the temporal scale “long-term”, the reversibility of changes was “slightly reversible” and the general assessment “severe”, as per Table 11-8 to Table 11-11. In consideration of the potential impacts to the receptors discussed above; water column concentration is considered to have the potential to cause a measurable significant adverse change to the production of aquaculture sites in the Aberdeenshire and Fife areas. Therefore, there is the potential for a MPI to occur via oil in the water column.

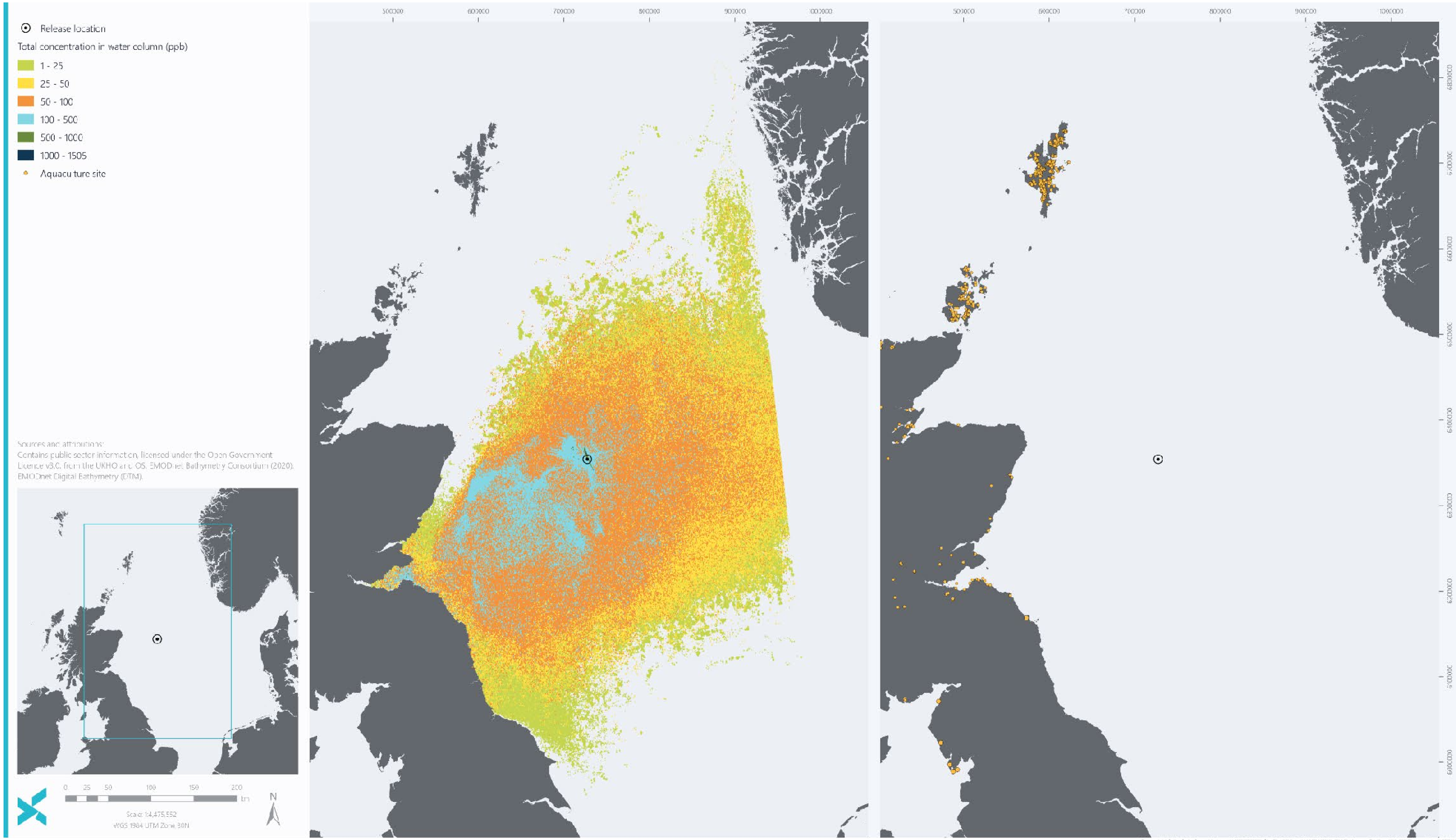


Figure 11-7 – Deterministic modelling: Total Oil Concentration in the Water Column

11.5.7. European Sites

As mentioned in Section 11.5, Figure 11-4 to Figure 11-7 show the worst-case well blowout for oil onshore on the UKCS. However, due to the north-easterly nature of the currents in the CNS, it is likely the overall worst-case scenario would have a significant impact on European protected sites as well.

Oil on the sea surface above 0.1 µm (0.0001 mm) threshold (O'Hara and Morandin, 2010) was predicted to occur at some time during the simulations within 16 Norwegian protected sites, 22 Swedish protected sites, 23 Danish protected sites and 1 German protected site, and the maximum thickness at any of these sites is approximately 0.027 mm.

There are no European sites which are predicted to have an oil concentration in sediment above the 6.88 g/m^2 estimate for background contamination.

Section 3.12 of the draft MEI guidance (BEIS, 2021), states:

"in relation to an incident that could potentially impact the waters of an adjacent State, it is sufficient to confirm that, in the event of an incident that could impact the coastal waters of an adjacent State, the operator would liaise with the relevant national authorities to assess the scale of any potential impacts."

In line with recent regulatory discussions that only UK sites are to be assessed as part of any MEI Assessment, BEIS require a brief determination of whether there is a potential for a European MEI to occur (i.e. beaching out with the UKCS). There are 15 Norwegian protected sites, 22 Swedish protected sites and 22 Danish protected sites which are predicted to be contaminated by oil on the shoreline. Although there is not the potential for heavy oiling (>8.43 kg/m^2) at any site, moderate oiling (>0.843 kg/m^2) is predicted at four of these sites with a maximum of approximately 2.1 kg/m^2. A further 37 sites could receive moderate oiling and the remaining 18 could receive light oiling (0.0843 kg/m^2). Given the levels of hydrocarbons predicted along the European coastline, it was concluded that there was a European MPI potential. In the event that a release crosses the median line, AHUK can confirm that there are relevant processes and procedures in place to liaise with member states should an event of this scale occur (Section 11.7)

11.5.8. Conclusion

The environmental impacts from oiling on the sea surface, shoreline, sediment and in the water column have been identified and assessed for the UKCS using the methods described by Patin (2004) as detailed in Table 11-8 to Table 11-11. This has determined whether there is potential for significant damage, as defined by the Environmental Liability Directive, to protected species or habitats (listed under the Annex I of the Birds Directive and/or Annex I, II and IV species listed under the Habitats Directive) in accordance with the Offshore Safety Directive. The justification for considering that all four of the aforementioned oil fates (sea surface, shoreline, sediment, and water column) may constitute an MPI is as follows:

- In terms of oil on the sea surface, a thickness greater than 0.1 µm was predicted to potentially contaminate 34 UK protected sites. Although the qualifying features of many of these sites are benthos-related, there are several protected sites that are designated under the Annex I of the Birds Directive or Annex II of the Habitats Directive. Therefore, it can be concluded that in terms of the potential for significant damage, a Teal West well blowout would constitute a MPI as a result of oil on the sea surface;

- Oil on the shoreline greater than 0.0843 kg/m^2 (i.e. light oiling) is predicted to occur at 20 protected sites. As there is the potential of oil onshore to result in a degradation of the qualifying features of these sites, a worst-case blowout is considered to constitute a MPI;
- The modelling predicted sediment contamination to occur over a large area of the seabed, with 7 protected sites within the UKCS predicted to have oil in sediment concentrations above the background concentration where significant impacts may occur. Two of these protected sites were designated for wading bird species or for mudflats and sandflats. Therefore, any contamination at these sites has the potential to adversely impact the conservation status of these protected sites and constitute a MPI; and
- Oil in the water column at a concentration above the 15 ppb threshold (damaging to aquaculture sites) is predicted to occur at multiple areas of aquaculture activity on the east coast of the Scotland. As there is the potential for this oil in the water column to result in an adverse impact on the aquaculture sites, a Teal West well blowout is considered to constitute an MPI.

11.6. Management and Mitigation Measures

AHUK will ensure that appropriate controls are in place to either reduce the probability of failure of a control resulting in a release (prevention) or reduce the consequences in the event of a release (mitigation). For example, this will include appropriate well control and blowout preventers. The Offshore Installation Regulations 2015 stipulate that SECEs performance standards with verification, equipment inspection, maintenance routines and management of operations will be in place during the operations.

As measures are being developed in accordance with requirements of legislation and of AHUK's own corporate demands, consistent with the principles of BAT and BEP, this ES does not present a list of all spill prevention measures and mitigation that will be in place through the life of the Teal West Development. However, a number of commitments have been made as part of this impact assessment, and they are reflected as follows:

- Drilling
  - Risk assessment and appropriate emergency response procedures will be implemented; Drilling rig will be built to MODU certified standards;
  - The drilling rig shall have an approved Safety Case with all SECEs verified by an independent verification body during operations;
  - The BOP will have fully redundant control systems;
  - Chemical storage areas will be contained to prevent accidental release of chemicals;
  - Weather forecasts will be monitored so that oil-based mud in the riser can be removed to the drilling rig prior to riser unlatch;
  - Responsible rig-based and shore-based personnel trained to international standards of well control;
  - Bulk handling procedures will be implemented, and personnel training will occur;
  - Environmental spill kits, including absorbent material, will be available on board the drilling rig to allow clean-up of any deck accidental releases or leaks;
  - A standby vessel will be present to monitor any spills; and
  - Oil spill response capability, including aerial surveillance provision.
- Dropped objects:
  - Dropped object risk assessments will be carried out for all lift activities;
  - Heavy equipment will be low in the water column to avoid dropping objects at heights
  - Procedures will be put in place to record the location of any lost material and to recover significant objects where practicable; and

- SIMOPS procedures will be in place, if applicable.

