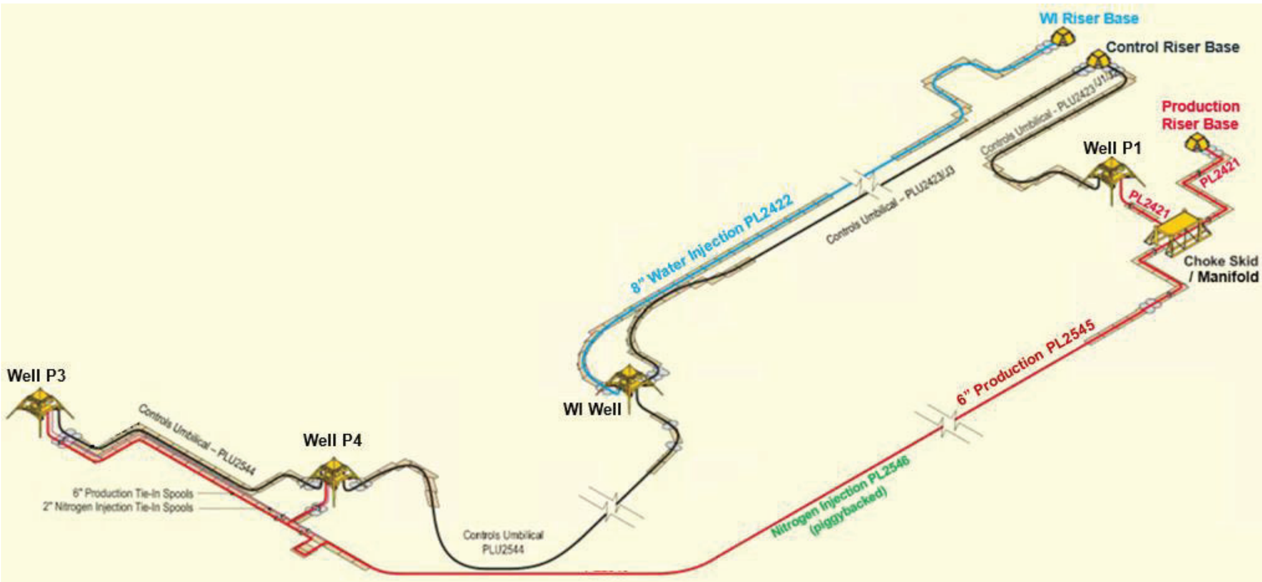
Chestnut Field Phase 2 Decommissioning Environmental Appraisal



SPIRIT ENERGY

Document Control

Document ID:		CHESDC-GEN-S-0000-REP-0001	
Document Classification:		PUBLIC	
Document Ownership:		Decommissioning	
Date of Document:	13 / 01 / 23	Signature	Date
Prepared by:	Lucy Dallas Grindall and Martha O' Sullivan (Genesis)	Lucy Dallas Grindall Digitally signed by Lucy Dallas Grindall Date: 2023.01.13 16:17:59 Z	13 / 01 / 2023
Reviewed by:	John Lynch	DocuSigned by: John Lynch 1D7972211A83400...	13 / 01 / 2023
Approved by:	John Mitchell	DocuSigned by: John Mitchell CD37CCBF80CC45F...	13 / 01 / 2023

Holds

N/A	

Revision Record

Revision No.	Date of Revision	Reason
A1	30 / 06 / 2022	Issued by Genesis (with holds) for review by Spirit Energy
C1	05/ 09 / 2022	Issued by Genesis for use by Spirit Energy
C2	13 / 01 / 2023	Reissued by Genesis for use by Spirit Energy (incorporating OPRED comments)

SUMMARY INFORMATION SHEET

Project Name:	Chestnut Field Phase 2 Decommissioning Environmental Appraisal	
Block Number:	22 / 2a	
Type of Project:	Decommissioning	
Undertaker:	Spirit Energy North Sea Oil Limited 5th Floor iQ Building 15 Justice Mill Lane Aberdeen AB11 6EQ	
Licensees / Owners:	Spirit Energy North Sea Oil Limited	82.206 %
	Dana Petroleum Bow Valley United Kingdom (BVUK) Limited	17.794 %
Short Description:	This document considers the environmental and socio-economic impact of the activities associated with the decommissioning of the Chestnut field in the Central North Sea (CNS). The field was produced via three production wells and supported by one water injection well. All wells were tied back to the Hummingbird Spirit Floating Production Storage and Offloading (FPSO). The field is now in the decommissioning phase, with Cessation of Production (CoP) being formally accepted by the North Sea Transition Authority (NSTA) in November 2021. Production from the field ceased in March 2022. The Hummingbird Spirit FPSO departed from the field in June 2022. Infrastructure at the Chestnut field comprises a number of flowlines and umbilicals that are trenched and buried along most of their length, with surface laid tie-in spools and umbilical jumpers; subsea installations and associated features; and protection and stabilisation features (mattresses, grout bags, and rock deposits) that are mostly surface laid, however, some are fully or partially buried. All surface laid flowlines and umbilicals will be fully removed. In line with the results of a Comparative Assessment (CA), the trenched and buried flowlines and umbilicals will be decommissioned *in situ* with the exposed end sections remediated. All exposed / partially exposed mattresses and grout bags will be removed and recovered as long as it is safe to do so. Protection and stabilisation features that are buried will be decommissioned *in situ*. Existing rock deposits will be decommissioned *in situ*. The impact assessment presented in this Environmental Appraisal (EA) determined that there are no significant environmental or socio-economic impacts associated with the proposed decommissioning activities.	
Company Document Reference No.	CHESDC-GEN-S-0000-REP-0001	
EA Prepared by:	Spirit Energy and Genesis Energies.	

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NON-TECHNICAL SUMMARY

The Chestnut field is located in Block 22 / 2a in the Central North Sea (CNS), *c*. 193 km from Aberdeen and *c*. 34 km from the UK / Norway jurisdictional median line. As operator, Spirit Energy has prepared this Environmental Appraisal (EA) under the Petroleum Act 1998, in support of the draft Decommissioning Programme (DP) that is being submitted to the Offshore Petroleum Regulator for Environment and Decommissioning (OPRED) to seek approval for the decommissioning of the remaining flowlines and infrastructure associated with the Chestnut field (Phase 2 of decommissioning activities at the field). This follows the disconnection and sailaway of the Hummingbird Spirit Floating Production Storage and Offloading (FPSO) and associated riser systems in June 2022 (Phase 1 of decommissioning activities at the field).

Background Information

The Chestnut field was discovered in 1986 and first oil was achieved in 2008. The development comprises three production wells supported by one water injection well. Before its disconnection and sailaway, all of the wells were tied back to the Hummingbird Spirit FPSO, as shown in Figure 1.

The Chestnut pipeline system comprises two production flowlines, one of which has a piggy-backed nitrogen injection flowline; one water injection flowline; two services umbilicals; and a number of associated tie-in spools and umbilical jumpers. The lines are generally trenched and buried along most of their length, with surface laid tie-in spools and umbilical jumpers being surface laid.

The Chestnut wells are currently inactive, and the water injection well has already been decommissioned. The flowlines and umbilicals have been flushed and cleaned to reduce the hydrocarbons to 'as low as reasonably practicable' and are currently filled with seawater. All flowlines are disconnected at the ends and open to the surrounding environment.

The Chestnut field is now in the decommissioning phase, with Cessation of Production (CoP) being formally accepted by the North Sea Transition Authority (NSTA) in November 2021. Production from the field ceased in March 2022.

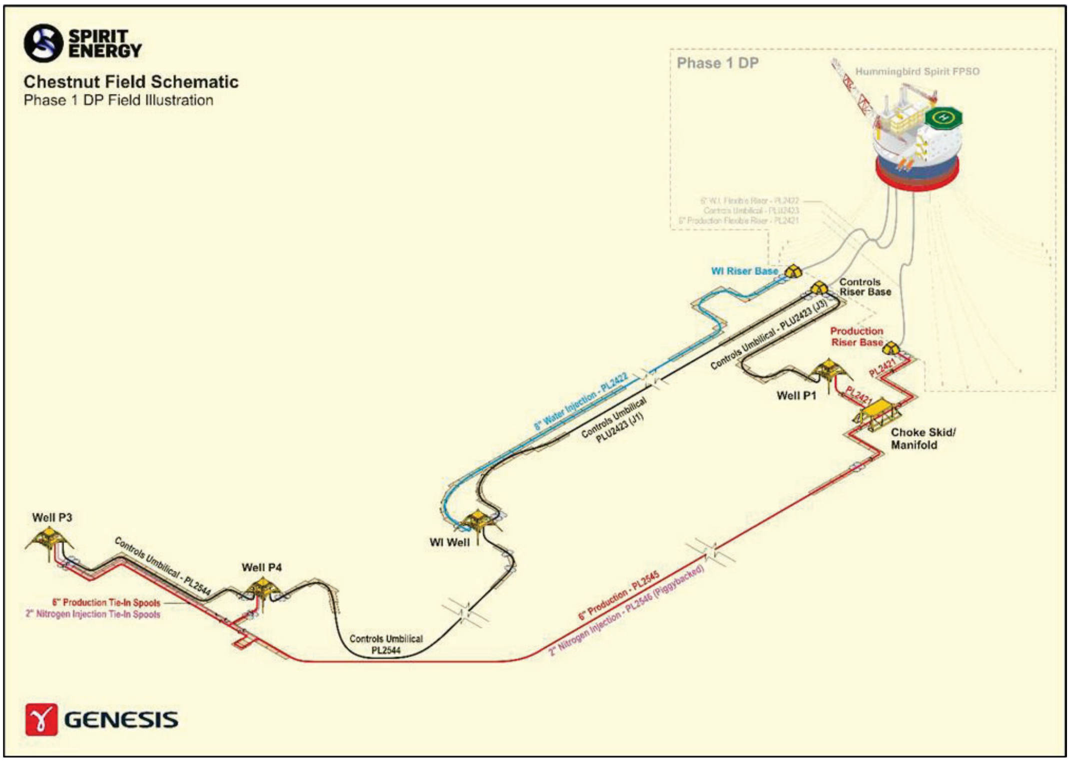

Figure 1: Schematic of the Chestnut field depicting infrastructure to be decommissioned.

Stakeholder Engagement

Informal responses received to date from stakeholders have been incorporated into the DP. Formal stakeholder consultation will begin with the submission of the DP, supported by this EA report, to OPRED. The consultation process, at this stage, will include the use of the Spirit Energy website to make these documents publicly available.

Decommissioning Activities

All subsea infrastructure and associated features, surface laid flowlines and umbilicals, pipeline-related structures and any exposed mattresses and grout bags (25 kg and 1 te) will be fully removed and recovered. A Comparative Assessment (CA) was carried out to determine the best method of decommissioning the flowlines and umbilicals associated with the Chestnut field, as well as some protection and stabilisation features deposited in 2010 to remediate a free span on the water injection flowline PL2422. The trenched and buried flowlines and umbilicals will be decommissioned *in situ* with the exposed ends remediated by back-filling excavated material, or by adding additional rock deposits, to prevent potential snagging by fishing gear.

In line with the results of a CA, the protection and stabilisation features associated with the free span on flowline PL2422 will be decommissioned *in situ* as they are not considered a snag hazard due to being partially buried. However, Spirit Energy are committed to carrying out future surveys to confirm this buried status. Should any of the protection and stabilisation features be found to be a snagging hazard, they will be removed, and rock cover will be added to ensure a safe seabed.

The total quantity of rock that will potentially be required for remediation activities across the Chestnut field is *c*. 2,857 te. Existing rock deposits will be decommissioned *in situ*.

Following recovery and remediation activities, Spirit Energy will get independent verification of a safe seabed. Preference will be given to methods not resulting in seabed disturbance e.g., side scan sonar surveys, however if deemed necessary over-trawl trials will be commissioned.

Environmental and Socio-Economic Baseline

Spirit Energy commissioned a pre-decommissioning environmental survey at the Chestnut field in 2022.

Water depths vary from *c.* 116.4 m to *c*. 126.4 m at the Chestnut field, with an average depth of around 120 m. The sediment types across the area comprise muddy sand with varying proportions of shell fragments and represent the habitat type ‘deep circalittoral mud’/ ‘offshore circalittoral mud’.

Sea pens and megafauna burrows were identified across the survey area and further investigation concluded that the sensitive habitat ‘sea pen and burrowing megafauna communities’ was widespread across the area. Juveniles of the Scottish Priority Marine Feature (PMF) *Arctica islandica* occurred at all but three sample stations, but no adult specimens were observed either in samples or on the seabed. No other sensitive habitats were identified.

No drill cuttings piles are present at the Chestnut field.

Plankton, benthic and fish species in the area are typical of the CNS. Of the fish species known to occur in the area, anglerfish, blue whiting, cod, herring, horse mackerel, ling, mackerel, Norway pout, sandeel, spurdog (spiny dogfish), and whiting are Scottish PMFs.

Minke whale, white-beaked dolphin, Atlantic white-sided dolphin, and harbour porpoise are among the cetacean species recorded in the area. All cetaceans in UK waters are European Protected Species (EPS) such that it is an offence to deliberately disturb, capture, injure or kill any of these species. Harbour porpoise is also protected under Annex II of the Habitats Directive.

A number of seabird species are known to occur in the area including (but not limited to) northern gannet, black-legged kittiwake, little auk, common guillemot, and Atlantic puffin.

Fishing gear types associated with the area are primarily demersal gear, such as seine nets and trawl gear. Available fishing effort and landings data suggests the area is of relatively low importance to the UK fishing industry.

Relative to other areas within the United Kingdom Continental Shelf (UKCS) shipping activity is considered low in Block 22 / 2.

The Chestnut field is situated in an area of the North Sea that is well-developed with oil and gas infrastructure. There are no offshore windfarm developments or military exercise areas within the vicinity of the Chestnut field.

Impact Assessment

In order to determine the significance of the impact of the proposed decommissioning activities, an ENVironmental Issues IDentification (ENVID) workshop was undertaken. Receptors considered included: air quality, climate, water quality, sediment quality, plankton, benthic communities, fish, marine mammals, seabirds, designated areas, resource availability (landfill and fuel), fisheries, and shipping.

The impacts associated with physical presence, resource use, atmospheric emissions, sound and vibration, seabed disturbance, discharges (and small releases) to sea, large releases to sea, and waste production were considered for each of the receptors.

Applying the industry standard mitigation measures (see Table 1), the severity of impact of each of the planned activities was considered to be 'low' such that any environmental and socio-economic impacts are considered to be negligible. Following scoping of the ENVID results, a further assessment was carried out on:

1. The impacts of the potential seabed disturbance associated with the proposed activities, and
2. The legacy impacts associated with decommissioning the buried flowlines and umbilicals, some protection and stabilisation features, and the surface laid rock deposits *in situ*.

In both cases the results of this further assessment aligned with the initial results of the ENVID workshop and concluded that, with the application of industry standard mitigation measures, the severity of impact is low with respect to seabed disturbance and legacy impacts (both environmental and socio-economic).

Environmental Management

The Chestnut Decommissioning Project will be aligned to Spirit Energy's goal to minimise the impact to the environment.

Atmospheric emissions will be managed by inspection of the vessels contracted to carry out the work and by planning vessel schedules to ensure efficient operations.