11.7. Cumulative and Transboundary Impacts

Existing hydrocarbon release risks in the North Sea are associated primarily with oil and gas industry activities as well as other marine industries such as merchant shipping and fishing. As indicated by historical data, the likelihood of one major accidental release occurring is remote or extremely remote, limiting the cumulative impact from the Teal West Development and other existing installations. An OPEP and Temporary Operations Oil Pollution Emergency Plan (TOOPEP) will be in place, outlining the response measures to be implemented in the event of any accidental release.

Worst-case scenario modelling undertaken for the Teal West Development indicates a 100% probability of hydrocarbons crossing a median line (UK/Norway/Denmark), with the potential to also reach Swedish, German, Dutch, Faroese, Icelandic, Jan Mayen, French and Belgian waters. Therefore, consultation under the Espoo Convention is likely to be required. The Espoo Convention requires notification and consultation only for projects likely to have a significant adverse environmental impact across boundaries. In the event that a release crosses the median line, AHUK can confirm that there are relevant processes and procedures in place to liaise with member states as outlined in the AHUK Onshore OPEP.

The risk of an accidental hydrocarbon release having a transboundary impact, particularly from UKCS operations, is recognised by the UK Government and other governments around the North Sea. Agreements are in existence for dealing with international releases with states bordering the UK (e.g. Bonn Agreement). These agreements would operate within the framework of the NCPs and are oriented towards major releases. This becomes operational when agreement to the request for its implementation is reached. Responsibility for implementing joint action with neighbouring states rests with the Action Co-ordinating Authority (ACA) of the country on whose side of the median line a spill originated. The UK's ACA is the Counter Pollution Branch of the Maritime Coastguard Agency. In the event of a major accidental release, which would likely have the potential to drift into Norwegian waters, the Norwegian/British oil spill response (NORBRIT) plan will be activated. As the oil is most likely to drift into Faroese waters, it should be noted that a local agreement of mutual support exists between the UK and Faroe Islands and remains extant. All other countries which have the potential to receive oil across a median line are members of the EU and therefore the European Maritime Safety Agency (EMSA) would be consulted in this instance. EMSA provides operational services to Member States including a network of stand-by oil spill response vessels, satellite imagery, pollution response experts and information service for chemical spills at sea. Additional engagement mechanisms with countries not covered by this arrangement, such as Iceland, will be defined prior to activities with potential for a significant transboundary movement of hydrocarbon are initiated.

11.8. Residual Impacts

11.8.1. Accidental Hydrocarbon Release

Although the probability of catastrophic releases from the Teal West Development is remote, even with comprehensive prevention measures in place the residual risk of accidental release, and thus impact on the marine environment, remains. This is recognised to be true for the offshore oil and gas industry in general and the formulation of detailed and fully tested contingency response plans is thus integral to such projects. As such, AHUK will have in place a range of response/mitigation measures to address these risks (detailed in Section 11.7). All activities will be covered by appropriate OPEPs and Shipboard Oil Pollution Emergency Plans (SOPEPs) which will set out the responses required and the available resources for dealing with releases of all sizes. The planning, design and support of all activities for the development will aim to eliminate or minimise potential environmental risks. AHUK's management processes will ensure that these mitigation commitments are implemented and monitored.

The residual Impact for the receptors of protected sites and socio-economic features is described in Table 11-12. It concludes that the residual impact is considered not significant. This is due to the mitigation measures in place and the remote likelihood of a release in the first place. It should also be reiterated that this modelling represents a worst-case blowout scenario where no response measures are in place, therefore this represents a conservative estimate as to the magnitude of the impact and the vulnerability of receptors as it assumes, for example, birds will be present at protected sites when hydrocarbons arrive.

Table 11-12 – Residual impact for protected sites and socio-economic features

Receptor	Sensitivity	Vulnerability	Value	Magnitude
Protected sites and socio-economic features	High	High	High	High
Rationale				
Given the possibility of interaction between a range of potential receptors following a release of hydrocarbons, the receptor sensitivity has been designated as **high**. Furthermore, it is anticipated that some features, particularly on the shoreline, could exhibit **high** value as some protected sites contain habitats and species protected under the EU Habitats Directive therefore the value has been assigned as such. The worst-case release assessment determined that, although highly unlikely, a potential spill is likely to have a long-term effect on the populations of the receptors, but with eventual recovery. Therefore, vulnerability was designated as **high**. The magnitude of the release is expected to be **high** as the potential hydrocarbon release is expected to be prolonged and extend across a large area of UKCS and has a transboundary impact. It is recognised that a hydrocarbon release could result in demonstrable change in receptors. However, for this type of accidental event, it is especially important to assess the likelihood of the impact occurring. A release of this nature can be considered **major** consequence; however it is also considered a **remote** probability. A review of UKCS historical data relating to hydrocarbon release events confirms that the likelihood of an event like this is indeed very remote. Given the mitigation measures that are in place (Section 11.6) and the remote likelihood of the release happening, the impact is considered **not significant**.				
Consequence	**Likelihood**	**Impact Significance**		
Major	Remote	Not significant		

11.8.2. Accidental Chemical Release

In addition to the hydrocarbon spill risk, there is also the risk of a chemical spill. Chemical spills may occur during chemical transfer, chemical/mud handling, or mechanical failure. The fate of any chemical entering the water column is dependent upon how physicochemical properties influence its partitioning between seawater and its susceptibility to degradation (DTI, 2001). Given the high energy marine environment of the Central North Sea, chemical spills are expected to disperse in the offshore marine environment with a negligible. Localised and transient impact on any water column receptors that may be present at the time. As discussed in (Section), there will be a variety of chemicals used in the various phases of the Teal West Development and therefore poses a risk of release into the marine environment. However, the volume of chemicals used will be limited and are typical chemicals that would be found on vessels and are commonplace in the industry.

In addition, release prevention measures in place will encompass chemicals as well as hydrocarbon spills, as described in Section 11.6. AHUK will work with its chemical suppliers to ensure that chemical use is minimised without compromising technical performance.

Taking the above mitigation measures into account, it is not considered that there is potential for released chemicals to cause a significant impact on the highly dispersive marine environment of the CNS.

12. ENVIRONMENTAL MANAGEMENT SYSTEM

12.1. Structure and Content

The Environmental Management System has been established and is maintained to provide a structured framework of controls at all levels within the organisation to ensure that activities are executed in accordance with legal and company internal requirements. Significant environmental aspects associated with the activities undertaken by these operations are managed in accordance with the Environmental Policy. The Management System is an integrated system which applies uniformly across all the departments and is in alignment with the principles of environmental management in the International Standard on environmental management systems (ISO 14001:2015). The structure, key processes involved and deliverables from the EMS (Figure 12.1) follow the 'plan, do, check, act' model, which aims to ensure continual improvement and provides a framework through which the requirements of the HSSE, Environmental, CMAP and Net Zero policies are delivered.

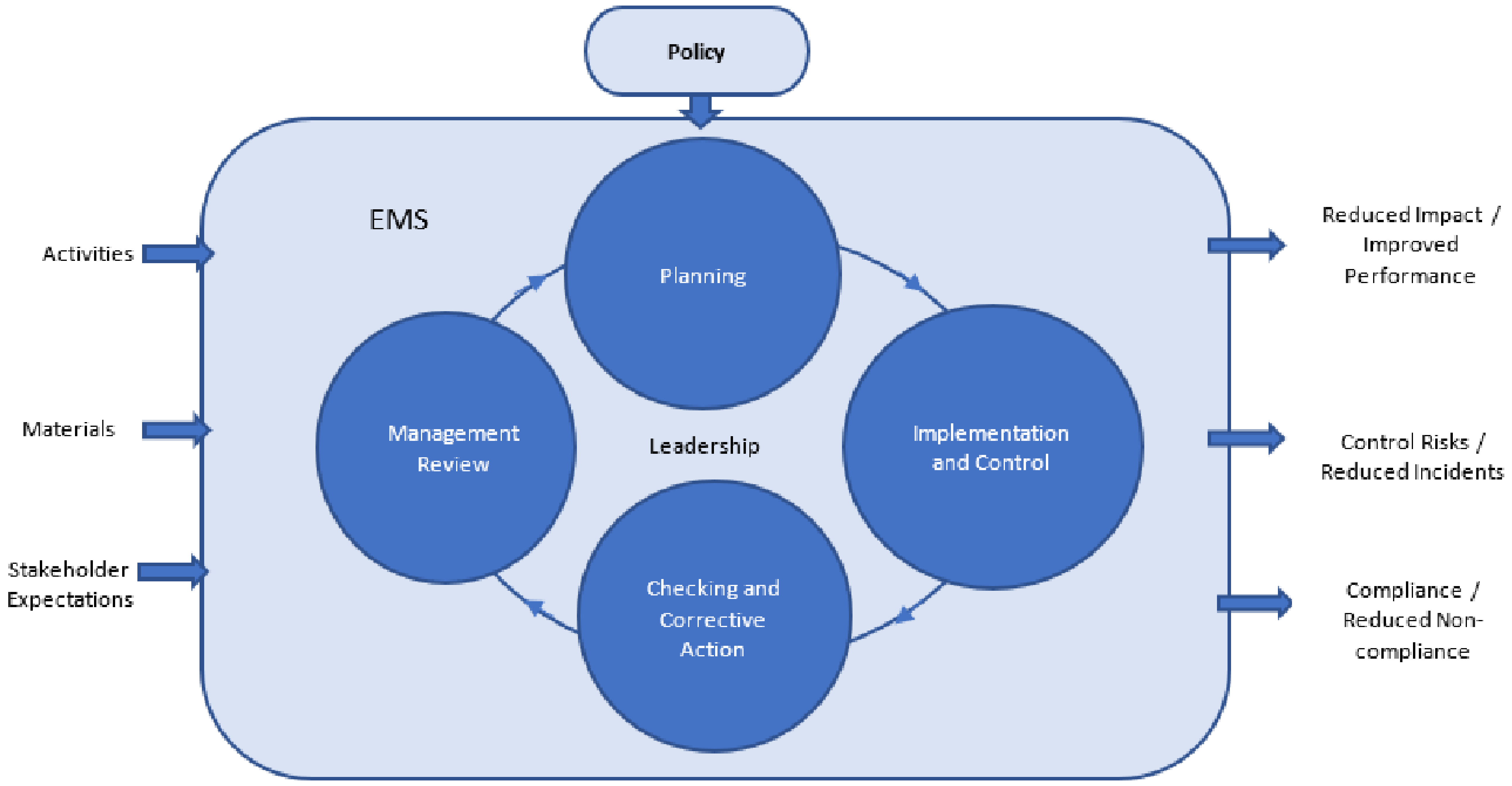


Figure 12.1 - EMS Structure, Processes and Outcomes

The accountability within the organisation for authorising the requirement to have in place an effective Environmental Management System and implementation of environmental management requirements, support, and assurance is embedded at the top management within (Figure 12.2). The accountabilities are cascaded from this strong and visible leadership through the company and contractors: everyone is accountable for their defined contribution to environmental performance.

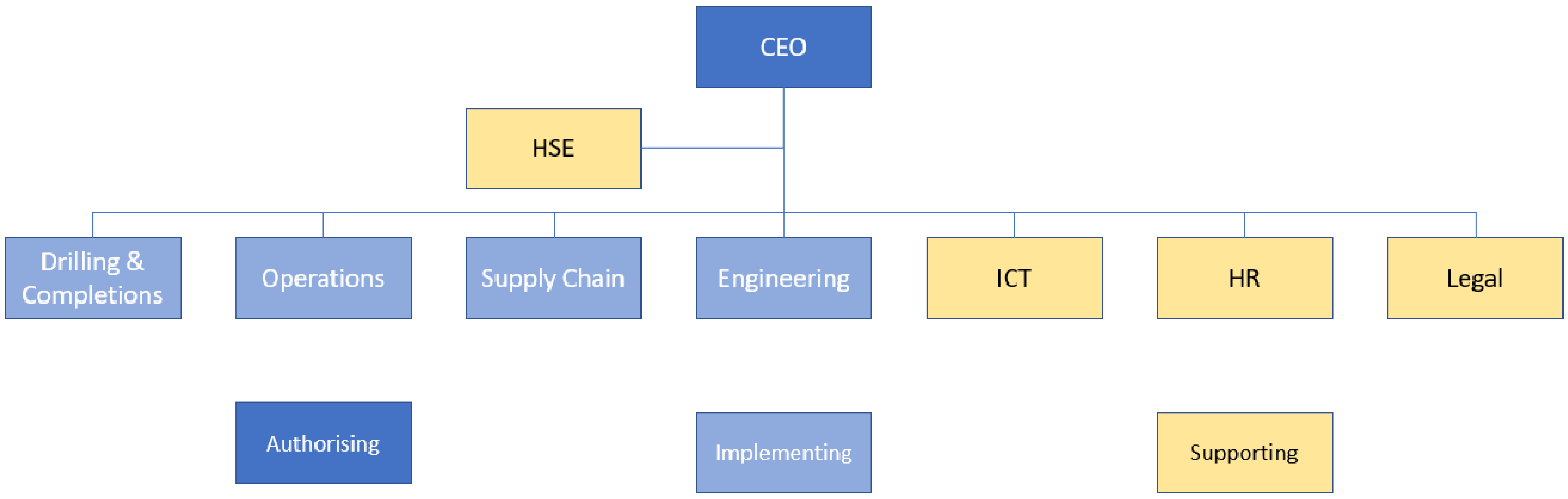


Figure 12.2 – AHUK Organogram

The management system contains process which are used to identify environmental aspects of activities, assess, and minimise their impact and risk. The results of this process are presented in this ES together with the operational commitments to ensure the impacts are not significant. The planning of activities also includes, assurance activities required to ensure compliance and performance monitoring, measuring, and reporting. Processes and procedures are in place to plan, manage and assure the management of compliance with legal and company requirements.

The management system also details requirements on the levels of training, awareness, and experience to ensure personnel have the required competence to fulfil their roles. The competencies will be supplemented with project specific requirements as appropriate e.g., in relation to oil spill response and clear guidelines for the management of change of people, plant and processes. Provision for emergency preparedness to manage the response to mitigate the effect of and facilitate recovery from unplanned events will be made in line with regulatory requirements. All requirements of environmental management are communicated internally and externally as appropriate e.g., to third parties involved in activities.

Assurance activities will be carried out in line with the management system requirements and will take the form of auditing and reviewing of compliance with legal and corporate requisites such as standards and objectives. Environmental incidents will be recorded and investigated to learn from the root cause of the incident. As with audit findings, areas of non-compliance will be address through corrective actions and amendments to the management system process and procedures as appropriate.

Review of environmental performance will be carried out routinely as appropriate to the business and operational areas and range from operational daily event recording to management to annual top management review of the effectiveness of the management system. Performance review including assurance activities will form the basis on which objectives and targets will be set for the company and the Teal West project. The objectives and targets will be cascading throughout the organisation and shared with 3rd parties through annual HS&E plans.

All planned and permitted environmental emissions, discharges and waste will be reported via the UK Environmental Emissions Monitoring System (EEMS) in line with legal requirements. An annual OSPAR "Convention for the Protection of the Marine Environment of the North-East Atlantic" environmental report will be submitted to the BEIS[21] demonstrating responsible environmental management of the Teal West asset.

[21] https://www.gov.uk/guidance/oil-and-gas-ospar-ems-recommendation#ems-public-statements

12.2. Delivery of Commitments

The Teal West project team are responsible for the tracking and delivery of the commitments starting with the cascading of the commitments within the company as appropriate within the organisational structure in relation to accountabilities. A commitments register will be established for tracking all the commitments made within the ES and any further commitments that arise out of the regulatory review of this ES. Assurance will be carried out, including regular review and update of the register at various stages of the development and execution of the project scope to ensure delivery of the commitments is embedded in further design and operational planning.

Many of the commitments made in this ES will require third party involvement to deliver. The contractor selection and management process will be used to support the communication, tracking and management of these commitments through to delivery.

12.3. Contractor Selection and Management

Management of contractors is an essential activity to ensure compliance with regulatory requirements and company policy. Clarification of primacy and procedural interfaces, including management of environmental aspects, is key to the management of contractors and ultimately environmental risks and impacts. The objectives of the contractor management processes are applicable to all phases of the Teal West Development to ensure that:

- All contractors apply the company policies and standards that are compatible with the environmental management requirements.
- All contractors' personnel are competent to perform their tasks.
- Environmental responsibilities of both contractor and the company are clearly defined and embedded within contracts; and
- Each contractor has a formal management process to minimise environmental risk.

The importance of Suppliers' own management systems to the success of operations is recognised. The effectiveness of 3rd party systems will be monitored through activities with a focus on continuous improvement. It is the responsibility of all contractors to ensure that their employees have the minimum competence requirements equal to or above the company standards. Assessment of contractor performance is conducted via internal and independent audits throughout the contract life.

In alignment with the NSTA´s Stewardship Expectations 11: Net Zero (2021), a Supply Chain Action Plan has been produced for the Teal West Development. As part of the plan, net zero emissions reduction is a core component of tender evaluations, and opportunities for supply chain and logistics synergies will be identified to reduce GHG emissions. Embedding 'low carbon thinking' mechanisms into how the supply chain interacts with and delivers for the company, including mission statements and training, will be highlighted in tender documents. Furthermore, supply chain agreements will include requirements for the measurement and reporting of relevant carbon emissions, as well as carbon targets to be achieved, and for decarbonisation innovation to be at the forefront of the supplied service.

12.4. Net Zero

AHUK supports the UK Net Zero target of 2050 and Scotland's target of 2045, and the Net Zero Policy is in alignment with the NSTA Strategy[22] and the Stewardship Expectations 11: Net Zero (2021). AHUK is committed to reducing carbon intensity and carbon footprint via operational improvement and maximising energy efficiency. The commitment to the continuous improvement of energy and emissions performance for delivery of the Net Zero Policy include, for example:

- Identifying areas for improvement in both operations and planning and implementing the action plan to reduce the emission and improve energy performance
- Reducing emission and energy consumption through a structured approach to monitoring and recording emissions and energy use
- Setting objectives and targets that aid continual improvement, monitoring of performance
- Critical review of all investment opportunities and projects to ensure that appropriate emissions reduction criteria is used to approve and execute all projects
- Continuous review of the standards, expectations, and targets to ensure their suitability and effectiveness

[22] https://www.nstauthority.co.uk/regulatory-framework/the-strategy/

13. CONCLUSIONS

13.1. Overview

An assessment of all the Teal West Development activities, which include the development of up to two production wells., a water injection well and associated flowlines and umbilicals in Block 21/24d and Block 21/25 of the CNS, and their interaction with the environment has been undertaken. In addition, an assessment has been undertaken to take into account the incremental change in environmental impact of the Anasuria FPSO has been assessed. A number of potential sources of impact were identified as part of an ENVID exercise; those that were identified as being potentially significant were assessed further. These include impacts from discharges to sea, seabed disturbance, underwater noise, physical presence of the Development, and accidental events.