The inventory of decommissioned items will distinguish equipment that can be reused, materials that can be recycled and waste for appropriate disposal. Waste management activities will be conducted in full compliance with all relevant legislation and regulatory controls. Disposal to landfill will be the waste management option of last resort.

Following the decommissioning activities, independent verification of the seabed state will be obtained, and evidence of a safe seabed will be provided to all relevant governmental and non-governmental organisations. A post-decommissioning environmental survey will be carried out following decommissioning activities to establish the condition in which the seabed is left. An ongoing monitoring survey strategy will be agreed with OPRED, the aim of which will be to verify recovery of the seabed and that all flowlines, umbilicals, and stabilisation features decommissioned *in situ* remain buried and do not present a risk of snagging to other users of the sea.

Stringent control measures and operational procedures will be implemented to prevent accidental events involving the release of hydrocarbons or chemicals. Table 1 lists procedural and technical controls and mitigation measures identified by the Project to reduce impacts to a level that is 'as low as reasonably practicable'.

Table 1: Chestnut Decommissioning - Key Control and Mitigation.

Underwater Noise
• A Simultaneous Operations (SIMOPS) plan for vessel activity in the field will be put in place. • Vessel and cutting operations will use standard methods and equipment. No explosives used.
Discharges to Sea
• All contracted vessels will operate in line with International Maritime Organisation (IMO) and International Convention for the Prevention and Pollution from Ships (MARPOL) regulations. • Flowlines and tie-in spools are to be flushed, filled with seawater, and isolated prior to disconnection. • All discharges will be permitted under applicable UK legislation.
Accidental Events
• All contracted vessels will have a Ship-board Oil Pollution Emergency Plan (SOPEP) in place. • A Collision Risk Management Plan will be developed and implemented. • Agreed arrangements in place with oil spill response organisation for mobilising resources in event of a spill. • Existing field Oil Pollution Emergency Plan (OPEP) in place to reduce the likelihood of hydrocarbon release and define spill response in place. • Lifting operations will be planned to manage the risk. • Recovery of any dropped objects will take place. • Vessel contactors will have procedures for fuel bunkering that meet Spirit Energy's standards. • Where practicable, re-fuelling will take place during daylight hours only.
Physical Presence of Infrastructure & Vessels
• All vessels will comply with standard marking conditions and consent to locate conditions. • If required, a specific SIMOPS plan for vessel activity in the field will be put in place, noting that a standard Diving Support Vessel (DSV) SIMOPS Guideline already exists for the asset. • All seabed infrastructure will be fully protected on the seabed in the interim period between Phase 1 & 2 decommissioning. • Should full seabed clearance of the FPSO 500 m zone not be completed, means of protection will be provided by Spirit Energy. This is explained in the DP for Phase 1. • Small quantities of rock may be required where exposed flowline ends remain after severance at existing deposited rock. • Seabed clearance certificate issued if an over trawl survey is carried out, otherwise survey findings will be described in the close out report.
Atmospheric Emissions & Energy Use
• Time vessels spend in the field will be optimised, with a SIMOPS plan in place. • Reuse or recycling of materials will be the preferential option.
Waste
• Onshore treatment will take place at waste management site with appropriate permits and licenses. • UK waste disposal sites will be used where practicable.
Seabed Disturbance
• Activities which may lead to seabed disturbance planned, managed, and implemented in such a way that disturbance is minimised. A Marine License will be in place for any planned operational disturbance. • Mechanical backfill of the excavated areas, but should any difficulties be encountered, as a contingency small quantity of deposited rock may be deposited over the remaining cut flowline ends but no remedial seabed levelling of flowline corridors. • Deposited rock will be used to remediate the excavations for the Well P1 Wellhead Protection Structure (WHPS) piles. • Deposited rock will be used to remediate any excavations or removal of concrete mattresses associated with free span in PL2422 between KP0.677 and KP0.701. • Debris survey undertaken on completion of the activities and where possible resultant debris will be recovered. • Minimising disturbance to seabed from over trawl through liaison with fishing organisations and regulator.

Conclusion

This EA has assessed the environmental and socio-economic impacts associated with the proposed Chestnut decommissioning activities in the context of the environment within which the field is situated. With implementation of the proposed mitigation measures, the environmental impact of the decommissioning activities is likely to be minimal and the proposed decommissioning activities will leave the area in a condition suitable for re-colonisation by local species and safe for fishermen.

In addition, the EA has considered the objectives and marine planning policies of the Scottish National Marine Plan across the range of policy topics including biodiversity, natural heritage, cumulative impacts and oil and gas. Spirit Energy considers that the proposed decommissioning activities are in broad alignment with such objectives and policies.

ACRONYMS AND ABBREVIATIONS

Acronym	Description
%	Percent
‰	Parts per thousand
°	Degree
°C	Degrees Celsius
“	Inch
<	Less than
£	Great British Pound
µg / g	Micro gram per gram
µM	Micro meter
BAT	Best Available Techniques
BEIS	(Department of) Business, Energy and Industrial Strategy
BEP	Best Environmental Practice
BVUK	Bow Valley United Kingdom
c.	Circa
CA	Comparative Assessment
cm	Centimetres
CNS	Central North Sea
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
COLREGS	International Regulations for the Prevention of Collisions at Sea
CSV	Construction Support Vessel
DP	Decommissioning Programme
DSV	Diving Support Vessel
DWCM	Diamond Wire Cutting Machine
E	East
EA	Environmental Appraisal
EBS	Environmental Baseline Survey
EEA	European Environment Agency
EET	Ecological Effects Threshold
EEMS	Environmental Emissions and Monitoring System
EIA	Environmental Impact Assessment
EMODnet	European Marine Observation and Data Network
ENVID	ENVironmental issues IDentification
EPS	European Protected Species
ERL	Effects Range Low

Acronym	Description
ESAS	European Seabirds at Sea
EU	European Union
EUNIS	European Nature Information System
EPR	Ethylene Propylene Rubber
FeAST	Feature Activity Sensitivity Tool
FPSO	Floating Production Storage and Offloading
GEN	National Marine Plan General Policies
GHG	Greenhouse Gas
GWP	Global Warming Potential
H	Height
HSE	Health and Safety Executive
HSES	Health, Safety, Environment, and Social Economics
IAMMWG	Inter-Agency Marine Mammal Working Group
ICES	International Council for the Exploration of the Sea
IPCC	Intergovernmental Panel on Climate Change
IMO	International Maritime Organisation
INTOG	Offshore Wind Innovation and Targeted Oil and Gas Decarbonisation
IoP	Institute of Petroleum
JNCC	Joint Nature Conservation Committee
kg	kilogram
km	kilometre
km^2	Kilometre squared
KP	Kilometre Point
kW / m	Kilowatt per metre
L	Length
LAT	Lowest Astronomical Tide
LTOBM	Low Toxicity Oil Based Mud
MARPOL	The International Convention for the Prevention of Pollution from Ships
MDAC	Methane Derived Authigenic Carbonates
MDPE	Medium-density Polyethylene
mg / l	Milligram per litre
m^3	Metre cubed
m^2	Metre squared
m	Metre
mm	Millimetre
MPA	Marine Protected Area
m / s	Metre per second
MSFD	Marine Strategy Framework Directive

Acronym	Description
MSV	Multi Support Vessel
MU	Management Units
ng / g	Nanogram per gram
N	North
N / A	Not Applicable
NCMPA	Nature Conservation Marine Protected Area
NIR	National Inventory Report
nm	Nautical miles
nm	Nanometre
NMPi	National Marine Plan Interactive
NMP	National Marine Plan
NORM	Naturally Occurring Radioactive Materials
NOx	Nitrogen oxides
NSTA	North Sea Transition Authority (formerly OGA)
OBM	Oil Based Mud
OGA	Oil and Gas Authority (now NSTA)
OEUK	Offshore Energies UK
OPEP	Oil Pollution Emergency Plan
OPRED	Offshore Petroleum Regulator for Environment and Decommissioning
OSPAR Convention	The Convention for the Protection of the Marine Environment of the North-East Atlantic
P1, P2, P3, P4	Chestnut production well identifiers
PAH	Polycyclic Aromatic Hydrocarbons
PL	Pipeline
PMF	Priority Marine Feature
POP	Persistent Organic Pollutants
PON2	Petroleum Operations Notice 2
PSD	Particle Size Distribution
PWA	Pipeline Works Authorisation
RB	Riser Base
ROV	Remotely Operated Vehicle
SAC	Special Area of Conservation
SACFOR	Superabundant, Abundant, Common, Frequent, Occasional, Rare
SCANS	Small Cetacean Abundance in the North Sea
SCOS	Special Committee on Seals
SDU	Subsea Distribution Unit
SIMOPS	Simultaneous Operations
SMP	Sectorial Marine Plan

Acronym	Description
SO_x	Sulphur Oxides
SOPEP	Ship-board Oil Pollution Emergency Plan
SOSI	Seabird Oil Sensitivity Index
SPA	Special Protection Area
Sp.	Species
SUT	Subsea Umbilical Termination
te	Tonne
THC	Total Hydrocarbon Content
UHB	Upheaval Buckling
UK	United Kingdom
UK BAP	United Kingdom Biodiversity Action Plan
UKCS	United Kingdom Continental Shelf
UKOOA	United Kingdom Offshore Operators Association
US EPA	United States Environmental Protection Agency
UNFCCC	United Nations Framework Convention on Climate Change
UV	Ultraviolet
W	Width
WGS84	World Geodetic System
WHPS	Wellhead Protection Structure
WI	Water Injection
WMP	Waste Management Plan
WoW	Waiting on Weather
3LPP	3-Layer Polypropylene

1. INTRODUCTION

The Chestnut field is located in Block 22 / 2a in the CNS, *c.* 193 km from Aberdeen and *c.* 34 km from the UK / Norway jurisdictional median line (Figure 1-1). The field is owned by Spirit Energy North Sea Oil Limited (hereafter referred to as Spirit Energy) and Dana Petroleum (BVUK) Limited (hereafter referred to as Dana Petroleum) and is operated by Spirit Energy. Cessation of Production (CoP) for the Chestnut field was formally accepted by the North Sea Transition Authority (NSTA) in November 2021. Production from the field ceased in March 2022.

The field was produced via three subsea production wells, supported by a single water injection (WI) well, all of which were tied back to the Hummingbird Spirit Floating (FPSO) facility.

The decommissioning of the field is being undertaken across two broad project phases, each with its own Decommissioning Programme (DP) (Figure 1-2). Phase 1 encompasses the disconnection and sailaway of the Hummingbird Spirit FPSO, including the decommissioning of its mooring and riser systems. Phase 2 encompasses the decommissioning of all subsea installations and associated structures, and the decommissioning of the subsea pipeline systems and associated structures, including protection and stabilisation features.

The DP for Phase 1 was approved in August 2021 and sailaway of the Hummingbird FPSO occurred in June 2022 (Spirit Energy, 2022a).

Spirit Energy has prepared this Environmental Appraisal (EA) under the Petroleum Act 1998, in support of the DP that is being submitted to the Offshore Petroleum Regulator for Environment and Decommissioning (OPRED) to seek approval for the Phase 2 DP (Spirit Energy, 2022b).

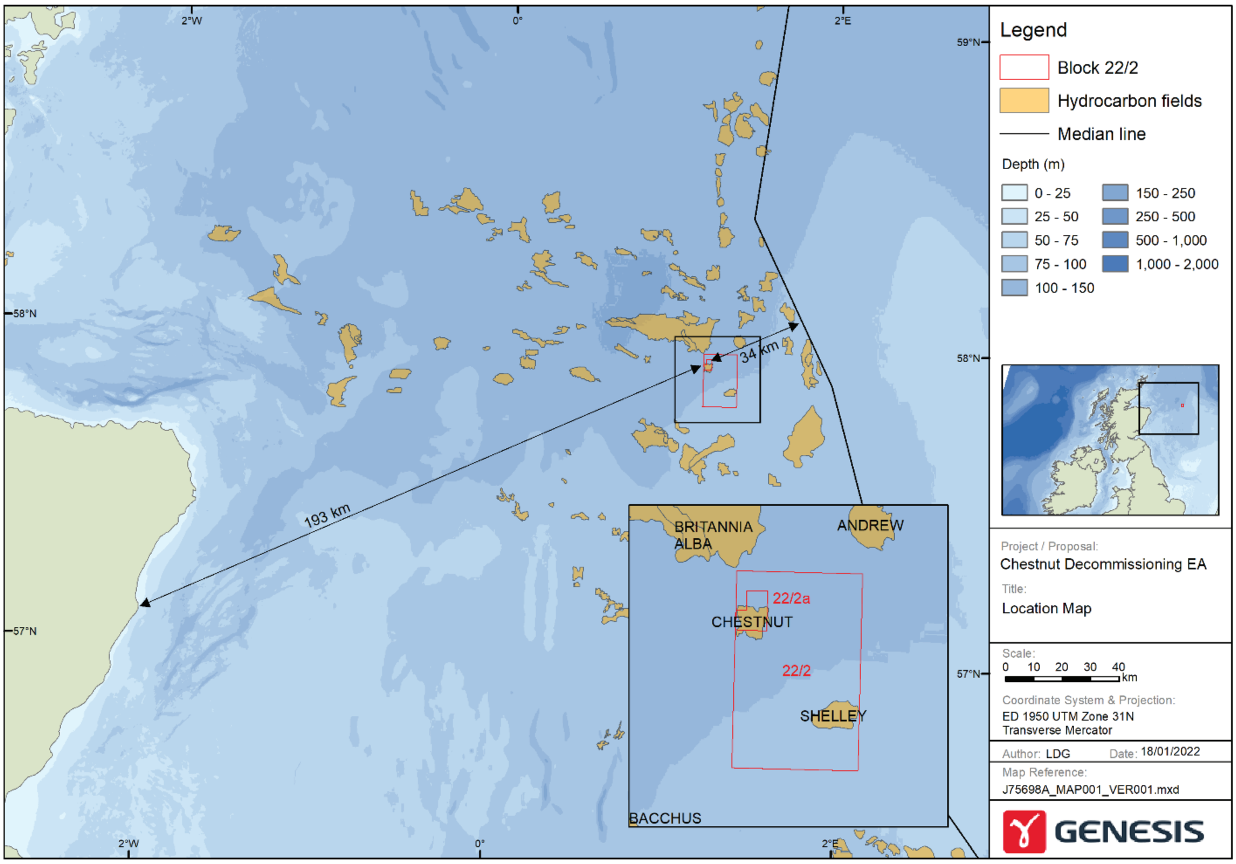

Figure 1-1: Location of the Chestnut field.

1.1 Overview of the Chestnut Field

The Chestnut field was originally discovered in 1986 and first oil was achieved in 2008. The field was produced via three production wells (21 / 2a-11X (P1), 22 / 2a-16Z (P2), 22 / 2a-18 (P3)) and supported by one water injection (WI) well (22 / 2a-12). Two of the production wells (P1 and P2) were drilled before the arrival of the Hummingbird Spirit FPSO. Spirit Energy carried out well construction activities to drill and complete Chestnut P3 well (located 85 m from the existing P2 well) in August 2017 during the Chestnut Infill Well Project, which was implemented to drain the areas of the reservoir. In March 2020, the P2 well was side-tracked to 22 / 2a-19Z (P4) to improve productivity and is now referred to as well P4. The WI well (22 / 2a-12) has previously been decommissioned and side-tracked to water injection well 22 / 2a-17.