Other potential impacts that were deemed negligible or minor during this exercise were not considered further, as reported in Appendix B

13.2. Environmental Management

AHUK commits to deliver all management measures listed in Appendix A Commitments Register to reduce the magnitude of or eliminate the potential environmental impacts from the Teal West Development. Therefore, there are no potential impacts of concern as a result of the control measures listed in Appendix A being in place.

AHUK has considered the objective and marine planning policies of Scotland's National Marine Plan across the range of policy topics including natural heritage, air quality, cumulative impacts and oil and gas. AHUK considers that the Teal West Development is in broad alignment with such objectives and policies. The extent to which the Development is aligned with the oil and gas objective and policies relevant to the Development is summarised in Section 1.5.1.

13.3. Residual impacts

Overall, with the implementation of the environmental risk management and mitigation measures, the Teal West Development, including the installation, production and decommissioning phases will not result in significant adverse effects on the environment or other users of the area.

A review of the potentially significant environmental impacts associated with the Teal West Development against the range of other anthropogenic activities in the region indicated that no cumulative impacts are expected.

The Teal West Development is located approximately 87 km from the UK/Norway median line, therefore any transboundary impacts from discharges to sea, seabed disturbance, underwater noise, and physical presence of the infrastructure and project vessels are not expected to cause transboundary interactions.

With respect to the risk from accidental events, hydrocarbon release modelling undertaken for the worst-case scenario of a well blowout indicates a 100% probability of hydrocarbons crossing the Norway, Denmark and Sweden median lines, with the potential to for oil to beach in the UK, Norway, Denmark, Sweden, Germany, the Netherlands, the Faroe Islands, Belgium, France and the Norwegian island Jan Mayen. The Espoo Convention requires consultation of affected parties only for projects likely to have a significant adverse environmental impact across boundaries. The likelihood of these transboundary impacts being remote, consultation is unlikely to be required.

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APPENDIX A COMMITMENTS REGISTER

Item	ES Section	Issue	Mitigation and Management Action
1	6.7.1	Drilling discharges	Drilling muds will be re-cycled as far as practicable.
2	6.7.1	Drilling discharges	Cuttings contaminated with Synthetic Oil Based Mud (SOBM) will be transferred to shore for proper treatment and disposal via industry standard skip and ship processes.
3	6.7.1	Drilling discharges	Completion brine contaminated with hydrocarbon or SOBM will be treated on the rig, transferred to vessel for onshore waste processing.
4	6.7.1	Drilling discharges	Alternatives to chemicals carrying substitution notifications will be sought.
5	6.7.1	Drilling discharges	Chemicals will only be used in accordance with the Drilling Permit conditions and according to AHUK's internal procedures.
6	6.7.1	Drilling discharges	A rig audit will be conducted to the ensure the drilling rig is in compliance with all relevant guidelines and legislation.
7	6.7.1	Drilling discharges	An environmental risk assessment will be carried out as part of Offshore Chemicals Regulations (OCR) approval process, and identification of measures to reduce risk including chemical selection procedures, to obtain approval for chemical use prior to operations commencing.
8	6.7.1	Drilling discharges	Cementing procedures will be implemented to reduce unused cement discharges.
9	6.7.1	Drilling discharges	BEIS sampling requirements will be followed when drilling through the reservoir section.
10	6.7.2	Aqueous discharges	Selection of chemicals will be made in accordance with AHUK's procedures and with relevant permit requirements
11	6.7.2	Aqueous discharges	The produced water system is designed to reduce the oil content in the produced water to a target of below 30 mg/l monthly average, for overboard discharge.
12	6.7.2	Aqueous discharges	Once the final chemical requirements are known, and prior to the commencement of operations, AHUK will submit the relevant permit applications, supported by appropriate detailed chemical risk assessments, to OPRED under the OCR in order to obtain approval prior to chemical use and discharge.
13	7.3.4	Seabed impacts	The pipelines and umbilical shall be trenched and buried over the majority of their lengths with protection mattresses only being used where necessary.

Item	ES Section	Issue	Mitigation and Management Action
14	7.3.4	Seabed impacts	The flexible design of the production flowline is anticipated to be less vulnerable to Upheaval Buckling (UHB) than a rigid pipe, thus rock requirements will be kept as low as possible (subject to UHB analysis).
15	7.3.4	Seabed impacts	Rock placement will be undertaken using fall pipe vessel to ensure the accuracy and optimisation of deposited rock, thus limiting the seabed impact to as low as reasonably practicable.
16	7.3.4	Seabed impacts	Survey data will be used to inform the placement of concrete mattresses/grout bags.
17	7.3.4	Seabed impacts	Pockmarks will be avoided wherever possible.
18	7.3.4	Seabed impacts	Consultation will be undertaken with relevant authorities, organisations and stakeholders, including Marine Scotland, JNCC and Scottish Fishermen's Federation (SFF).
19	7.3.4	Seabed impacts	The jack-up rig footprint will be minimised by re-using the existing spud can depressions during second and third drilling campaigns, where possible, subject to the same or similar rig being deployed.
20	8.8.1	Underwater noise	The JNCC (2017) guidance for minimising the risk of disturbance and injury to marine mammals from geophysical surveys will be followed.
21	8.8.2	Underwater noise	MMOs on board the vessel from which the VSP will be deployed (in this case, the drilling rig) will monitor for the presence of marine mammals, during the pre-source start search, soft-start and survey, and will recommend delays in the commencement of source activity should any marine mammals be detected within the 500 m mitigation zone. Dedicated PAM operators may also be required to cover the hours of darkness and during periods when day-time conditions are not conducive for visual surveys (e.g. fog or increased sea states). The survey contractor will be providing a team to cover 24-hour observations / PAM during the survey.
22	8.8.3	Underwater noise	All observations (MMO or PAM) will be undertaken during a pre-shooting search of 30 minutes i.e. prior to the commencement of the seismic sources in waters < 200 m. This will involve a visual (during daylight hours) and/or acoustic assessment (during hours of darkness / reduced visibility) to determine if any marine mammals are present within the 500 m mitigation zone from the centre of the device deployed. If marine mammals are detected in the mitigation zone during the pre-shooting search, then operations must be delayed until their passage. Either way there should be a minimum of a 20-minute delay from the time of the last sighting within the mitigation zone and the commencement of the soft-start and / or start 8.of operations, to allow animals unavailable for detection to leave the area.
23	8.8.4	Underwater noise	There should be a soft start conducted every time prior to survey operations. Regardless of duration, where possible power should

Item	ES Section	Issue	Mitigation and Management Action
			be built up gradually, in uniform stages from a low energy start-up. Surveys should be planned to avoid unnecessary firing at operational power before commencement of an acquisition line and to time operations to commence data collection as soon as possible once full operational power is achieved. Survey operations should be planned to avoid unnecessary time at operational power before the commencement of an acquisition line and to time operations to commence data collection as soon as possible once full operational power has been achieved.
24	8.8.5	Underwater noise	All recordings of marine mammals will be made using JNCC Standard Forms. At the end of the survey, a monitoring report detailing the marine mammals recorded, methods used to detect them, and details of any problems encountered will be submitted to the JNCC. The report will also include feedback on how successful the mitigation measures were. This requirement will be communicated to the MMO at survey start up meetings and at crew change. If the MMO has any queries on the application of the guidelines during the survey they will contact the JNCC for advice.
25	9.6.1	Increased vessel traffic and collision risk	A Consent to Locate will be in place for the drilling rig, and AHUK will consult with relevant authorities, licensees of adjacent licences and organisations to minimise interference impacts resulting from the proposed drilling activities.
26	9.6.1	Increased vessel traffic and collision risk	A safety exclusion zone of 500 m in radius will be established around the drilling rig during drilling and around the Teal West wells for the life of the Development.
27	9.6.1	Increased vessel traffic and collision risk	Information on the location of subsea infrastructure, safety zones and vessel operations will be communicated to other sea users (via the UK Hydrographic Office) through the standard communication channels including Kingfisher, Notice to Mariners and Radio Navigation Warnings.
28	9.6.1	Increased vessel traffic and collision risk	Infrastructure and safety zones will be marked as hazards on admiralty charts and entered into the FishSafe system so that it may be avoided by fishing vessels.
29	9.6.1	Increased vessel traffic and collision risk	During installation, the number of vessels and length of time they are required on site will be reduced as far as practicable through careful planning of the installation activities.
30	9.6.1	Increased vessel traffic and collision risk	A guard vessel will be present on site in the interim period between the laying of the pipeline and umbilical and arrival of the trenching support vessel to ensure that other sea users are aware of the surface laid pipeline and umbilical.
31	9.6.1	Increased vessel traffic and collision risk	Consultation will be undertaken with relevant authorities and organisations.

Item	ES Section	Issue	Mitigation and Management Action
32	9.6.1	Increased vessel traffic and collision risk	Environmental awareness training will be given to all relevant crew members to reduce the risk of collisions between vessels and animals.
33	9.6.1	Increased vessel traffic and collision risk	Development and implementation of a fisheries liaison strategy.
34	9.6.2	Temporary and Permanent Exclusion	AHUK has reduced vessel numbers and vessels days as far as practicable whilst adhering to safety and emergency response requirements.
35	9.6.3	Snagging risk	The location of subsea infrastructure will be communicated to other sea users through standard communication channels, including Notices to Mariners and Kingfisher bulletins.
36	9.6.3	Snagging risk	A fishing-friendly integrated XT will be installed, reducing the potential for snagging risks.
37	9.6.3	Snagging risk	Should it be required, the spread of contingency rock will be minimised through the use of a fall pipe vessel.
38	9.6.3	Snagging risk	A post-installation survey will be performed once activities are completed to identify any hazards to fishing and shipping and navigation.
39	9.6.3	Snagging risk	Regular maintenance inspection surveys will be undertaken throughout the Development's lifetime to ensure structures remain in a favourable condition.
40	9.6.4	Dropped objects	Personnel will be suitably trained as to minimise the potential for dropped objects.
41	9.6.4	Dropped objects	Lift planning will be undertaken to manage risk during lifting activities, and all lifting equipment will be tested and certified.
42	9.6.4	Dropped objects	All deck items will be securely stowed.
43	9.6.4	Dropped objects	All equipment and material on installation vessels will be adequately stowed or sea fastened.
44	9.6.4	Dropped objects	Transfers of objects will use specialist equipment and consider environmental conditions.
45	9.6.4	Dropped objects	Procedures will be put in place to ensure that the location of any lost material is recorded and that significant objects are recovered where practicable.
46	9.6.4	Dropped objects	The contractor will have a dropped objects procedure which will be used for the proposed installation operations to minimise any issues with dropped objects.
47	9.6.4	Dropped objects	Compliance to Lifting Operations and Lifting Equipment Regulations (LOLER) including inspection/testing.

Item	ES Section	Issue	Mitigation and Management Action
48	9.6.4	Dropped objects	A post-installation survey will be performed once activities are completed to identify any significant dropped objects and seabed anomalies.
49	10.5	Atmospheric emissions	The identification of emissions reduction opportunities has been carried out at the current stage of the design process and as the Development progresses, opportunities will be sought to minimize emissions. AHUK will minimise Development emissions by carrying out emissions reduction reviews as part of further detailed design, installation processes, and through supporting AOC in the operations and maintenance on the Anasuria installation. These reduction reviews will include third party contractors, where appropriate.
50	10.5.1	Atmospheric emissions (operational phase)	In alignment with the NSTA Net Zero Stewardship Expectation 11, (NSTA 2021), AOC (as Operator of the Anasuria FPSO and therefore in control of the majority of Teal West operational emissions) will seek to deliver continuous improvement across all areas of GHG emissions reduction during the operations phase.
51	10.5.2	Atmospheric emissions (installation, commissioning, maintenance and decommissioning)	In alignment with the NSTA Net Zero Stewardship Expectation 11, (NSTA 2021), minimisation of emissions from vessels will form part of the selection criteria for the installation vessels through the tendering and selection process. • Each vessel will have a Shipboard Energy Efficiency Management Plan (SEEMP) which contains information for minimising fuel consumptions e.g., economical speeds when operationally appropriate. • Green DP or economical speeds when operationally appropriate. • Developing the subsea installation programme to minimise the number of mobilisations, demobilisations and length of vessel transit. • Streamlining of activities through planning to reduce the time required for vessels and helicopters will support the drive to reduce emissions.
52	11.7	Accidental events	AHUK will ensure that appropriate controls are in place to either reduce the probability of failure of a control resulting in a release or reduce the consequences in the event of a release.
53	11.7	Accidental events (drilling)	Risk assessment and appropriate emergency response procedures will be implemented.
54	11.7	Accidental events (drilling)	Drilling rig will be built to MODU certified standards.
55	11.7	Accidental events (drilling)	The drilling rig shall have an approved Safety Case with all Safety and Environmental Critical Elements (SECEs) verified by an independent verification body during operations.
56	11.7	Accidental events (drilling)	The Blow-out Preventer (BOP) will have fully redundant control systems.

Item	ES Section	Issue	Mitigation and Management Action
57	11.7	Accidental events (drilling)	Chemical storage areas will be contained to prevent accidental release of chemicals.
58	11.7	Accidental events (drilling)	Weather forecasts will be monitored so that oil-based mud in the riser can be removed to the drilling rig prior to riser unlatch.
59	11.7	Accidental events (drilling)	Responsible rig-based and shore-based personnel trained to international standards of well control.
60	11.7	Accidental events (drilling)	Bulk handling procedures will be implemented, and personnel training will occur.
61	11.7	Accidental events (drilling)	Environmental spill kits, including absorbent material, will be available on board the drilling rig to allow clean-up of any deck accidental releases or leaks.
62	11.7	Accidental events (drilling)	A standby vessel will be present to monitor any spills.
63	11.7	Accidental events (drilling)	Oil spill response capability, including aerial surveillance provision.
64	11.7	Accidental events (dropped objects)	Dropped object risk assessments will be carried out for all lift activities.
65	11.7	Accidental events (dropped objects)	Heavy equipment will be low in the water column to avoid dropping objects at heights.
66	11.7	Accidental events (dropped objects)	Procedures will be put in place to record the location of any lost material and to recover significant objects where practicable.
67	11.7	Accidental events (dropped objects)	Simultaneous Operations (SIMOPS) procedures will be in place, if applicable.

APPENDIX B ENVID

ID	Project aspect	Project stage relevance?		Description of potential effects	Mitigation	Potentially significant in EIA terms?	Stakeholder expectation to assess in ES?	Take forward further in EIA?	Justification for Scoping Decision
Discharges to Sea									
1	Skip and ship of oil based drill cuttings, including those contaminated with reservoir hydrocarbons (i.e. drilling through payzone) and seawater sweeps.	Drilling Subsea installation Operations Decommissioning	Yes No No No	The well will initially be drilled riserless with cuttings discharged to the seabed during the 42" x 36" and 26" hole sections. The 17.5", 12.25" and 8.5" sections will be drilled with OBM on a closed system resulting in zero discharge to sea. All OBM and associated cuttings will be returned to the drilling rig and skipped and shipped to shore for onshore disposal.	Environmental risk assessment through the MATs/SATs system (OCR and OPPC). Skip and ship of cuttings for well sections drilled with OBM. Chemicals will be appropriately selected and managed in accordance with the Offshore Chemicals Regulations.	No	No	Scoped Out	All OBM and associated cuttings will be returned to the drilling rig and skipped and shipped to shore for onshore disposal. No offshore discharge of OBM cuttings.
2	Routine discharge of water based drill cuttings and chemicals associated with the drilling. Other discharges to sea associated with drilling, cementing, well completion and wellbore cleanup. These will include: - Drilling discharges: The well will initially be drilled riserless with cuttings discharged to the seabed during the 42" x 36" and 26" hole sections. Seawater with bentonite sweeps will be discharged to sea during drilling of these top hole sections. - Cement discharges: The excess cement will be discharged at the wellbore following cementing operations. This will form a cement patio which will have a seabed impact. - Completion discharges: 400bls per well for completion brine prior to production discharged to sea.	Drilling Subsea installation Operations Decommissioning	Yes No No No	Cuttings, dissolved metals, dissolved organics and any chemicals released to sea may cause detrimental impacts on local water quality and marine flora and fauna. There will be some volumes of discharges during the operations associated with the project and these will be further assessed in permit applications. Chemicals not known at this time but will be selected using AHUK chemical management system. The discharges will be very limited and of short duration. Given the distance between the wells and that this is a phased development, there is limited potential for cuttings discharges to overlap.	Selection of chemicals with less potential for environmental impact (i.e. PLONOR). Environmental risk assessment through the MATs/SATs system (OCR). All chemicals to be used within the cement will be selected based on their technical specifications and environmental performance. Chemicals with sub warnings will be avoided where technically possible. All chemicals to be used will be selected following AHUK's chemical management and selection policy.	No	Yes	Scoped In	Stakeholders would expect an assessment of the potential impacts of cuttings and cement discharges on the seabed and water column. However, given that Teal West is is not located within a sensitive area, a reasonable assessment can be made with existing information.
3	Routine chemical use and discharge to sea during pipeline commissioning, subsea structure commissioning. Nominal discharge to Sea will result from Pressure/Leak testing after initial installation. (Hydraulic fluid & dye) Types of chemical used during pipeline pre-	Drilling Subsea installation Topsides modifications Operations Decommissioning	No Yes No No No	Chemical use also to include from the pipeline pre commissioning, gels and dye in new pipelines or structures, release from spool tie ins, barrier checks on the trees and at manifold (dye/inhibited fluid discharge). Chemicals discharged to sea may cause contamination of seawater and disturbance to aquatic ecosystem. There will be some volumes of	All cements and chemicals used offshore will be subject to the Offshore Chemicals Regulations and risk assessed as part of the application for use/ discharge.	Yes	Yes	Scoped In	Stakeholders would expect an assessment of the potential impacts of routine chemical discharges on the seabed and water colunmn.