The Chestnut pipelines system comprises two production flowlines, one of which has a piggy-backed nitrogen injection flowline; one water injection flowline; two services umbilicals; and a number of associated tie-in spools and umbilical jumpers. The lines are generally trenched and buried along their length, with tie-in spools and umbilical jumpers being surface laid.

A field layout schematic showing the infrastructure associated with Phase 2 decommissioning (that remaining after the completion of Phase 1 decommissioning) is shown in Figure 1-2. It includes:

- Subsea installations and associated structures, including four wellhead protection structures (WHPS);
- Subsea pipeline systems including production and water injection flowlines, services' umbilicals, and tie-in spools and umbilical jumpers;
- Various pipeline-related structures, including three riser bases (one each associated with the production and WI flowlines, and one associated with the control umbilical), and a choke / skid manifold; and
- Pipelines' protection and stabilisation features including concrete mattresses, grout bags (25 kg and 1 te), and deposited rock.

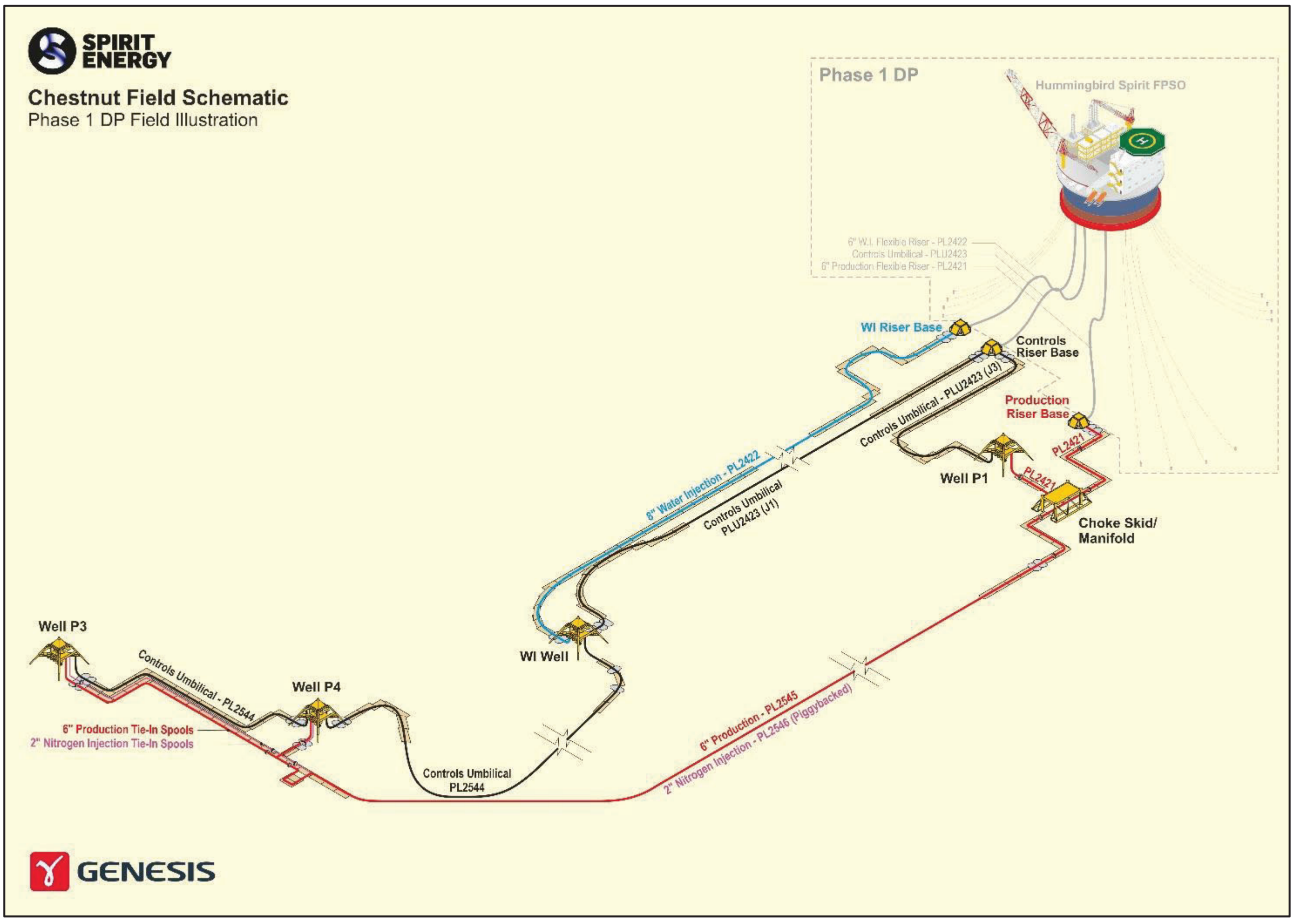

Figure 1-2: Schematic of the Chestnut field depicting infrastructure to be decommissioned.

1.2 Purpose of the Document

The purpose of the EA is to assess and describe, in a proportionate manner, the potential environmental and socio-economic impacts associated with the proposed decommissioning activities, and to identify mitigation measures to reduce the level of these impacts to 'as low as reasonably practicable'.

1.3 Regulatory Context

The UK's international obligations on decommissioning are governed principally by the 1992 Convention for the Protection of the Marine Environment of the North East Atlantic (OSPAR Convention). OSPAR Decision 98 / 3 require that all installations should be completely removed and recovered to shore for re-use, recycling or final disposal unless a derogation is granted. Pipelines and cables are not included within the Decision, however OPRED's decommissioning guidance notes (OPRED, 2018) require that operators aim to achieve a safe seabed and robustly assess decommissioning options, based on evidence and data, using a Comparative Assessment (CA) process.

The decommissioning of offshore oil and gas infrastructure (including pipelines) in the UKCS is principally governed by the Petroleum Act 1998 (as amended by the Energy Act 2008). This Act sets out the requirements for a formal DP, which must be approved by OPRED before the owners of an offshore installation or pipeline may proceed with decommissioning.

There is no statutory requirement to undertake an Environmental Impact Assessment (EIA), but OPRED's decommissioning guidance notes (OPRED, 2018) advise that any DP is supported by an assessment of the environmental impacts of undertaking the decommissioning activities described. This EA has been prepared to meet this requirement.

1.4 Document Layout

Table 1-1 details the structure of the EA Report.

Table 1-1: Structure of the EA Report.

Section Number	Title	Contents
0	Non-Technical Summary	A summary of the EA Report.
1	Introduction	Introduction to the project and scope of the EA. This chapter also includes a summary of applicable legislation.
2	Stakeholder Engagement	Details of the consultation process to date.
3	Project Description	A description of the infrastructure to be decommissioned, the proposed decommissioning activities and an indicative schedule of activities.
4	Comparative Assessment	Summary of the results of the CA carried out for the flowlines, umbilicals, and protection and stabilisation features.
5 and 6	Environmental and Socio-Economic Baseline	A description of the environmental (Section 5) and socio-economic (Section 6) receptors in the area.
7	Scoping of Potential Environmental Impacts	Overview of the method used to determine the environmental and socio-economic impact severity of the proposed decommissioning activities. Results of the ENVID workshop and justification for both selecting, and for not selecting, aspects requiring further assessment. Justification is also provided for those aspects that are assessed further.
8 and 9	Assessment of Aspects	Assessment of seabed disturbance during activities (Section 8) and of legacy impacts (Section 9).
10	Environmental Management	A description of Spirit Energy's Environmental Management Procedures and how they apply to the project.
11	Conclusions	A summary of the key findings of the EA.
12	References	Data sources used to support the EA.
Appendix A:		Impact Assessment Method.

2. STAKEHOLDER ENGAGEMENT

Engagement with stakeholders is an important part of the decommissioning process as it enables the issues and concerns of stakeholders to be incorporated into the EA and presented within the Chestnut Phase 2 DP, where applicable, and acted upon during the subsequent planning and implementation stages of the project.

Informal responses received to date from stakeholders have been incorporated into the DPs. Formal stakeholder consultation will begin with the submission of the DP, supported by this EA report, to OPRED. The consultation process, at this stage, will include the use of the Spirit Energy website to make these documents publicly available.

3. PROJECT DESCRIPTION

This section describes the subsea infrastructure requiring to be decommissioned, and the activities required.

3.1 Chestnut Field Overview

As described in Section 1.1, the Chestnut field was produced via three production wells (21 / 2a-11X (P1), 22 / 2a-16Z (P2), 22 / 2a-18 (P3)) and supported by one WI well (22 / 2a-12). In March 2020, the P2 well was side-tracked to 22 / 2a-19Z (P4) and is now referred to as well P4. The water injection well 22 / 2a-12 has previously been decommissioned and side-tracked to water injection well 22 / 2a-17.

A schematic depicting the layout of the infrastructure requiring to be decommissioned (that remaining after completion of Phase 1 decommissioning) is shown in Figure 3-1.

The Chestnut production flowline system comprises two flowlines (PL2421 and PL2545).

In summary, the 6" production flowline PL2421 is 45 m in length, surface laid, and connects well P1 to the production riser base.

The 6" production flowline PL2545 is 3,747 m in length and runs from the choke skid / manifold to the remaining wells (well P3 and well P4), including the connections between wells and flanges. For the most part this flowline is trenched and buried (3,400 m) to a good depth of cover with up to 347 m surface laid. Some rock cover has been added along the line to achieve the required depth of cover.

A *c.* 3,400 m x 2" nitrogen injection flowline (PL2546) is piggy-backed onto the trenched and buried section of PL2545. On approaches to well P4 and well P3 the nitrogen flowline is no longer piggy-backed on PL2545 and is surface laid (155 m).

An 8" flexible water injection flowline (PL2422) runs between the water injection riser base and the WI well. The main length of this flowline (2,400 m) is trenched and buried with good depth of cover. The tie-in spools connecting the ends of the flowline to the riser base and WI well (total 7 m) are surface laid.

Two services umbilicals (PLU2544 and PLU2423) supplied the hydraulics, chemicals, gas lift and controls to the wells. Note that Pipeline Works Authorisation (PWA) 10-W-07 lists PLU2423, PL2423 / J1, PL2423 / J2 and PL2423 / J3 as being part of the same umbilical, therefore collectively these components have been counted as one line.

PLU2423 runs from the control riser base to well P1 and to the WI well. The umbilical jumpers between the control riser base and well P1 (PLU2423 / J1 and PLU2423 / J2) (167 m) are surface laid and covered by mattresses, and the section between the control riser base and the WI well (PLU2423 / J3) (2,385 m) is trenched and buried with good depth of cover.

PLU2544 runs from the WI well to well P4 and to well P3. The section between the WI well and well P4 (980 m) is trenched and buried with good depth of cover. Surface laid umbilical jumpers connect well P3 and well P4 (130 m). In 2019, the signal and power cores in PLU2544 were disconnected from well P4 and well P3, and left *in situ* under mattress protection. They were replaced by electrical jumpers PL4706 and PL4707 (both *c.*150 m in length and surface laid).

There are also a number of protection and stabilisation features such as concrete mattresses (*c.* 173 total) and grout bags (*c.* 41 (1 te) and 4,982 (25 kg) total) associated with the Chestnut field.

There are no drill cuttings piles present at the Chestnut field (Fugro, 2022a) (Section 3.2.7)..

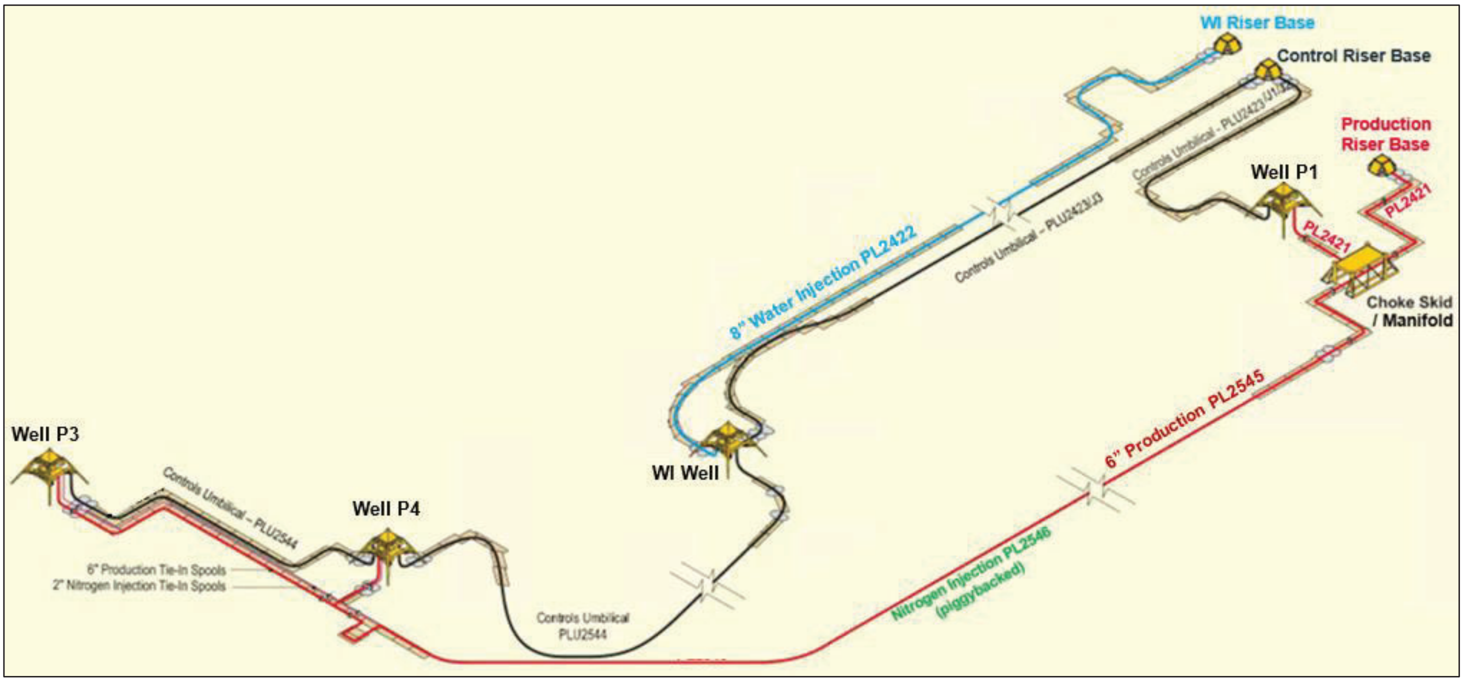

Figure 3-1: Schematic of the Chestnut field depicting the infrastructure requiring to be decommissioned (following Phase 1 decommissioning).

3.2 Proposed Activities

3.2.1 Schedule

Spirit Energy propose to progress decommissioning activities in line with the indicative schedule shown in Figure 3-2.

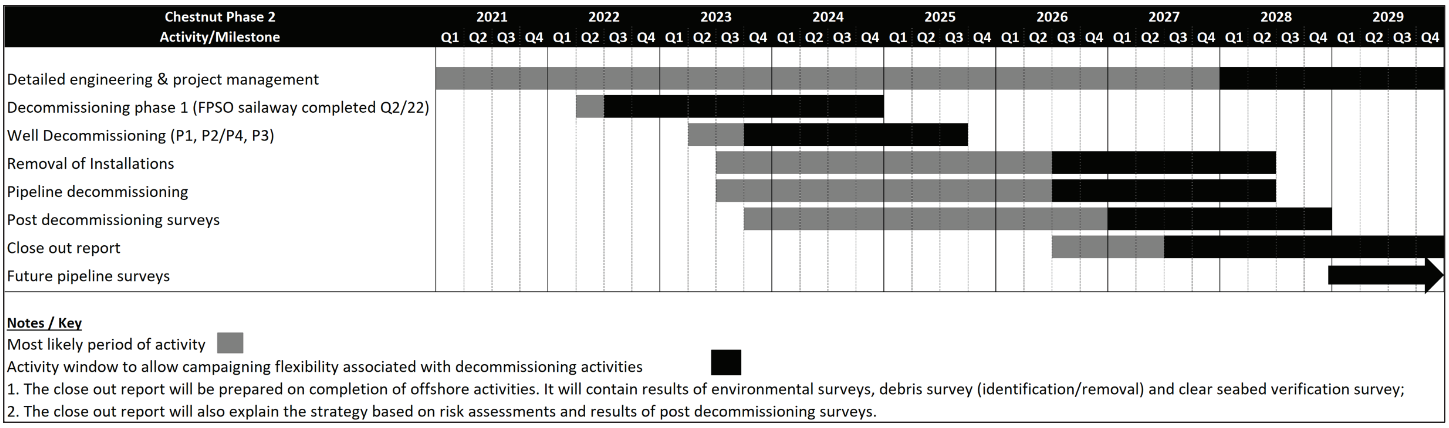

Figure 3-2: Indicative schedule for the Chestnut decommissioning project.

3.2.2 Preparatory Activities

All the production flowlines including associated risers, production flowlines, WI flowlines, and umbilicals were flushed and cleaned as part of the preparatory activities prior to disconnection from the Hummingbird Spirit FPSO. A Best Available Techniques (BAT) / Best Environmental Practice (BEP) approach was taken to minimise hydrocarbon content remaining in the flowlines to a target of 30 mg / l oil in water.

The flowlines are currently filled with seawater. The chemical cores within the umbilicals were flushed and cleaned and filled with seawater, however, cores containing water-based hydraulic fluid were not flushed. As the hydraulic fluid is water-based, leaving these cores unflushed was not considered to result in a significant environmental impact. All flowlines are disconnected at the ends and open to the surrounding environment.

3.2.3 Decommissioning of Wells

All wells will be decommissioned to comply with Health and Safety Executive (HSE) “Offshore Installations and Wells (Design and Construction, etc.) Regulations 1996” and in accordance with the latest version of the Offshore Energies UK (OEUK) Well Decommissioning Guidelines (OEUK, 2018). Decommissioning activities will be carried out using a well intervention vessel or a semi-submersible drilling rig as deemed necessary (Spirit Energy, 2022b).

3.2.4 Decommissioning of Subsea Installations

Table 3-1 summarises the subsea installations and associated structures contained in the DP and includes a WHPS and anode skid associated with each well. All these installations will be fully removed and recovered. All installations, with the exception of the piled well P1 WHPS, will be removed and recovered using a single lift. The piles associated with the well P1 WHPS will be cut at 1 m below seabed. Further details are provided in Section 3.2.4.1.

Table 3-1: Subsea installations at the Chestnut field.

Description	Mass (te)	Dimensions (Length x Width x Height) (m)	Location (WGS84 Decimal Minute)	Comments / Status
Well P1 WHPS	93	16 x 16 x 6.5	57°58.59718 N 1°14.3945 E	Piled structure. 4 “Anchortech” 3 m x 1.5 m steel piles, 15.5 m long (Figure 3-3). Remove and recover to shore.
Well P1 WHPS Anode Skid	0.5	1.8 x 2 x 0.5		No protection frame. Remove and recover to shore.
Well P4 WHPS	58	5.7 x 5.7 x 3.3	57°57.11418 N 1°12.91512 E	Remove and recover to shore.
Well P4 WHPS Anode Skid	0.5	1.8 x 2 x 0.5		No protection frame. Remove and recover to shore.
Well P3 WHPS	58	5.7 x 5.7 x 3.3	57°57.13105 N 1°12.83604 E	Remove and recover to shore.
Well P3 WHPS Anode Skid	0.5	1.8 x 2 x 0.5		No protection frame. Remove and recover to shore.
WI well WHPS	58	5.7 x 5.7 x 3.3	57°57.39742 N 1°13.73262 E	Remove and recover to shore.
WI well WHPS Anode Skid	0.5	1.8 x 2 x 0.5		No protection frame. Remove and recover to shore.

3.2.4.1 Well P1 WHPS

The WHPS for well P1 is a 'standard' WHPS, but it is piled. The four "Anchortech" piles are of an unusual design whereby they are not tubular piles and instead are fabricated from 3.0 m x 10 mm and 1.5 m x 6 mm steel plates that have been welded together, of length 15.4 m. A diagram of the well P1 WHPS and associated piles is provided in Figure 3-3.

Due to their unusual design, the piles are required to be cut from the outside and the seabed will need to be excavated to access the required cut depth. The excavation will need to be made deeper and wider than the cut point to allow access for the cutting equipment and stability of the soil. The base case is that a diamond wire cutting machine (DWCM) will be used, and a clearance of 1 m has been allowed all the way around the pile for this. A photograph of a DWCM cutting through an Anchortech pile is shown in Figure 3-4.

To compromise excavation requirements and minimise impact on the seabed, it is proposed that the piles be cut at a depth of 1 m below seabed, instead of the 3 m below seabed recommended by OPRED's decommissioning guidance notes (OPRED, 2018). The difference in seabed excavation requirements between achieving a cut depth of 1 m below seabed compared to 3 m below seabed is quite significant. Figure 3-5 shows the indicative pile excavation requirements.

The estimated volume of excavation required for a cut depth of 1 m is 272 m^3 per pile (total 1,088 m^3). It is proposed that deposited rock will be used to remediate the excavated area when activities are complete. The quantity of rock required for a cut depth of 1 m would be *c.* 635 te per pile excavation (total *c.* 2,541 te).

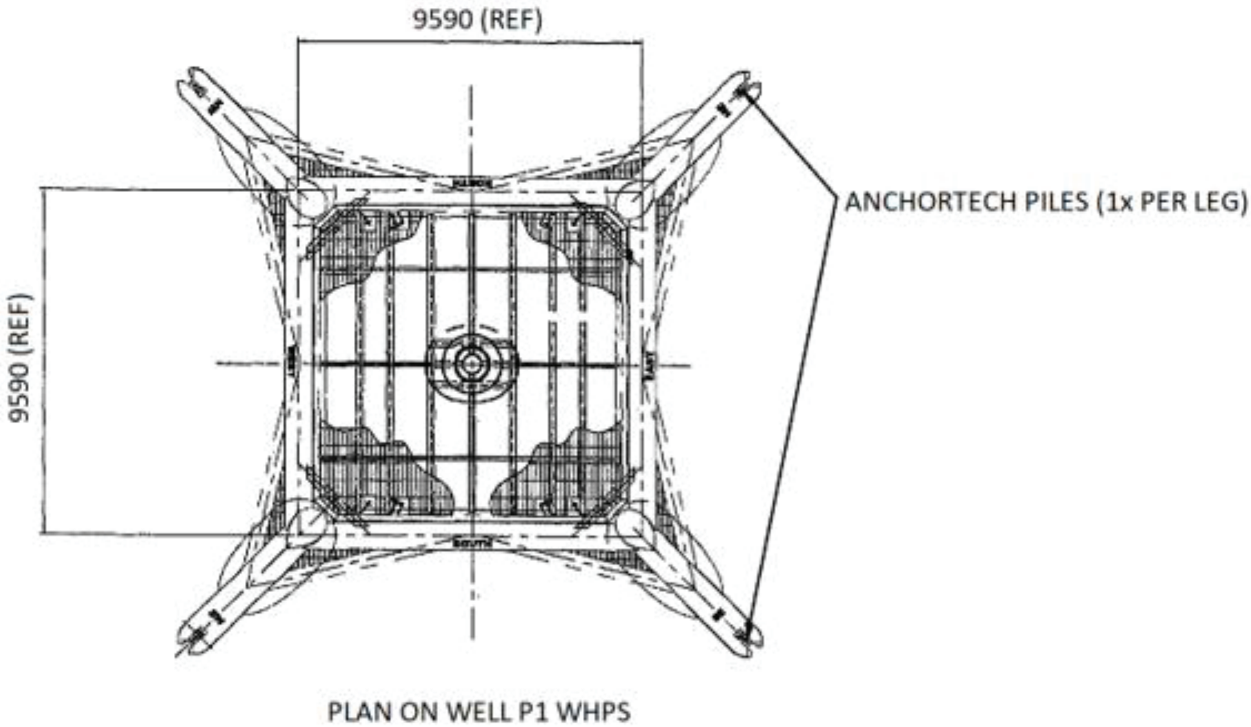

Figure 3-3: Diagram of well P1 WHPS and associated piles.

Figure 3-4: Anchortech pile with the 'Machtech ™' 120" DWCM.

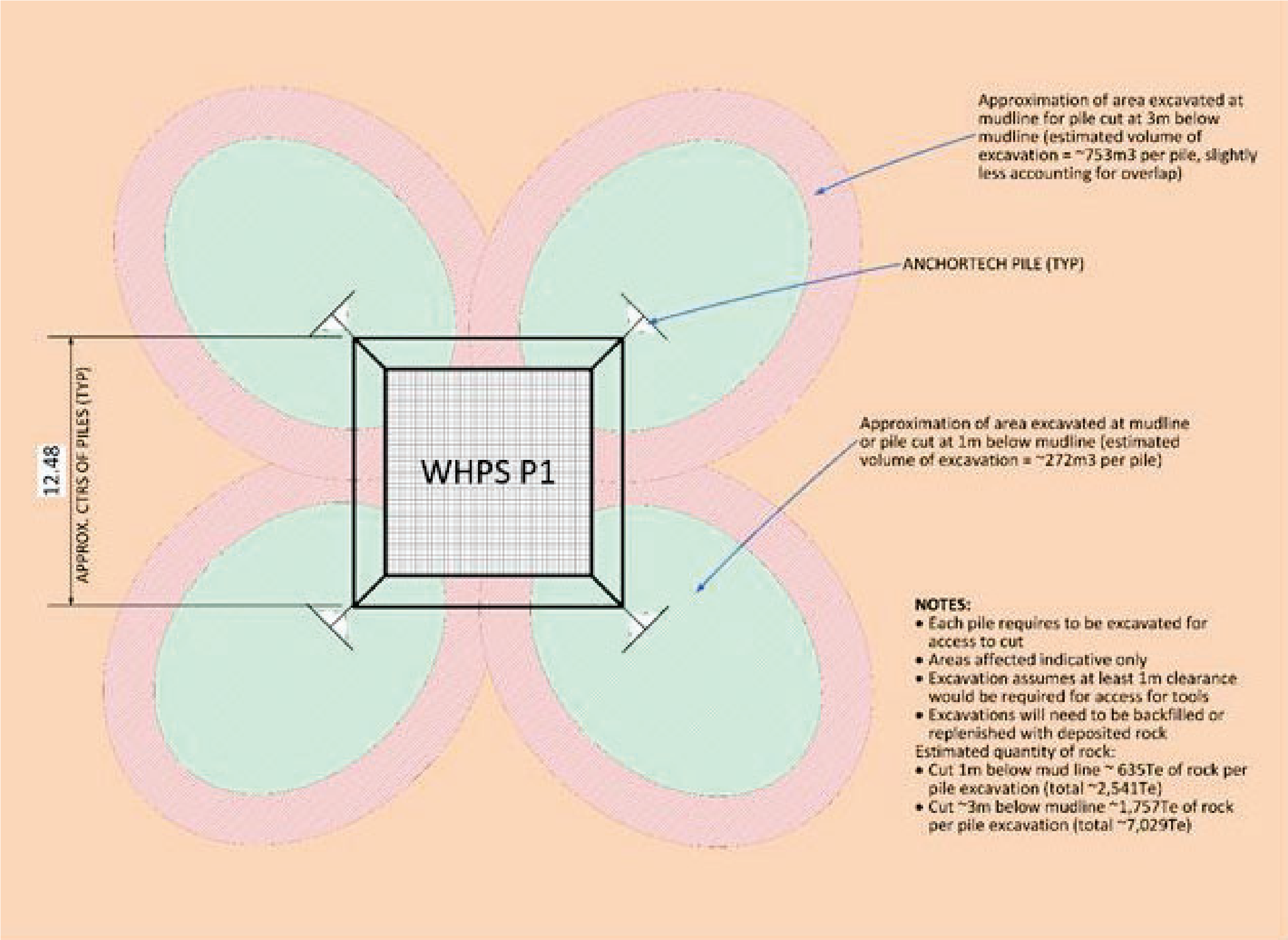

Figure 3-5: Well P1 WHPS indicative pile excavation requirements.

3.2.5 Decommissioning of Flowlines, Umbilicals, Tie-in Spools, Umbilical Jumpers, and Pipeline Related Structures

Table 3-2 summarises the flowlines and umbilicals associated with the Chestnut field (information is taken from Table 2.2.1 of the DP; Spirit Energy, 2022b). The table shows which sections of the flowlines / umbilicals are surface laid and which are trenched and buried, and summarises the fate of the flowlines, umbilicals, tie-in spools and umbilical jumpers.

A CA was carried out to determine the optimal approach to decommissioning the trenched and buried sections of the flowlines and umbilicals. The CA approach and results are detailed in the CA report (Spirit Energy, 2022c) and summarised in Section 4.

The exposed end sections of the flowlines and umbilicals did not require to be considered in the CA as they will be removed and recovered. In addition, the tie-in spools and umbilical jumpers, which are surface laid, will be fully removed and recovered. The total length of lines to be recovered to shore is *c.* 1,151 m.

In line with the results of the CA, the trenched and buried sections of the flowlines and umbilicals will be decommissioned *in situ*. For the most part, the lines exhibit a good depth of burial and stability along their trenched and buried lengths, with a minimum of 0.6 m depth of cover along the entire lengths. The only exception to this is a short, remediated free span section on PL2544.

In 2010, due to it being a potential snagging hazard it was necessary to remediate a free span of *c.* 12 m on PL2422. The free span occurred between KP0.677 and KP0.701 and was mitigated by adding 30 x 1 te grout bags beneath the flowline and four concrete mattresses over the line. Further details (including the selected approach to decommissioning the free span and associated grout bags and mattresses) are provided in Section 3.2.6.

The total length of trenched and buried lines to be decommissioned *in situ* is *c*. 9,165 m, taking account of the fact that the nitrogen injection flowline (PL2546) is piggy-backed onto the trenched and buried section of PL2545, and therefore does not add any additional length.

Following removal and recovery of the exposed line ends, it is proposed that the cut ends of the trenched and buried lines are buried by mechanically backfilling any seabed material that may require to be excavated to allow cutting at a depth of 0.6 m. However, in the event that any difficulties are encountered, small quantities of rock (a total of *c.* 15 te across all locations) may be deposited over the flowline / umbilical ends as a contingency. The EA assesses a worst case whereby it is assumed that rock cover will be added to the cut ends of the lines.

Table 3-2: Flowlines, umbilicals, tie-in spools and umbilical jumpers.