	commissioning and fate of these chemicals are still to be confirmed. Once the production and EHC umbilical systems have been demonstrated to be leak tight and all pre-commissioning / start-up checks have been successfully completed, then commissioning of the Teal West system will proceed with all water/MEG linefill from both the gas lift and production pipelines being received back at the Anasuria FPSO.			discharges during the operations associated with the project and these will be further assessed					
4	Routine chemical use and discharge during operations (e.g. well workover, subsea valves, leak detection dyes) and any incremental use and discharge at Anasuria (e.g. deck cleaning, deck drainage run-off).	Drilling Subsea installation Operations Decommissioning	No No Yes No	Chemicals discharged to sea may cause contamination of seawater and disturbance to aquatic ecosystem.	Selection of chemicals with less potential for environmental impact. Environmental risk assessment through the MATs/SATs system (OCR). All chemicals to be used within the cement will be selected based on their technical specifications and environmental performance. Chemicals with sub warnings will be avoided where technically possible. All chemicals to be used will be selected following AHUK's chemical management and selection policy.	No	No	Scoped Out	Volumes that will be discharged will be small and limited in nature and extent, which will be assessed in environmental risk assessments through the MATs/SATs system.
5	Routine discharge of ballast water and removal/fall-off of fouling growth from ships and drilling rig.	Drilling Subsea installation Operations Decommissioning	Yes Yes Yes Yes	Ballast water and marine growth on ships coming into the Project area may contain non-native organisms. Some species may survive and establish themselves. Non-native species may cause serious ecological impacts, particularly if they become invasive.	IMO Ballast Water Management Convention, including Ballast water plan and log book (all). Fouling procedures for vessels under hire (all). It is not expected that any of the vessels will come from outside of UK waters. Vessel CMID (Common Marine Inspection Documents) and HSE assurance audits conducted to ensure that contracted vessels meet IMO/MARPOL and POUK marine and HSE standards.	No	No	Scoped Out	Discharges from vessels during the installation are typically well-controlled activities that are managed on an ongoing basis as per the International Maritime Organisation (IMO) standards. The duration of the installation campaign is relatively short-term.
6	Routine blackwater production (i.e. sewage), grey water (i.e. from showers, laundry, hand and eye wash basins and drinking fountains) and food waste (macerated) disposal (from vessels and	Drilling Subsea installation Operations Decommissioning	Yes Yes Yes Yes	Additional survey inspection and maintenance vessels required only periodically. Discharge of sewage, grey water and macerated food has an associated BOD and may contribute to	Treatment to IMO standards (all). Vessel CMID and HSE assurance audits conducted to	No	No	Scoped Out	Implementation of IMO Standards.

	drilling rig and any incremental occurrence at Teal West).			organic enrichment in the vicinity of the discharge possibly leading to a small increase in plankton and fish population.	ensure that contracted vessels meet IMO/MARPOL and POUK marine and HSE standards.				
7	Produced water. Teal West produced water will be treated and discharged overboard meeting 30ppm oil in water discharge limit. Production chemicals include Wax inhibitor, scale inhibitor, hydrate inhibition (methanol) and oxygen scavanger. Wax inhibitor, scale inhibitor, hydrate inhibition (methanol) and oxygen scavanger. Of these, only wax inhibitor will be new to the FPSO, selection not determined at the time of writing.	Drilling Subsea installation Operations Decommissioning	No No Yes No	Oil, dissolved metals, dissolved organics and chemicals released to sea in produced water may cause detrimental impacts on local water quality and marine flora and fauna. Potential for oily sheens to appear and possible seabird contamination.	Within existing consent limits.	Uncertain	Yes	Scoped In	Stakeholders would expect an assessment of the potential impacts of increased discharge of produced water.
8	The maximum expected sand production rate will be verified in a Sand Control study conducted in parallel with the FPSO FEED. • Particle size; assumed to be less than 40 microns • Sand loading: assumed to be less than 1 lb/1000 bbl • Sand density assumed to be 2650 kg/m3. Produced sand will accummulate in process vessels. It will be removed during planned shutdowns and shipped to shore.	Drilling Subsea installation Operations Decommissioning	No No Yes No	Oil, dissolved metals, dissolved organics and chemicals released to sea in produced sand may cause detrimental impacts on local water quality and marine flora and fauna. Potential for oily sheens to appear and possible seabird contamination. The production wells shall be designed to minimize sand production. The subsea xmas trees may be fitted with acoustic sand monitors to monitor sand production.	Within existing consent limits.	Uncertain	Yes	Scoped In	Stakeholders would expect an assessment of the potential impacts of increased discharge of produced water.
8	Discharge to sea during well bore cleanup and wel testing. Wells will be cleaned up with clean up package rigged up on the drilling rig. Wells will be flowed for planned 24hrs with rates +/- 2000bbls/day at controlled choke sizes to separaters and burners. Surge tank will be rigged up to ensure zero spill overboard with flare system to burn flowed oil at surface. Filtration system will also be rigged up to ensure fluid is filtered to required levels prior to discharge.	Drilling Subsea installation Operations Decommissioning	Yes No No No	Chemicals discharged to sea may cause contamination of seawater and disturbance to aquatic ecosystem.	Selection of chemicals with less potential for environmental impact. Environmental risk assessment through the MATs/SATs system (OCR). All chemicals used offshore will be subject to the Offshore Chemicals Regulations and risk assessed as part of the application for use/discharge. Low toxicity and/or PLONOR chemicals will be used where possible and deemed technically feasible. Well testing discharges will be subject to Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations. COSHH, Task Hazard Assessments and MSDS sheets will be available on the drilling rig.	Uncertain	Yes	Scoped In	Stakeholders would expect an assessment of the potential impacts of chemical discharges associated with well testing

					POUK will undertake environmental audits of the drilling rig, as appropriate.				

ID	Project aspect	Project stage relevance?		Description of potential effects	Mitigation	Potentially significant in EIA terms?	Stakeholder expectation to assess in ES?	Take forward further in EIA?	Justification for Scoping Decision
Physical Presence									
1	Seabed disturbance. Installation of infrastructure on the seabed. Structures that will be installed on the seabed: - Drill centre valve skid - Riser base manifold (RBM) - Three Wellheads - Three production horizontal Xmas trees (2 production and 1 water injection). - Protection frames around wellheads - Pipelines and umbilicals - Water injection flowline - Jumpers, spools - Rock placement, rock/sand bags, concrete mattresses	Drilling	No	Installation of the production pipeline, gas lift pipeline and controls and umbilicals (trenched and backfilled), tie in spools, manifold, valve skid and protection material (concrete mattresses, rock dump) throughout the Development. Trenching and backfilling of pipelines/umbilical is the base case. How many lines are going to be installed, and will they installed within the same trenches? One of the pipeline route option goes through an NCMPA. Geotechnical/geophysical survey plus prelay surveys will be conducted to confirm no obstructions. Up to four crossings will require strategic placement of concrete mattresses. Direct damage to benthic habitats and fauna. Increased turbidity of water column and wider smothering caused by the resultant sediment plume. Disturbance of drill cuttings piles possible during manifold and Teal West valve skid installation (covered in Discharges to Sea). Area survey to be conducted post-drilling but pre-installation of subsea infrastructure.		Yes	Yes	Scoped In	Potentially significant in terms of EIA and stakeholders would expect an assessment of the impacts on the seabed to be included in the ES.
		Subsea installation	Yes		The volumes and locations of concrete mattresses and rock berms used will be refined during detailed design to reduce the footprint on the seabed to the extent practicable. The spread of contingency rock during placement will be minimised through the use of a fall pipe vessel. Environmental survey data will be used to inform the placement of concrete mattresses/rock.				
		Operations	Yes						
		Decommissioning	Yes		Guidance and best practice at time of decommissioning will be followed.				
2	Primary option considered for EIA is Jack Up Rig x 3 deployments (one for each well).	Drilling	Yes	Could lead to exclusion of marine species from an area, or to collision between vessel and animals. Disturbance to benthic communities and habitats.	Anchor plan, including restricting number of anchor movements. Environmental survey data will inform anchor laying.	Yes	Yes	Scoped In	Potentially significant in terms of EIA and stakeholders would expect an assessment of the impacts on the seabed to be included in the ES.
		Subsea installation	No						
		Operations	No						
		Decommissioning	No						
3	Proximity of Project to features of archaeological interest.	Drilling	Yes	There are no protected wrecks or Historic MPAs in the vicinity of the Development. The 2021 will provide information on the presence/absence of wrecks in the project area.		No	No	Scoped Out	No features of archaeological interest expected to be present, therefore no potential significant impact.
		Subsea installation	Yes						
		Operations	No						
		Decommissioning	Yes		Guidance and best practice at time of decommissioning will be followed.				

4	Physical presence of the subsea infrastructure, including deposited material - exclusion/obstruction for the life of the development.	Drilling	Yes	Long term potential obstruction or exclusion from structures laid/fixed on seabed, e.g. manifold, associated pipelines and umbilicals. Anchor mounds may impede commercial fishing activities (including through snag risk) and other sea users. The new structures may also provide a hard substrate in soft sediment environment affecting benthic communities.	Environmental survey data will inform baseline (all) Once installed, a 500 m safety zone will be in place at the drill centre	Yes	Yes	Scoped In	Potentially significant in terms of EIA and stakeholders would expect an assessment of the impacts to be included in the ES.
		Subsea installation	Yes		Back filling over trenches will reduce snagging risk. At crossings, rock berms will be fishing friendly. Wellhead and manifold structures will be fishing friendly. UKHO standard communication channels including Kingfisher, Notice to Mariners and radio navigation warnings (all) Consultation will be undertaken with relevant authorities and organisations (all) Development and implementation of a fishery liaison strategy (all)				
		Operations	Yes		Regular maintenance and pipeline route inspection surveys. Fishing friendly structures will be installed - SFF consultation had.				
		Decommissioning	Yes		Guidance and best practice at time of decommissioning will be followed.				
5	Temporary physical presence of vessels.	Drilling	Yes	Vessels include support and standby vessels during drilling and installation, anchor handling vessels during drilling, and DSVs during installation and pipeline maintenance activities. The Teal West DC is over 6 km from Anasuria FPSO. Short term potential obstruction or exclusion from vessel use may impede commercial fishing activities and other sea users. However, a 500 m safety zone already exists around the Anasuria FPSO and therefore other sea users are already excluded from using this area. There will also be 500 m safety zones in place at the drill centre around the drill rig during the drilling phase.	As above (all) The number of vessels and length of time they are required on site will be reduced as far as practicable through careful planning of operations (all) A 500 m safety zone will be put in place around the drilling rig while on location.	Yes	Yes	Scoped In	Potentially significant in terms of EIA and stakeholders would expect an assessment of the impacts to be included in the ES.
		Subsea installation	Yes		As above (all)				
		Operations	Yes		Regular maintenance and pipeline route inspection surveys.				
		Decommissioning	Yes		Guidance and best practice at time of decommissioning will be followed.				
6	Light from installation, drilling rig and vessel activities.	Drilling	Yes	Additional lighting at the rig will be temporary. No additional lighting at the FPSO. Disturbances to the seabird communities, particularly migrating species.	Lighting directed below the horizontal plane unless required for technical or safety reasons (all)	No	No	Scoped Out	Not considered to be a major issue for the Project (a few vessels present on site for short duration) nor industry.
		Subsea installation	Yes						
		Topsides modifications	No						