Description	Pipeline Number	Diameter[1]	Length (m)	Description of Component Parts	Product Conveyed	From – To End Points[2]	Current Contents	Burial Status	Recommended Decommissioning Option
Production pipeline system	PL2421	6"	40	Tie-in spools, steel coated with 3LPP	Oil	Well P1 to Production Riser Base (RB)	Seawater	Surface laid	Remove and recover to shore.
	PL2421	8"	5			Mounted on Production RB			
Water injection pipeline system	PL2422	8"	5	Tie-in spools, steel coated with 3LPP	Produced water and de-aerated seawater	Mounted on WI RB	Seawater	Surface laid	Remove and recover to shore.
	PL2422		2,400	Flexible water injection flowline Composite		WI RB to tie-in spools at end of WI flowline		Trenched and buried with good depth of cover	Decommission *in situ*.
	PL2422		2	Tie-in spools, steel coated with 3LPP		End of flexible flowline to WI well		Surface laid	Remove and recover to shore.
Umbilical	PLU2423 / J1	100 mm	85	Hydraulic, chemical, electrical control system umbilical	Nitrogen, hydraulic fluids	Controls RB to production well P1	Seawater, hydraulic fluids, electrical signals and power	Surface laid	Remove and recover to shore.
	PLU2423 / J2	33 mm	82	Electrical control system jumper	Electrical signals	Controls RB to production well P1	N / A	Surface laid	
	PLU2423 / J3	122 mm	2, 385	Hydraulic, chemical, electrical control system umbilical	Chemicals, Methanol, Hydraulic fluids, Electrical signals	Controls RB to WI well	Seawater, hydraulic fluids, electrical signals and power	Trenched and buried with good depth of cover	Decommission *in situ*.
Umbilical[7]	PLU2544	153 mm	10	Control and chemical umbilical jumper hoses	Chemicals, Methanol, Hydraulic fluids, Electrical signals and power	WI well to WI well Subsea Umbilical Termination (SUT)	Seawater, hydraulic fluids	Surface laid	Remove and recover to shore.
	PLU2544		980	Control and chemical umbilical		WI well SUT to well P4 SUT		Trenched and buried with good depth of cover	Decommission *in situ*.
	PLU2544		10	Control and chemical umbilical jumper hoses		Well P4 SUT to well P4		Surface laid	Remove and recover to shore.

Description	Pipeline Number	Diameter[1]	Length (m)	Description of Component Parts	Product Conveyed	From – To End Points[2]	Current Contents	Burial Status	Recommended Decommissioning Option
	PLU2544		10			Well P4 to Subsea Distribution Unit (SDU)		Surface laid	
	PLU2544		100	Control and chemical umbilical		SDU to well P3		Surface laid	
Production pipeline system	PL2545	6”	130	Tie-in spools, steel coated with 3LPP	Oil	Well P3 to well P3 T-piece flange		Surface laid	
	PL2545		97			Well P3 T-piece flange to well P2 T-piece flange	Seawater		
	PL2545		120			Well P2 to well P2 T-piece flange			
	PL2545		3,400	Production pipeline piggy-backed by PL2546		Well P2 T-piece flange to well P2 choke manifold		Trenched and buried with good depth of cover	Decommission *in situ*.
Nitrogen injection system	PL2546	2”	3,400	Nitrogen injection system piggy-backed onto PL2545	Nitrogen	Well P1 to well P2 T-piece flange	Seawater		
	PL2546		44	Tie-in spools, steel coated with 3LPP		Well P2 to well P2 T-piece flange		Surface laid	Remove and recover to shore.
	PL2546		95			Well P2 T-piece flange to well P3 T-piece flange			
	PL2546		16			Well P3 T-piece flange to well P3			
Electrical jumper	PL4706[6]	28.7 mm	150	Ethylene Propylene Rubber (EPR / Polyurethane	Electrical power and signals	Prod Well P2 SDU to well P3	N / A	Surface laid	Remove and recover to shore.
Electrical jumper	PL4707[7]	28.7 mm	150	E.P.R. / Polyurethane	Electrical power and signals	Prod Well P2 SDU to well P3	N / A	Surface laid	Remove and recover to shore.

Notes:
1. If diameter is expressed in mm it refers to outside diameter of electrical cable or umbilical.
2. For clarity, the description of the from-to-end points may differ slightly from those consented for simplification and to add clarity.

Description	Pipeline Number	Diameter[1]	Length (m)	Description of Component Parts	Product Conveyed	From – To End Points[2]	Current Contents	Burial Status	Recommended Decommissioning Option

3. Note that all pipelines are “out of use”.
4. Decommissioning of the pipeline infrastructure during Phase 1 (e.g., PL2421, PL2422, PLU2423 is addressed in the Hummingbird Spirit Decommissioning Programmes.
5. On PLU2544, two signal and two power cores disconnected at both SDU and at Well P3 ends and left *in situ* under mattress protection.
6. PL4706 replaces the functionality of cores 1 and 3 in PLU2544 between well P4 SDU and Production well P3.
7. PL4707 replaces the functionality of cores 2 and 4 in PLU2544 between well P4 SDU and Production well P3.

3.2.5.1 Pipeline Related Structures

Table 3-3 summarises the pipeline related structures associated with the Chestnut field and includes three riser bases and one choke skid / manifold and protection structure (information is taken from Table 2.3.1 of the DP; Spirit Energy, 2022b). All these structures will be fully removed and recovered using a single lift.

Table 3-3: Pipeline related structures.

Description	Mass (te)	Dimensions (Length x Width x Height) (m)	Location (WGS84 Decimal Minute)	Comments / Status
Production Riser Base	31.5	4.9 x 4.93 x 1.8	57°58.60318 N 1°14.41495 E	Exposed. Remove and recover to shore.
WI Riser Base	31.5	4.9 x 4.93 x 1.8	57°58.59657 N 1°14.30514 E	
Control Riser Base	48.9	6.5 x 6 x 5.35	57°58.62568 N 1°14.35413 E	
Choke Skid / Manifold and Protection Structure	16.7	3 x 3.5 x 3.6	57°58.59013 N 1°14.4051 E	

3.2.5.2 Third Party Crossings

There are no third-party crossings associated with the Chestnut field infrastructure.

3.2.6 Decommissioning of Protection and Stabilisation Features

Protection and stabilisation features associated with the Chestnut field are illustrated in Figure 3-6 and summarised in Table 3-4. Protection and stabilisation features include concrete mattresses (*c.* 173 total) and grout bags (*c.* 41 (1 te) and 4,982 (25 kg) total) and deposited rock (4,635 te).

Table 3-4 also summarises the fate of the protection and stabilisation features. Where technically feasible to do so, all mattresses and 25 kg grout bags will be removed and recovered on the approaches to their destination or termination point. Three concrete mattresses on the south approach to well P1 are buried under deposited rock and will therefore be decommissioned *in situ*. Should it not be possible to remove any other mattresses or grout bags on the approaches, Spirit Energy will consult with OPRED before any alternative option is executed.

In addition to the protection and stabilisation features located at the approaches, there are also 30 1 te grout bags and four concrete mattresses associated with the free span remedial activities carried out on PL2422 (Section 3.2.5 and Figure 3-7). Survey data to date have indicated that the flowline remains buried beneath the mattresses which are also thought to be buried.

The protection and stabilisation features on PL2422 were subject to a CA, as summarised in Section 4 of this EA and detailed in the CA Report (Spirit Energy, 2022c).

In line with the results of the CA, the 30 x 1 te grout bags laid beneath the free span will remain *in situ*. The four mattresses over the line inside the trench are buried except for a short section that covers a buckled section of the flowline and where the mattresses overlap the sides of the trench where they are partly exposed. Therefore, the CA determined that they should be decommissioned *in situ*. However, Spirit Energy are committed to carrying out future surveys to confirm this buried status. Should the four mattresses be found to be a snagging hazard, they will be removed, and rock cover will be added to ensure the *c.* 12 m free span is not a hazard. Depositing rock over the mattresses was not considered as it would result in a higher rock berm than required if the mattresses are removed and recovered.

Rock has previously been laid on PL2545 and PL2546 to mitigate the effects of upheaval buckling (UHB) (the vertical-upwards displacement of a pipeline) and to mitigate any shallow depth of cover at the time of installation. All previously deposited rock will be decommissioned *in situ*.

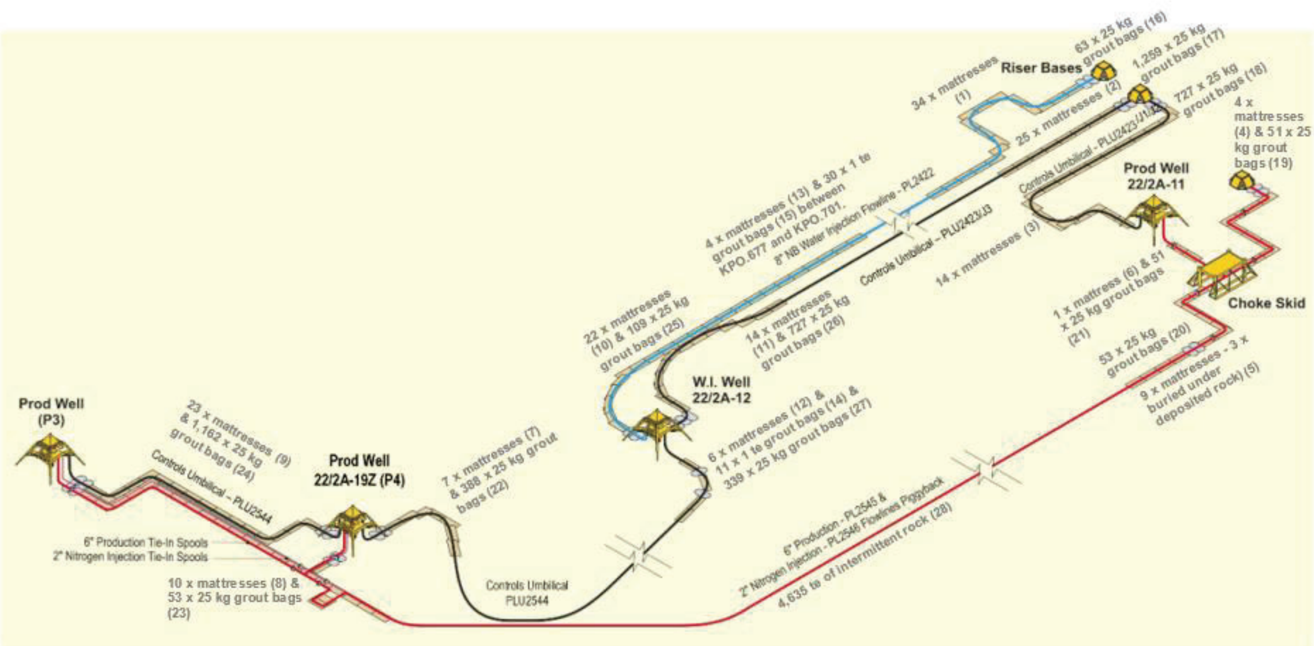

Figure 3-6: Protection and stabilisation features. Numbers in brackets correspond to the number identifiers for each item provided in Table 3-4.

Table 3-4: Protection and stabilisation features associated with the Chestnut field.

Description	Number of Items	Location	Number identifier in Figure 3-6	Burial Status	Recommended Decommissioning Option
Concrete Mattresses 6 m (L) x 3 m (W) x 0.15 m (H) (4.6 te each)	87	PL2422: **34** south of WI riser base	1	Exposed except for three buried under deposited rock.	It is intended to remove and recover all exposed concrete mattresses to shore for re-use, recycling, or disposal. In the event of technical difficulties during execution, OPRED will be consulted.
		PLU2423 / J3: **25** south of control riser base	2		
		PLU2423 / J1, PLU2423 / J2: **14** between controls riser base and well P1	3		
		PL2421: **Four** between production riser base and well P1	4		
		PL2545, PL2546: **Nine** on south approach to well P1, **three** buried under deposited rock	5		
		PL2421(5): **One** between choke valve skid / manifold and Well P1.	6		
	40	PLU2544: **Seven** on north approach to well P4	7		
		PL2545, PL2546: **10** on south approach to well P4	8		
		PLU2544, PL2545, PL2546: **23** on approach to well P3.	9		
	42	PL2422: **22** on north approach to WI well	10		
		PLU2423 / J3: **14** on north approach to WI well	11		
		PLU2544: **Six** on south approach from WI well	12		
	4	PL2422: **Four** between KP0.677 and KP0.701.	13	Inside the trench the mattresses are buried except for a short section that covers a buckled section of the flowline and where the mattresses overlap the sides of the trench where they are partly exposed. Their burial status will be confirmed at the time of decommissioning.	If the concrete mattresses are found to pose a snagging hazard at the time of decommissioning, they will be removed and recovered to shore for re-use and recycling or disposal and replaced with deposited rock (*c*.121 te).
Grout Bags (1 te each)	11[1]	PLU2544: **11** ramp for pipeline at WI well.	14	Exposed but to be confirmed at time of decommissioning.	It is intended that all 1 te grout bags be removed and recovered to shore for re-use, recycling, or disposal. However, in the event of technical difficulties, OPRED will be consulted.

Description	Number of Items	Location	Number identifier in Figure 3-6	Burial Status	Recommended Decommissioning Option
	30[1]	PL2422: **30** between KPO.677 and KPO.689.	15	These are buried, but their burial status will be confirmed at the time of decommissioning.	Leave *in situ*.
Grout Bags (25 kg each)	2,204[1]	PL2422: **63** south of WI riser base	16	Exposed in mattress joints or buried under the mattresses protecting the umbilical(s). To be confirmed at time of decommissioning.	It is intended to remove and recover all exposed 25 kg grout bags to shore for re-use, recycling, or disposal.
		PLU2423 / J3: **1,259** south of control riser base	17		
		PLU2423 / J1, PLU2423 / J2: **727** between control riser base and well P1	18		
		PL2421: **51** between production riser base and well P1	19		
		PL2545, PL2546: **53** on south approach to well P1	20		
		PL2545, PL2546: **51** between choke skid / manifold and well P1	21		
	1,603[1]	PLU2544: **388** on north approach to well P4	22		
		PL2545, PL2546: **53** on south approach to well P4	23		
		PLU2544, PL2545, PL2546: **1,162** on approach to well P3	24		
	1,175[1]	PL2422: **109** on north approach to WI well	25		
		PLU2423: **727** on north approach to WI well	26		
		PLU2544: **339** on south approach from WI well	27		
Deposited Rock	4,635 te total[2]	Intermittent throughout the length of PL2545 and PL2546. Used to mitigate against UHB, and any shallow depth of cover at time of installation.	28	Expected to be predominantly exposed.	Deposited rock will be decommissioned *in situ*.

Notes:
1. Quantity of grout bags is an estimate as the 'as-built' details are not definitive.
2. The quantity of deposited rock is based on 'as-built' installation reports.

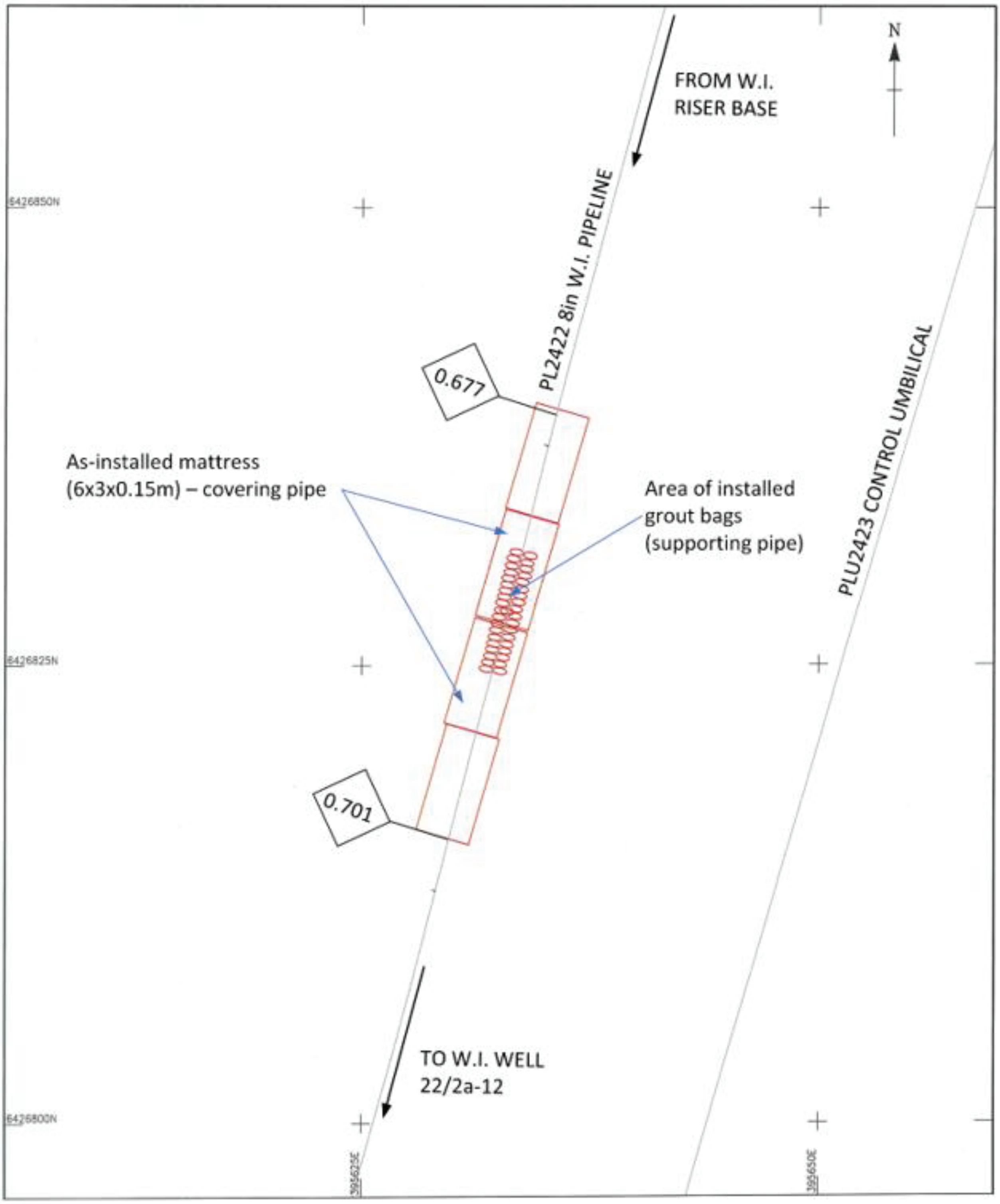

Figure 3-7: Free span rectification protection and stabilisation features on PL2422.

3.2.6.1 Concrete Mattresses

Of the 173 flexible mattresses associated with the Chestnut field, a total of 170 mattresses will be removed and recovered to shore (including worst case whereby the four mattresses laid to mitigate the free span on PL2422 will also be removed and recovered). The three mattresses buried under rock on the approach to well P1 will be decommissioned *in situ*.

The mattresses will be removed and recovered to a vessel either using a grab or will be lifted onto recovery frames, steel cargo nets, or speed loaders while subsea, and then lifted to the surface via vessel crane. Should any individual mattresses be found to be severely degraded and at risk of disintegrating on removal, baskets may be deployed on the seabed for filling by Remotely Operated Vehicle (ROV) or divers.

3.2.6.2 Grout Bags (25 kg)

Where technically feasible to do so, it is proposed to remove and recover all of the 25 kg grout bags to shore for re-use, recycling, or disposal. It is likely these will be placed into baskets for removal to the surface.

3.2.6.3 Grout Bags (1 te)

Where technically feasible to do so, it is proposed to remove and recover 11 exposed 1 te grout bags to shore for re-use, recycling, or disposal. It is likely these will be placed into baskets for removal to the surface.

The 30 x 1 te grout bags associated the free span remedial activities on PL2422 will be decommissioned *in situ.* These are buried, but their burial status will be confirmed at the time of decommissioning.

3.2.6.4 Deposited Rock

All existing deposited rock will be decommissioned *in situ*. Surveys to monitor the burial status of the flowlines, umbilicals and associated protection materials are discussed in Section 3.3.

3.2.7 Drill Cuttings

Cuttings were discharged during the drilling of each well. However, as these wells were drilled after the introduction of OSPAR Decision 2000 / 3, no Oil Based Mud (OBM) was used. The results of the pre-decommissioning environmental survey (Fugro, 2022) indicate that there are no drill cuttings piles present at the Chestnut field.

3.2.8 Vessel Use

A range of specialist and support vessels (Table 3-5) will be required to complete the decommissioning activities, such as a Construction Support Vessel (CSV), a trawler (if used), and a survey vessel. At the time of writing, specific vessels have not yet been selected, however, the types of vessel required are well known and standard performance characteristics for typical vessels have been used for the purposes of estimating energy consumption and emissions to air. By estimating the fuel use based on generic vessel types (Institute of Petroleum (IoP) Guidelines (2000) and industry experience) and the likely duration of the work programme for each vessel, estimates of fuel consumption can be made (Table 3-5). Although the detailed schedule for the workscope is still to be defined, the estimated maximum vessel days have been presented. Including a Waiting on Weather (WoW) allowance, the total number of vessel days associated with the decommissioning activities is *c.* 74.

Table 3-5: Anticipated vessel and fuel use requirements for Chestnut decommissioning activities.

Vessel type	Duration (days)[1]			Fuel consumption rate (te / day)[2]			Total fuel use (te)[3]
	Working	Mobilisation / Demobilisation	In transit	Working	Mobilisation / Demobilisation	In transit	
Subsea decommissioning							
CSV	44	8	2	21.5	1.5	27	1012
Seabed clearance and over-tawl surveys							
Trawler (if used)	12	1	1	4	4	4	56
Post-decommissioning survey							
Survey vessel (assumes seabed sampling and visual surveys full length of lines and within the 500 m safety zones)	4	1	1	14	3	21	80
Maximum anticipated fuel use across all operations							**1068**

[1] Vessel day estimates include a contingency for WoW (10 %).
[2] IoP Guidelines (2000) do not always have exact equivalent vessel: e.g., Multi Support Vessel (MSV) used to represent CSV and Diving Support Vessel (DSV) used to represent survey vessel.
[3] Calculated using Environmental Emissions Monitoring System (EEMS) Atmospheric Emissions Calculations (EEMS, 2008).
Note: Vessel days quoted here are considered to be worst case estimates and include mobilisation, transit and working days. Prior to contract award it is difficult to determine accurately. Final vessel days will be captured in the EIA supporting the Marine Licence to be submitted prior to commencement of offshore activities.

3.3 Post-Decommissioning Survey Programme

A post-decommissioning site survey will be carried out on final completion of all decommissioning activities. Surveys will be undertaken within the three 500 m safety zones associated with the field (located at Chestnut well P1, well P4 and the WI well) and along a 100 m wide corridor (50 m either side) of the length of all flowlines and umbilicals that have been decommissioned *in situ* (Spirit Energy, 2022b). Any significant debris will be removed and recovered for onshore recycling or disposal. Independent verification of the seabed state will be obtained for the flowline areas and installation locations and evidence of a safe seabed will be provided to all relevant governmental and non-governmental organisations. Preference will be given to an approach not impacting on the seabed for example using multibeam sonar or side scan sonar to show a safe seabed. However, if deemed necessary by any of the stakeholders, an over-trawl trial may be carried out. The EA assumes a worst case of an over-trawl trial being carried out.

Inspections of the flowlines, umbilicals, and protection and stabilisation features decommissioned *in situ* will be carried out to confirm that no further exposures develop, and that existing deposited rock has maintained its position. The timeline for inspections will be agreed with OPRED.

A post-decommissioning environmental seabed survey (centred on the sites where subsea infrastructure has been removed and those sections of flowlines and umbilicals where remedial activities are required) will be carried out. The objective of the survey will be to identify any chemical or physical disturbances to the seabed remaining after decommissioning and to provide a baseline from which future surveys can be compared. The survey reports will be submitted to OPRED, and a post-monitoring survey regime will be agreed.

4. COMPARATIVE ASSESSMENT

4.1 Introduction

OPRED's Guidance Notes on the decommissioning of offshore installations and pipelines (OPRED, 2018) provide for a case by case consideration of pipeline decommissioning alternatives on the basis of a CA.

A CA was carried out in line with the OEUK CA Guidelines (OEUK, 2015) to determine the optimal approach for decommissioning the trenched and buried sections of the flowlines and umbilicals. In addition, a CA was carried out to determine the optimal approach for decommissioning of the protection and stabilisation features associated with the remediation of the free span on PL2422. The CA Report (Spirit Energy, 2022c), submitted in support of the DP provides full details of the assessment carried out for the two CAs. This chapter summarises the process followed and the results of the CA.

4.2 Flowlines and Umbilicals

In order to facilitate the CA workshop, and as per standard CA method, the Chestnut flowlines and umbilicals were split into two groups:

- Group 1: Individual pipelines laid and buried in their own trench; and
- Group 2: Pipelines which are piggy-backed and trenched and buried.

The flowline and umbilical groupings were as identified in Table 4-1. The surface laid end sections of the lines will be fully removed and recovered and therefore only the trenched and buried sections of the lines were considered in the CA.

Table 4-1: Flowline and umbilical groupings used for the CA.

Group Identification	Component type / As-laid condition	Flowline / Umbilical
1	Flexible flowline, trenched and buried	PL2422
	Umbilical, trenched and buried	PLU2423 / J3
	Umbilical, trenched and buried	PLU2544
2	Rigid flowlines, piggy-backed; trenched and buried, including rock	PL2545
		PL2546

4.3 Free Span Protection and Stabilisation Features

Spirit Energy also opted to carry out a CA to determine the optimal approach to decommissioning the 30 x 1 te grout bags and four concrete mattresses associated with the free span remedial activities carried out in 2010 on PL2422.

4.4 Decommissioning Options

4.4.1 Flowlines and Umbilicals

Two decommissioning options were considered for each group:

- Complete removal – this would involve the complete removal of the trenched and buried line sections. Once the flowlines and umbilicals have been excavated, reverse reel was considered the most technically feasible approach for Group 1. The 'cut and lift' method was considered to be the most viable solution from a technical perspective for the complete removal of the Group 2 flowlines.
- Leave *in situ* – this would involve leaving the trenched and buried sections of the flowlines and umbilicals *in situ* with no remedial activities, but possibly needing to verify their status via future post-decommissioning surveys.

4.4.2 Free Span Protection and Stabilisation Features

For the protection and stabilisation features used to remediate the free span on PL2422, the following decommissioning options were considered:

- Complete removal – this would involve the complete removal of the grout bags and concrete mattresses, removing the short section of PL2422 (*c*. 12 m long) and replacing the excavated material with deposited rock.
- Partial removal – this would involve removal of the overlying concrete mattresses and replacing them with deposited rock.
- Leave *in situ* – this would involve leaving the grout bags and overlying mattresses *in situ* with no remedial activities.

For each option, the CA assumed that post-decommissioning surveys would be required.

4.5 Comparative Assessment Approach and Results

4.5.1 Flowlines and Umbilicals

For both options considered for each of the groups, an assessment considering five main criteria were considered: technical feasibility, safety related risks, environmental, societal effects, and cost. As detailed in the CA Report (Spirit Energy, 2022c) multiple sub criteria were considered.

The CA process concluded that leave *in situ* is the recommended option for decommissioning the trenched and buried sections of the flowlines and umbilicals in both Groups 1 and 2. Spirit Energy propose to decommission the lines in line with the results of the CA.

4.5.2 Free Span Protection and Stabilisation Features

Given that the 30 x 1 te grout bags are below the level of the seabed and are expected to be buried, the results of the CA indicate that they should be left *in situ*.

The four mattresses over the line inside the trench are buried except for a short section that covers a buckled section of the flowline and where the mattresses overlap the sides of the trench where they are partly exposed. Therefore, the recommendation is that they should be decommissioned *in situ*. However, Spirit Energy are committed to carrying out additional surveys to confirm that the mattresses do not pose a snag hazard. If they are found to be partially exposed and are considered to present a snagging hazard, the partial removal option will be implemented. This option involves removing and recovering the four overlying concrete mattresses to shore and replacing them with deposited rock, ensuring that the section of PL2422 affected (*c*. 12 m long underneath the concrete mattresses) will remain buried. Future surveys will be required to confirm burial status. Though the base case is to decommission the four mattresses in situ, the EA assumes a worst case whereby the mattresses are removed and recovered, and rock cover is added.

5. ENVIRONMENTAL BASELINE

5.1 Introduction

This section describes the environment and the environmental receptors in the vicinity of the Chestnut field and has been prepared with reference to available literature and the results from a pre-decommissioning environmental survey carried out across the field in October 2021 (Fugro, 2022a and Fugro, 2022b).

5.2 Pre-Decommissioning Environmental Survey

As part of the pre-decommissioning survey, a combination of geophysical and acoustic datasets, physical seabed samples and high-definition seabed imagery were acquired. Following acquisition of acoustic data, seabed photography / video was used to ground-truth all key seabed habitats identified in the acoustic data.

A geophysical seabed survey, habitat assessment and an environmental baseline survey (EBS) was carried out at the four existing wells at the Chestnut field. The main objectives of the surveys were:

- Geophysical survey – To identify the presence of any potential sensitive habitats in the area; to identify any seabed objects / debris that may cause an obstruction to the survey; and to identify any indications of drill cuttings discharge around the existing wellheads (Fugro, 2022a).
- Habitat assessment – To identify and quantify any species / features / habitats of conservation importance near to the infrastructure to be decommissioned (Fugro, 2022a).
- EBS – To establish the physico-chemical and biological properties of the sediments across the survey area prior to any decommissioning operations (Fugro, 2022b).

Figure 5-1 shows the location of the completed grab sample stations and transect lines.

In total, 28 sampling stations were proposed. Videos and stills were successfully acquired at 26 stations, a full suite of grab samples obtained at 20 stations, and a partial suite of grab samples (physico-chemical sample only) acquired at one station (WI-SW2). Due to weather and time constraints, samples were not obtained at the remaining stations (Fugro, 2022b).