		Operations	Yes						
		Decommissioning	Yes		Guidance and best practice at time of decommissioning will be followed.				
7	Physical interaction between vessels and wildlife	Drilling	Yes	Presence could lead to exclusion of marine species from an area, or to collision between vessel and animals		No	No	Scoped Out	Not considered to be a major issue for the Project (a few vessels present on site for short duration) nor industry.
		Subsea installation	Yes						
		Operations	Yes						
		Decommissioning	Yes		Guidance and best practice at time of decommissioning will be followed.				
8	Impact on seascape	Drilling	Yes	Presence of vessels or new surface infrastructure which could potentially affect visual amenity.		No	No	Scoped Out	There is no surface infrastructure and the limited vessel presence will be sufficiently offshore not to affect visual amenity.
		Subsea installation	Yes						
		Operations	Yes						
		Decommissioning	Yes		Guidance and best practice at time of decommissioning will be followed.				

ID	Project aspect	Project stage relevance?		Description of potential effects	Mitigation	Potentially significant in EIA terms?	Stakeholder expectation to assess in ES?	Take forward further in EIA?	Justification for Scoping Decision
Atmospheric Emissions									
1	Use of diesel on drilling rig (operations, transit). Transit to next project not covered by project scope. Basis for calculation is 100 days on each well (excluding transit).	Drilling	Yes	Emissions of CO2, CH4, CO, VOCs, SOx, NOx and particles of carbon (soot) may contribute to global warming, acid precipitation, ozone depletion and deterioration of local air quality. Possible transboundary issues.	Operations will be carefully planned to reduce vessel numbers and the duration of operations. Low sulphur diesel. All vessels will comply with the Merchant Shipping (Prevention of Air Pollution from Ships) (Amendment) Regulations 2014. All vessels will have the appropriate UKAPP or IAPP in place as required. Rig inspection conducted. Optimised use of vessels through efficient journey planning to minimise diesel combustion and emissions. Vessel CMID (Common Marine Inspection Documents) and HSE assurance audits conducted to ensure that contracted vessels meet IMO/MARPOL and POUK marine and HSE standards.	Yes	Yes	Scoped In	Stakeholder expectation that this would be considered in the ES.
		Subsea installation	No						
		Operations	No						
		Decommissioning	No						
2	Vessel use of diesel for transit and working. Subsea installation only has 45 days duration DP2 contrsuction vessle/DSV	Drilling	Yes	Vessels will include supply vessel, standby vessel, survey vessels, pipelay/ umbilical lay vessel, trenching vessel, dive support vessel, other support vessels and helicopters etc including during installation and survey activities. Emissions of CO2, CH4, CO, VOCs, SOx, NOx and particles of carbon (soot) may contribute to global warming, acid precipitation, ozone depletion and deterioration of local air quality. Possible transboundary issues.	Low sulphur diesel (all) Sulphur content in bunkered fuels must be ≤ 0.10%. Vessel audits (all)	Yes	Yes	Scoped In	Stakeholder expectation that this would be considered in the ES.
		Subsea installation	Yes						
		Operations	Yes						
		Decommissioning	Yes		Guidance and best practice at time of decommissioning will be followed. Optimised use of vessels through efficient journey planning to minimise diesel combustion and emissions. Vessel CMID (Common Marine Inspection Documents) and HSE assurance audits conducted to ensure that contracted vessels meet IMO/MARPOL and POUK marine and HSE standards.				

3	Flaring during well-clean up, testing and during production. Wells will be cleaned up with clean up package rigged up on the drilling rig. Wells will be flowed for planned 24hrs with rates +/- 2000bbls/day at controlled choke sizes to separaters and burners.	Drilling	Yes	Emissions of CO2, CH4, CO, VOCs, SOx, NOx and particles of carbon (soot) may contribute to global warming, acid precipitation, ozone depletion and deterioration of local air quality. Possible transboundary issues.	Flaring management plan Flare Consent Demonstration of BAT The length of flaring will be limited as far as is practicable to reduce the requirement to flare. Extended Well Test permitting [TBC]	No	Yes	Scoped In	Stakeholder expectation that this would be considered in the ES.
		Subsea installation	No						
		Operations	Yes		Anasuria FPSO PPC permit				
		Decommissioning	No						
4	Increased fuel usage as a result of the 2 new production wells and water injection well coming online at Anasuria FPSO.	Drilling	No	Emissions of CO2, CH4, CO, VOCs, SOx, NOx and particles of carbon (soot) may contribute to global warming, acid precipitation, ozone depletion and deterioration of local air quality. Possible transboundary issues.	Demonstration of BAT/energy optimisation. Quantitative comparison with alternative tie-back options for overall greenhouse gas emissions inc. installation of pipelines (Installations + Operations)	No	Yes	Scoped In	Small increase, not likely to be significant in terms of EIA but expected to be inclued.
		Subsea installation	No						
		Operations	Yes						
		Decommissioning	No						
5	Increased fuel usage as a result of the 2 new wells coming online by increasing frequency of tanker loading operations(including oil to tanker but exluding the tanker transportation). Increased power demand and fuel usage as result of cargo offloading will be included in output of Topsides FEED.	Drilling	No	Emissions of CO2, CH4, CO, VOCs, SOx, NOx and particles of carbon (soot) may contribute to global warming, acid precipitation, ozone depletion and deterioration of local air quality. Possible transboundary issues.		No	Yes	Scoped In	Small increase, not likely to be significant in terms of EIA but expected to be inclued.
		Subsea installation	No						
		Operations	Yes		Demonstration of BAT/energy optimisation.				
		Decommissioning	No						
6	Increase in operational flaring of excess hydrocarbons (e.g. for pressure relief and gas disposal/testing) at Anasuria FPSO as a result of 2 new wells production.	Drilling	No	Emissions of CO2, CH4, CO, VOCs, SOx, NOx and particles of carbon (soot) may contribute to global warming, acid precipitation, ozone depletion and deterioration of local air quality. Dense particles may contaminate seawater. Possible transboundary issues.		No	No	Scoped in	Small increase, not likely to be significant in terms of EIA ut expected to be included.
		Subsea installation	No						
		Operations	Yes		Venting management plan Flare Consent Demonstration of BAT The length of flaring will be limited as far as is practicable to reduce the requirement to flare.				
		Decommissioning	No						
7	Increase in venting rate of unburnt hydrocarbons (e.g. tank & process vents) predicted at Anasuria FPSO as a result of 2 new wells production.	Drilling	No	Emissions of VOCs and CH4 may contribute to global warming (unburned VOCs and methane have a high global warming potential), formation of localised photochemical smog, and deterioration of local air quality.		No	No	Scoped in	Small increase, not likely to be significant in terms of EIA but expected to be included
		Subsea installation	No						
		Operations	Yes		Venting management plan Flare Consent Demonstration of BAT The length of flaring will be limited as far as is practicable to reduce the requirement to flare.				
		Decommissioning	No						

ID	Project aspect	Project stage relevance?		Description of potential effects	Mitigation	Potentially significant in EIA terms?	Stakeholder expectation to assess in ES?	Take forward further in EIA?	Justification for Scoping Decision
Noise									
1	Installation of piles for the manifold and Teal West valve skid.	Drilling	Yes	Disturbances to the marine mammals and fish may occur within a range of tens of kms. Potential injury to fauna by short range exposure (tens of metres).	Limit the duration of the noise emitting activities (all).	Unsure	No	Scoped In	It is unsure if the piling activities could result in an impact deemed to be significant in terms of EIA. Therefore an assessment of the potential impacts will need to be considered in the ES.
		Subsea installation	Yes		Adoption of JNCC measures for minimising disturbance from any piling activities, where soft-start approach required or use of marine mammal observers (MMO).				
		Operations	No						
		Decommissioning	Yes		Guidance and best practice at time of decommissioning will be followed.				
2	Vertical Seismic Profiling at Teal West using seismic airgun array	Drilling	yes	Disturbances to the marine mammals and fish may occur within a range of tens of kms. Potential injury to fauna by short range exposure (tens of metres).	sorft start procedures, JNCC guidelines will be adhered to and MMO/PAM deployed for pre shooting searches..	Unsure	Yes	Scoped in	It is unsure if the VSP activities could result in an impact deemed to be significant in terms of EIA. Therefore an assessment of the potential impacts will need to be considered in the ES.
		Subsea installation	no						
		Operations	no						
		Decommissioning	no						
3	Noise emissions from installation, jetting (TBC), trenching, rock-placement, drilling rig and vessel activities (including operations).	Drilling	Yes	Disturbances to the animal communities may occur within a range of hundreds of metres. Potential disturbance to fauna (e.g. birds and cetaceans) by short range exposure (tens of metres).	Limit the duration of the noise emitting activities (all). Vessel audits (all). No explosives to be used.	No	No	Scoped out	
		Subsea installation	Yes		Procedures in place if UXO discovered.				
		Operations	Yes						
		Decommissioning	Yes		Guidance and best practice at time of decommissioning will be followed.				