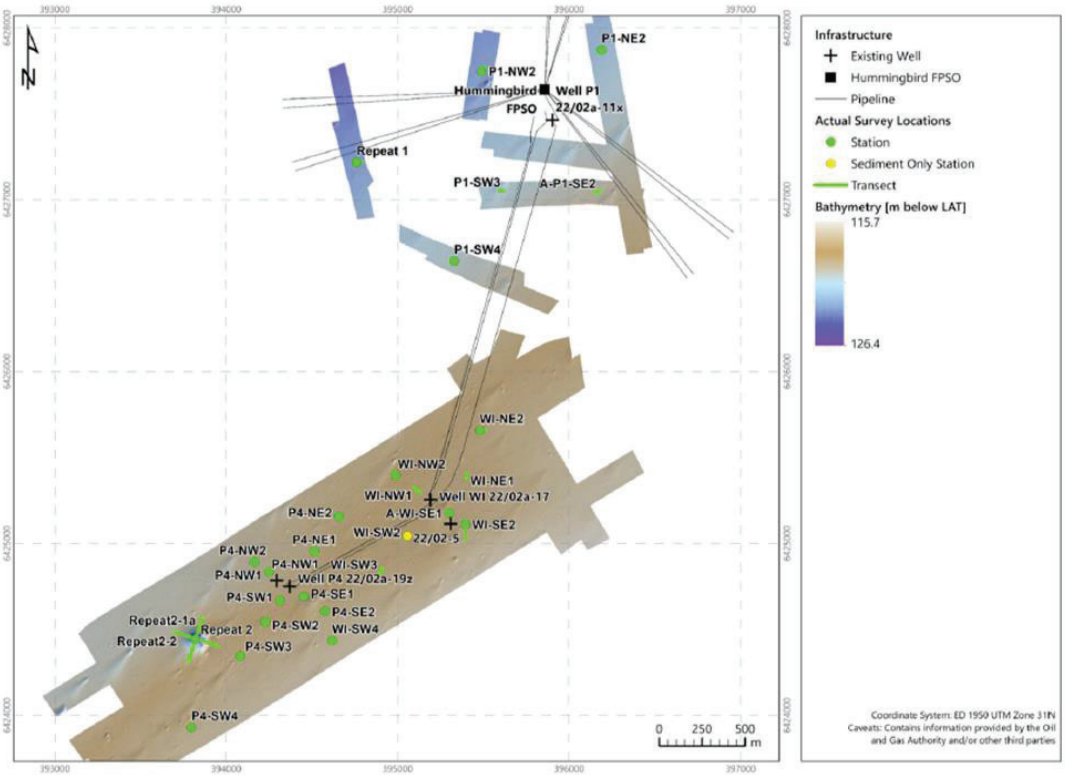

Figure 5-1: Locations of grab sample stations and transect lines completed during pre-decommissioning survey (Fugro, 2022a; Fugro, 2022b).

5.3 Metocean Conditions

Metocean (meteorological and oceanographic) conditions including bathymetry, currents, tides and circulation patterns all influence the type and distribution of marine life and the behaviour of emissions and discharges from offshore facilities. For example, the speed and direction of water currents have a direct effect on the transport, dispersion, and ultimate fate of any discharges from a vessel or installation.

5.3.1 Bathymetry

The seabed in the Chestnut area is relatively flat, deepening slightly in an east-northeast to west-southwest direction. Water depths across the pre-decommissioning survey area ranged from 116.4 m Lowest Astronomical Tide (LAT) to 126.4 m LAT, with an average depth of *c.* 120 m.

The deepest area was found to occur within a pockmark to the west-southwest of the survey area and southeast of well P3 and well P4 (Fugro, 2022b).

5.3.2 Hydrology

Water masses, and local current speeds and direction all influence the transport, dispersion, and fate of marine discharges. The major water masses in the North Sea can be classified as Atlantic water, Scottish coastal water, northern North Sea water, Norwegian water, CNS water, southern North Sea water, Jutland water and Channel water (Turrell *et al.,* 1992).

The Chestnut field is located in the area influenced by the northern North Sea water mass. The predominant regional current in the CNS originates from the vertically well-mixed coastal water and Atlantic water inflow of the Fair Isle / Dooley current, which flows around the north of the Orkney Islands and into the North Sea (Figure 5-2).

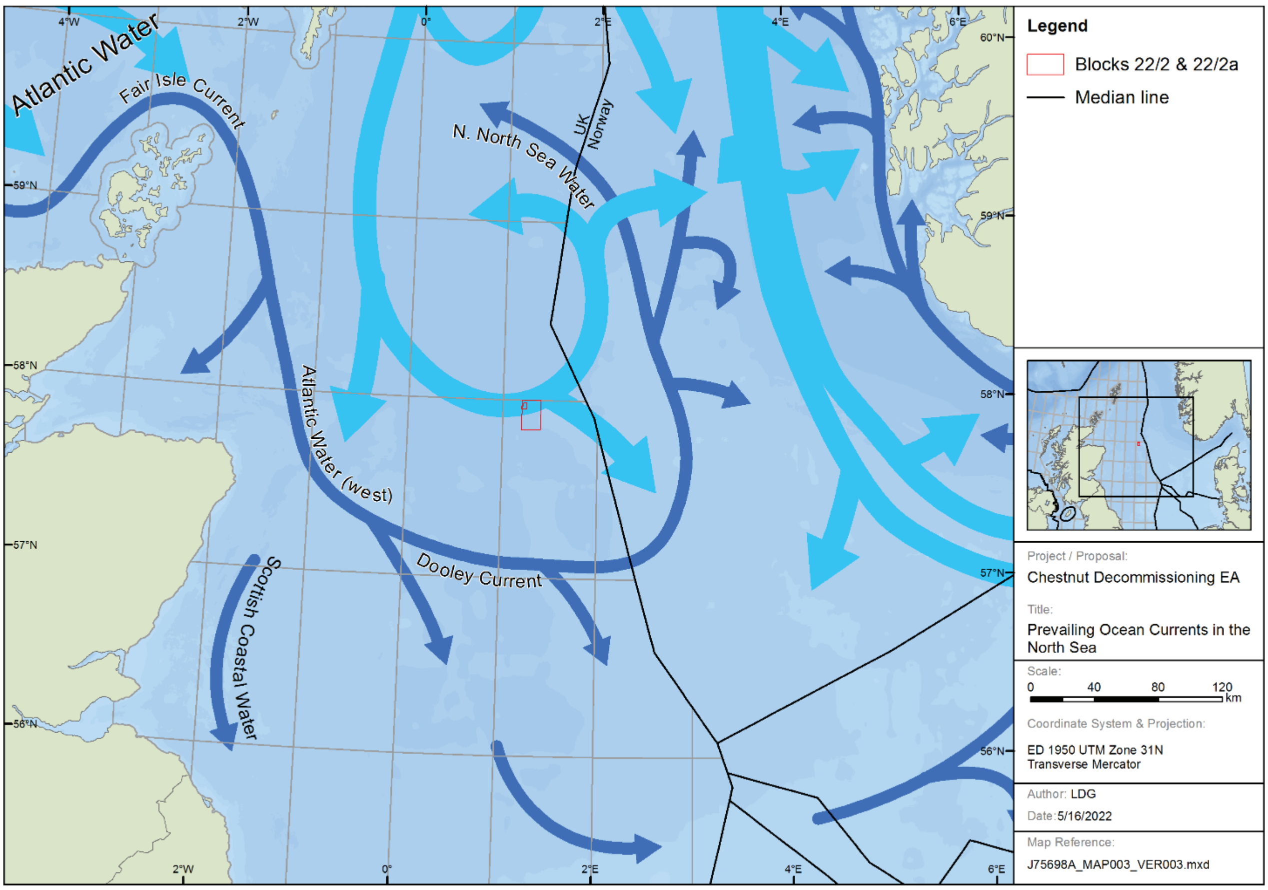

Figure 5-2: General circulation in the North Sea (Turrell *et al.*, 1992).

Mean significant wave height in the Chestnut area is 2.3 m and as can be seen from Figure 5-3 (a), *c.* 35% of the waves originate from a north / northwest direction and *c.* 15% from a south / southwest direction (Data Explorer, 2018).

The mean spring tidal range within the area is 0.1 – 1.0 m and the annual mean wave power is between 24.1 - 30 kW / m (Scottish Government National Marine Plan Interactive (NMPi)).

5.3.3 Meteorology

Wind speed and direction directly influence the transport and dispersion of atmospheric emissions. These factors are also important for the dispersion of water borne emissions, including oil, by affecting the movement, direction and break up of substances on the sea surface. Mean wind speed in the area is 8.8 m / s and as can be seen from Figure 5-1 (b), winds in the area originate from all directions though primarily from the south / southwest / west and northwest (Data Explorer, 2018).

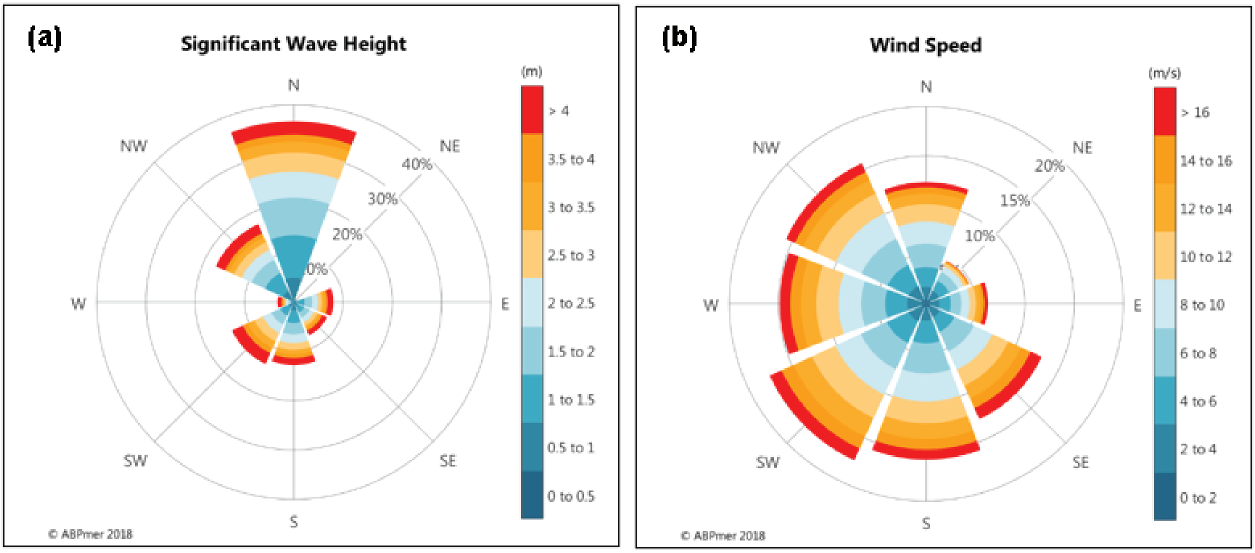

Figure 5-3: Wave rose (a), and wind rose (b) for the Chestnut area (Data Explorer, 2018).

5.3.4 Sea Temperature and Salinity

Sea surface temperature and salinity in the area are governed by the flow of oceanic Atlantic waters into the North Sea through the Fair Isle Channel (Turrell,1992). According to data collected between 1971 and 2000, the annual mean seawater surface temperature in the Chestnut field area is *c.* 9.5 °C and the annual mean temperature near the seabed is *c.* 7 °C (Scottish Government NMPi).

Salinity in the area shows little seasonal variation through the water column, with both annual mean salinity near the seabed and in surface waters *c.* 35 ‰ (Scottish Government NMPi).

5.4 Seabed Sediments

5.4.1 Sediment Characterisation

In the CNS, the sediment is predominantly deep circalittoral sand, with a large area of finer sediments – deep circalittoral mud – in the deeper CNS. Nearshore and in scattered offshore patches there are areas of deep circalittoral coarse sediment (BEIS, 2022a).

The sediment type in the Chestnut area is considered to be typical of the region and appeared largely homogenous with sediment described as muddy sand with varying proportions of shell fragments (Fugro, 2022a; Fugro, 2022b).

Based on the European Marine Observation and Data Network (EMODnet) seabed habitats map (Figure 5-4), Block 22 / 2a is classified as Marine Strategy Framework Directive (MSFD) broad habitat type 'Offshore circalittoral mud' (EMODnet, 2020).

Based on seabed acoustic character, environmental camera visuals and grab samples from the pre-decommissioning survey; the seabed sediments across the Chestnut area were found to consist of clayey silty sand, while localised high reflectivity patches are associated with rock deposits along the existing flowlines and umbilicals within the survey area. Two objects were also identified within the survey area, interpreted as boulders. One boulder (measuring 0.4 m in height) was located 478 m east-south-east of the WI well, and the other (measuring 0.2 m in height) was located 567 m east of well P3 and 648 m east of well P4 (Fugro, 2022a).

Video data across the large pockmark (as described in Section 5.3.1) did not highlight the presence of any methane-derived authigenic carbonates (MDAC) and comprised of similar sediments to the rest of the survey area (Fugro, 2022a).

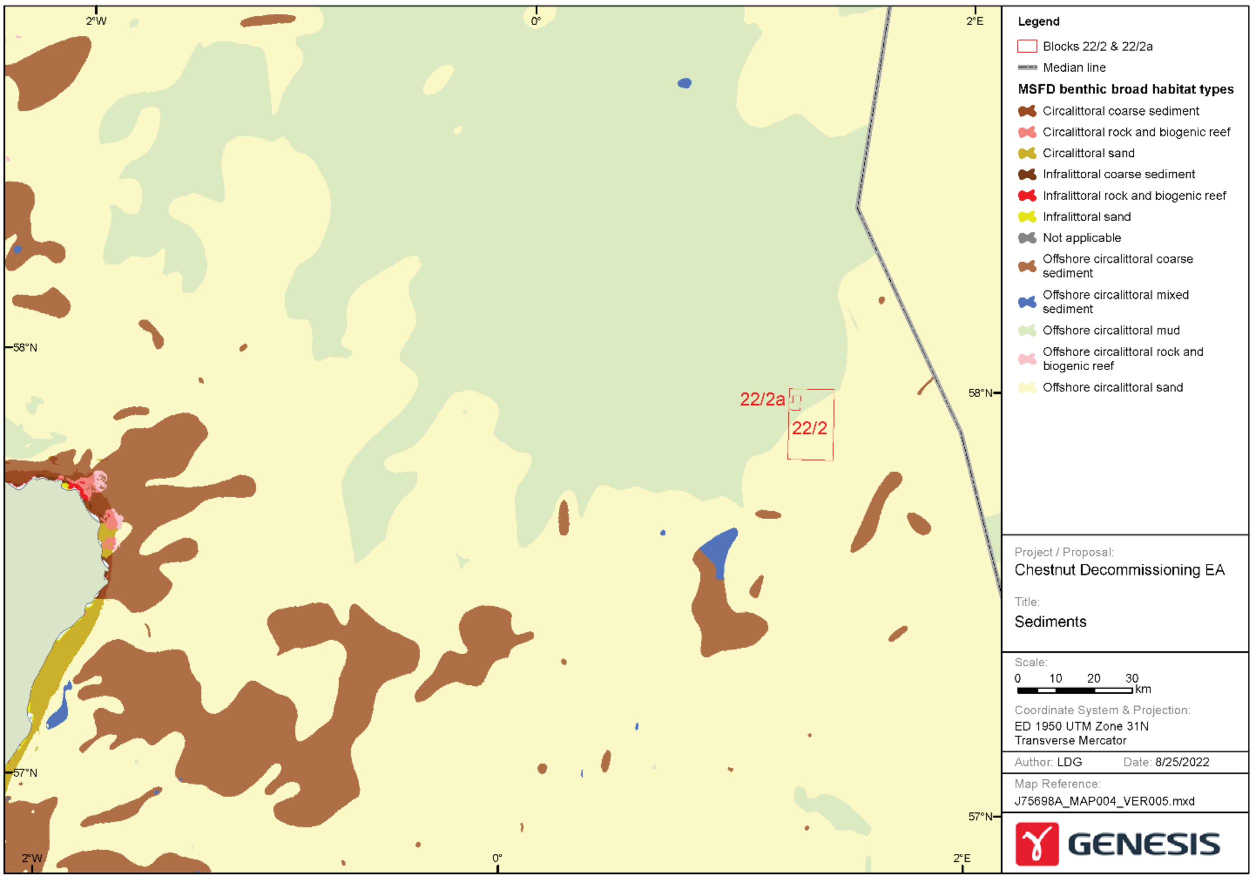

Figure 5-4: North Sea sediment distribution (EMODnet, 2020).