ID	Project aspect	Project stage relevance?		Description of potential effects	Mitigation	Potentially significant in EIA terms?	Stakeholder expectation to assess in ES?	Take forward further in EIA?	Justification for Scoping Decision
Waste									
1	Routine generation and disposal of all waste streams.	Drilling	Yes	Disposal to land of inert waste materials.	Project waste management plan, use of licensed waste contractors/sites, waste transfer notes/ Garbage Record Book/ maceration of food/ Skip audit carried out by waste Contractor/ Monthly waste report.	No	No	Scoped Out	Through the implementation of mitigation measures, including waste management plans the impacts are not expected to be significant in terms of EIA not are they expected by stakeholders to be included in an ES.
		Subsea installation	Yes		Project waste management plan, use of licensed waste contractors/sites, waste transfer notes/Monthly waste report.				
		Operations	Yes		Skip audit carried out by waste Contractor/ Monthly waste report.				
		Decommissioning	Yes		Project waste management plan, use of licensed waste contractors/sites, waste transfer notes/ Monthly waste report.				
2	Routine generation and disposal of special/ hazardous wastes, e.g. oily rags, medical waste, solvents, batteries, computers, fluorescent tubes, oil/grease/chemical cans/drums/sacks, contaminated produced sand, contaminated cuttings, pigging waste, and halons.	Drilling	Yes	Disposal to land of special/ hazardous waste materials.	Project waste management plan, use of licensed waste contractors/sites, waste consignment notes Skip and ship of OBM managed through AHUK EMS/existing contractors/ Monthly waste report.	No	No	Scoped Out	Through the implementation of mitigation measures, including waste management plans the impacts are not expected to be significant in terms of EIA not are they expected by stakeholders to be included in an ES.
		Subsea installation	Yes		Project waste management plan, use of licensed waste contractors/sites, waste consignment notes/ Monthly waste report.				
		Operations	Yes		Modifications to Anasuria FPSO waste management plan (if required).				
		Decommissioning	Yes		Project waste management plan, use of licensed waste contractors/sites, waste consignment notes/ Monthly waste report				
3	Routine generation and disposal of wastes for recycling, e.g. paper, card, toner cartridges, fluorescent tubes, wood and clean metal drums.	Drilling	Yes	Recycling activities.	Project waste management plan, use of licensed waste contractors/sites, waste transfer notes/ Garbage Record Book/ maceration of food/ Skip audit carried out by waste Contractor/ Monthly waste report.	No	No	Scoped Out	Through the implementation of mitigation measures, including waste management plans the impacts are not expected to be significant in terms of EIA not are they expected by stakeholders to be included in an ES.
		Subsea installation	Yes		Project waste management plan, use of licensed waste contractors/sites, waste transfer notes/ Monthly waste report.				
		Operations	Yes		Modifications to Anasuria FPSO waste management plan (if required)/ Monthly waste report.				
		Decommissioning	Yes		Project waste management plan, use of licensed waste contractors/sites, waste transfer notes/ Monthly waste report.				

4	Routine generation and disposal of radioactive wastes (disposal onshore) (e.g.radiation sources in flare meters).	Drilling	No	Disposal to land of radioactive wastes	Project waste management plan, use of licensed waste contractors/sites, waste consignment notes, further assessment as part of permits to handle such waste/ Monthly waste report.	No	No	Scoped Out	Through the implementation of mitigation measures, including waste management plans the impacts are not expected to be significant in terms of EIA not are they expected by stakeholders to be included in an ES.
		Subsea installation	No		Project waste management plan, use of licensed waste contractors/sites, waste consignment notes, further assessment as part of permits to handle such waste/ Monthly waste report.				
		Operations	No		Modifications to Anasuria FPSO waste management plan (if required), further assessment as part of permits to handle such waste/ Monthly waste report.				
		Decommissioning	Yes		Project waste management plan, use of licensed waste contractors/sites, waste consignment notes, further assessment as part of permits to handle such waste/ Monthly waste report.				

ID	Project aspect	Project stage relevance?		Description of potential effects	Mitigation	Potentially significant in EIA terms?	Stakeholder expectation to assess in ES?	Take forward further in EIA?	Justification for Scoping Decision
Accidental Events									
1	CATASTROPHIC Accidental release/ spill of oil to sea (e.g. spills of crude oil, fuel oil, diesel from e.g. drilling rig and other vessels, lubricating oil, flare dropout, hydraulic oil, base oil, cable oil, produced water spills over 100 mg/l, well blowout, loss of pipeline containment). Spills caused by e.g. collision, mechanical failure (e.g. hose failure during tanker offload), loss of well control, human error, corrosion & erosion etc. Well blow out modelling scenario might be sufficient for oil spill modelling as the pipeline is relatively short i.e. Pipeline release modelling may not be necessary however this needs discussed with the regulator.	Drilling	Yes	Larger spills may contaminate/pollute surrounding water and cause disturbance to the aquatic ecosystem and other users / communities. Impact on seabird populations and protected habitats and species (e.g. mammals). Potential shoreline impact and associated environmental concerns. Possible transboundary impacts.	Primary Well control Blowout preventer Drilling Rig TOOPEP and Anasuria OPEP [TBC], including modelling and appropriate response planning. Safety Case Verification Scheme (SECE) Bridging Document Regular & documented kick drills. Maintenance procedures (all). Environmentally critical equipment is identified in the maintenance system and inspected regularly.	Yes	Yes	Scoped In	Potentially significant in EIA terms and expectation from regulator.
		Subsea installation	Yes		SOPEP, Anasuria OPEP, Safety Case, SIMOPS.				
		Operations	Yes		Existing Anasuria OPEP and procedures, including modelling and appropriate response planning. New modelling for Teal West Development undertaken to inform MEIs and EIA. SSIV. SIMOPS.				
		Decommissioning	Yes		SOPEP, Anasuria OPEP, Safety Case, SIMOPS.				

2	SMALL SCALE Accidental release/ spill of oil to sea.	Drilling	Yes	Sources are the two wells, and drilling and installation diesel bunkering. Smaller spills may cause localised, short-term contamination of seawater and limited damage to the aquatic ecosystem.	Rig drain system will be closed loop Procedures will be put in place for bunker transfer, other bulk storage transfers and mud-handling in order to reduce the risk of release. Bulk handling procedures and personnel training (all) Fail safe valves will be installed on hoses (all) Maintenance procedures (all) Vessels will be selected which comply with IMO/MCA codes for prevention of oil pollution (all) Pre-mobilisation audits will be carried out including a comprehensive review of spill prevention procedures (all) Preferred operational procedures to be in place onboard vessels including use of drip trays under valves, use of pumps to decant lubricating oils, use of lockable valves on storage tanks and drums (all) SOPEP (all) Management of ECE (all) Drilling Rig TOOPEP (all) Anasuria OPEP [TBC] (all) Environmentally critical equipment is identified in the maintenance system and inspected regularly.	No	No	Scoped Out	The small volumes being considered and the proposed mitigation control measures, likelihood is expected to be very low, and this is not expected to result in any significant impact. The Industry and AHUK has effective management controls in place therefore impacts are not expected to be significant in terms of EIA not are they expected by stakeholders to be included in an ES.
		Subsea installation	Yes						
		Topsides modifications	Yes						
		Operations	Yes		Anasuria OPEP and procedures, including modelling and appropriate response planning. Oil spill modelling for Teal West Development to be undertaken to inform MEIs and EIA				
		Decommissioning	Yes						

3	Accidental release/ spill of chemicals to sea.	Drilling	Yes	Additional chemicals could include drilling chemicals and OBM from the drilling rig, vessels and those stored on the Anasuria FPSO. Chemicals released to sea may cause contamination of seawater and disturbance to aquatic ecosystem.	Chemical storage areas contained to prevent accidental release of chemicals (all). Maintenance procedures (all). Pre-mobilisation audits will be carried out including a comprehensive review of spill prevention procedures (all) Chemical Permit - Recording daily usage and release of all permitted chemicals (all). Reporting to BEIS using Chemical permit OCR or/and PON1 (all)	No	No	Scoped Out	The small volumes being considered and the proposed mitigation control measures, likelihood is expected to be very low, and this is not expected to result in any significant impact. The Industry and AHUK has effective management controls in place therefore impacts are not expected to be significant in terms of EIA not are they expected by stakeholders to be included in an ES.
		Subsea installation	Yes						
		Operations	Yes		Anasuria OPEP and procedures, including modelling and appropriate response planning. Oil spill modelling for Teal West Development to be undertaken to inform MEIs and EIA.				
		Decommissioning	Yes						
4	Accidental dropping of objects overboard into the sea.	Drilling	Yes	Interaction with seabed (direct or indirect) and other sea users (e.g. exclusion, snag risk).	Installation and SIMOPS procedures will be in place to reduce the potential for dropped objects (all). Training and awareness will be provided to installation contractors (all). Lift planning will be undertaken to manage risks during lifting activities, including the consideration of prevailing environmental conditions and the use of specialist equipment where appropriate (all). All lifting equipment will be tested and certified (all). Procedures will be put in place to make sure that the location of any lost material is recorded and that significant objects are recovered where practicable (all). Debris clearance surveys will be carried out at appropriate points through the Project life-cycle (including following the completion of drilling activities) and reported to	No	No	Scoped Out	The Industry has effective management controls in place for dropping objects. The impacts are not expected to be significant in terms of EIA not are they expected by stakeholders to be included in an ES.

					BEIS using PON 2 notification (all).				
		Subsea installation	Yes		Dropped object protection - lines trenched and buried, manifold protection and trees protection.				
		Operations	Yes		Dropped object protection - lines trenched and buried, manifold protection and trees protection.				
		Decommissioning	Yes						