5.4.2 Particle Size Distribution

This section focuses on the results of the analysis of the EBS samples (Fugro, 2022b).

Particle Size Distribution (PSD) analysis of sediment from grab samples confirmed that sand was the dominant fraction across all stations (mean 67.93 %) followed by mud / fines (mean 32.01 %) and a low proportion of gravel (mean 0.06 %) (Figure 5-5). The median particle size ranged from 75 µm to 97 µm (overall median 92 µm) and had a low variability in the proportions of different particle sizes present (Fugro, 2022b).

This corresponds to data from previous surveys in the area (Fugro, 2005; 2009a), which characterised sediments as silty sand. The habitat types associated with this sediment type are discussed in Section 5.5.2

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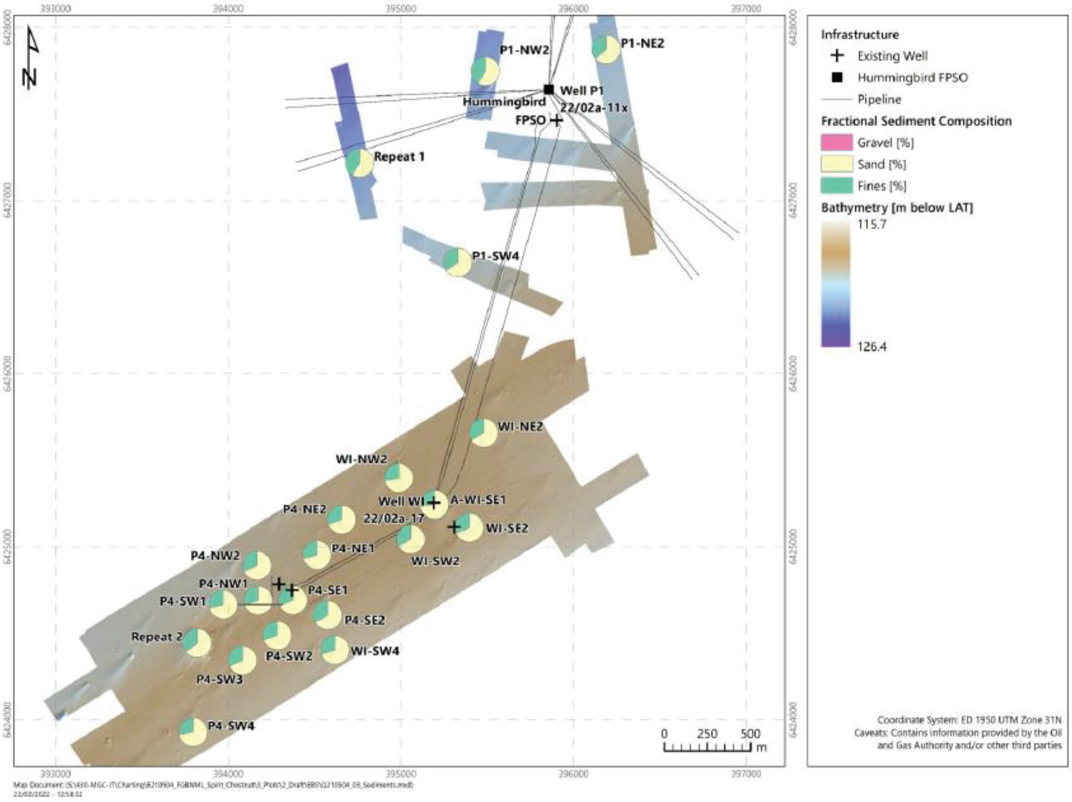


Figure 5-5: Sediment fractional composition overlaid on bathymetry (Fugro, 2022b).

5.4.3 Sediment Hydrocarbons

5.4.3.1 Total Hydrocarbon Concentrations

The Total Hydrocarbon Content (THC) values across the Chestnut survey area ranged from 3.8 µg / g (station P1-NE2) to 65.7 µg / g (station P4-SE2), with a mean of 10.5 µg / g and a median of 6.7 µg / g (Fugro, 2022b).

The highest THC values were recorded at stations located within 250 m from the nearest wellhead (stations A-WI-SE1, WI-SE2, P4-SE1 and P4-SE2). THC values at these stations were above the CNS mean background concentration (9.51 µg / g; UKOOA, 2001). The THC value at one station (P4-SE2) exceeded the ecological effects threshold (EET) of 50 µg / g (OSPAR, 2006).

The higher THC values observed at these stations corresponds with the presence of a 'kerosene like' low toxicity oil-based mud (LTOBM), assumed to be the result of contaminated cuttings historically discharged to the seabed. From the seabed photography data, no cuttings were observed at any of the stations sampled or along either of the transects completed in the survey area.

Beyond 250 m, THC values were broadly comparable to the mean CNS background concentration (9.51 µg / g; UK Offshore Operators Association (UKOOA), 2001) and to previous surveys at the Chestnut field (6.1 µg / g; Fugro, 2005 and 11.0 µg / g; Fugro, 2009).

5.4.3.2 Polycyclic Aromatic Hydrocarbons

Within the Chestnut survey area, the Total 2 to 6 ring Polycyclic Aromatic Hydrocarbon (PAH) concentrations followed the same trend as demonstrated for THC values for all stations except station P4-SE2, indicating that increased sediment PAH concentrations are related to an increase in THC (Fugro, 2022b).

The 2 to 6 ring PAH concentrations recorded in sediment ranged from 0.104 µg / g (station P4-SW1) to 0.264 µg / g (station WI-SE2), with a mean value of 0.168 µg / g and low variability (Fugro, 2022b).

Total 2 to 6 ring PAH concentrations were higher than the CNS mean background concentration (0.233 µg / g; UKOOA, 2001) at one station (station WI-SE2) but were below the 95th percentile value (0.736 µg / g; UKOOA, 2001). The mean total 2 to 6 ring PAH concentration was lower than the mean concentrations recorded during the previous surveys within the area (0.198 µg/g; Fugro, 2005 and 0.393 µg / g; Fugro, 2009) (Fugro, 2022b).

Total United States Environmental Protection Agency (US EPA) 16 PAH concentrations ranged from < 39.3 ng / g (station P4-SW1) to 108 ng / g (station WI-SE2), with a mean of 66.1 ng / g and low variability. All US EPA 16 PAH concentrations were below their respective effects range low (ERL) values where available (Fugro, 2022b).

5.4.4 Heavy Metals

Drilling activities tend to result in increased concentrations of a number of metals in the surrounding seabed.

Sediments collected from the 21 stations across the Chestnut survey area were analysed for selected heavy and trace metals: aluminium, arsenic, barium, cadmium, chromium, copper, iron, lead, lithium, manganese, mercury, nickel, strontium, vanadium and zinc.

The majority of sediment metals concentrations recorded across the Chestnut survey area were below their respective ERL values. However, the ERL value was exceeded for chromium at three stations (P4- SW4, WI-SW4 and P4-SE2) and mercury at one station (P1-SW4).

As fine sediment is known to be a natural environmental sink for metals, it is likely that the high metal concentrations at these stations is related to the natural sediment characteristics of the survey area and not due to oil and gas development activities.

Sediments which exceed ERL values have a higher risk of adverse effects on macrofaunal communities, however, no negative correlations were observed between either chromium or mercury concentrations at the Chestnut field and macrofaunal diversity indices (Fugro, 2022b).

5.5 Marine Flora and Fauna

5.5.1 Plankton

The plankton community in the waters around the Chestnut field is similar to that found over the wider CNS area. The phytoplankton community is dominated by the dinoflagellate genus *Tripos (T. fusus, T. furca, T. lineatum)*, with diatoms such as *Thalassiosira spp*. and *Chaetoceros spp*. also abundant (BEIS, 2016).

The zooplankton community is dominated by calanoid copepods, although other groups such as *Paracalanus* and *Pseudocalanus* are also abundant. There is also a high biomass of *Calanus* larval stages present in the region. Euphausiids, *Acartia*, and decapod larvae are all important components of the zooplankton assemblage (BEIS, 2022a).

Jellyfish are typically less abundant in northern and eastern coasts of the UK, although species commonly sighted include *Aurelia aurita*, *Cyanea capillata* and *Cyanea lamarckii* (Pikesley *et al.* 2014).

5.5.2 Habitat Type and Benthic Communities

5.5.2.1 Habitat Type

Habitat type in the survey area was classified as European Nature Information System (EUNIS) type ‘Deep circalittoral mud’ (A5.37), which falls within the broad Priority Marine Feature (PMF) habitats ‘Burrowed mud’ and ‘Offshore deep-sea muds’, as well as the United Kingdom Biodiversity Action Plan (UKBAP) Priority Habitat ‘Mud habitats in deepwater’. This biotope complex was observed within all transects and sampling stations during the Chestnut pre-decommissioning survey. Table 5-1 presents the classification hierarchy for the habitat type (Fugro, 2022a).

Table 5-1: Habitat classifications.

EUNIS (2019) Habitat Classification				Equivalent JNCC (2015) Classification
Environment Level 1	Broad Habitat Level 2	Habitat Level 3	Biotope Complex Level 4	
A Marine	A5 Sublittoral sediment	A5.2 Sublittoral sands and muddy sands	A5.37 Deep circalittoral mud	SS.SSa.Omu Offshore circalittoral mud
References: European Environment Agency (EEA), 2019; Joint Nature Conservation Committee (JNCC), 2015				

Photographs showing the habitat type observed during the survey are shown in Figure 5-6. The priority habitat ‘Subtidal sands and gravels’ might also be present within the survey area, due to sand being the dominant sediment fraction across the survey area (Fugro, 2022a). The specific sensitive habitats identified in the area are discussed in Section 5.5.2.3.

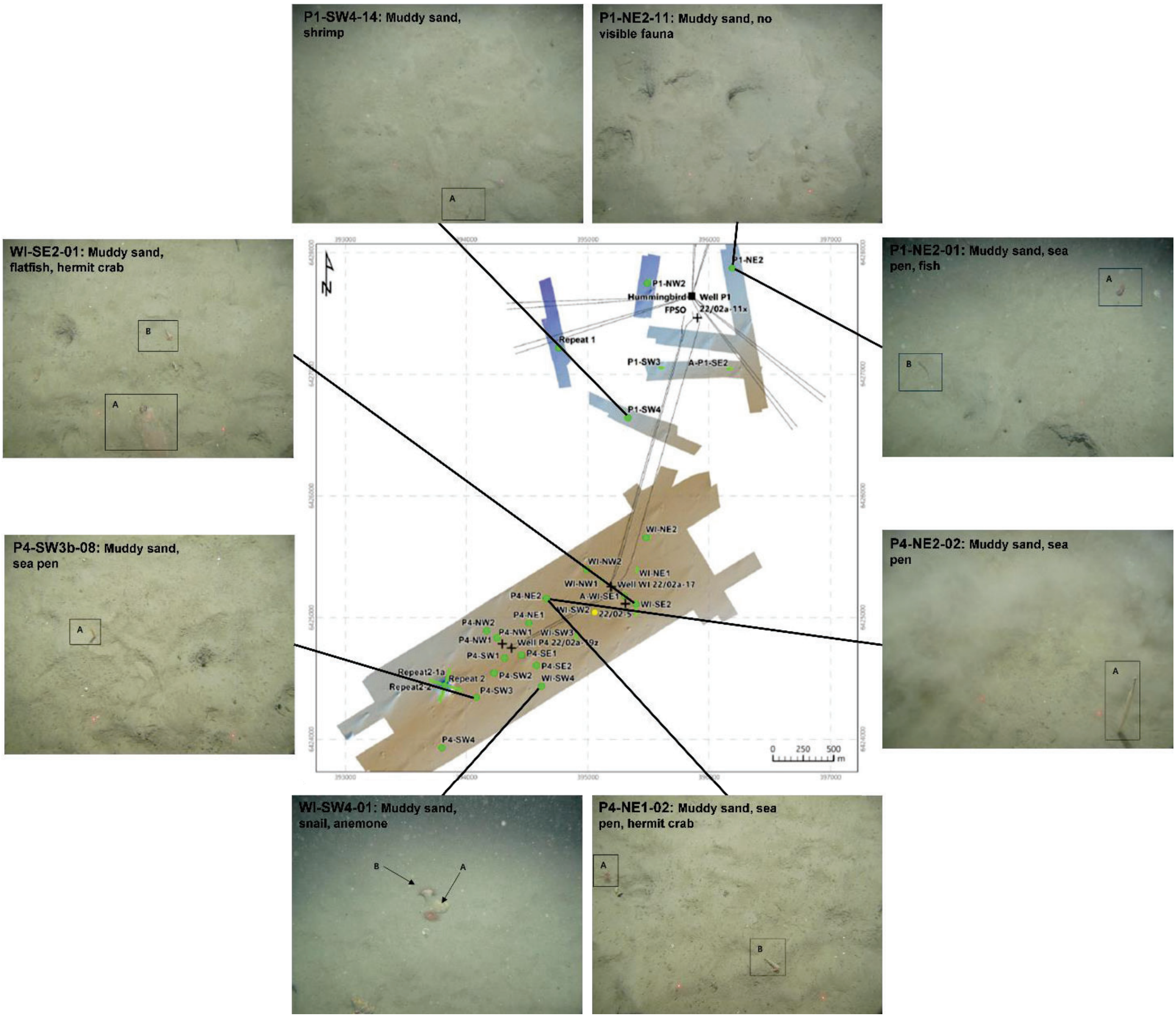


Figure 5-6: Example seabed photographs of 'Deep circalittoral mud' (A5.37) (Fugro, 2022a).

5.5.2.2 Benthic Communities

Bacteria, plants and animals living on or within the seabed sediments are collectively referred to as benthos. Species living on top of the sea floor may be sessile (e.g., seaweeds) or freely moving (e.g., starfish) and collectively are referred to as epibenthic or epifaunal organisms. Animals living within the sediment are termed infaunal species (e.g., tubeworms and burrowing crabs). Semi-infaunal animals, including sea pens and some bivalves, lie partially buried in the seabed.

The benthic community in the deeper, finer sediments within the Fladen Ground area of the CNS is generally typified by the echinoderms *Asterias rubens*, *Astropecten irregularis* and *Brissopsis lyrifera*. Within the region, deeper, mud-dwelling communities are characterised by the seapen *Pennatula phosphorea* and shallower areas tend to have larger numbers of the hermit crab *Pagurus bernhardus*, the shrimp *Crangon allmanni*, the purple heart urchin *Spatangus purpureus* and the gastropod *Colus gracilis* (BEIS, 2022a).

The level of organic matter and mud within the 'Deep circalittoral mud' (A5.37) habitat type identified in the Chestnut area influences the associated benthic community, which is typically dominated by polychaetes, bivalves, echinoderms and foraminifera (EEA, 2019). Whilst benthic epifauna was generally sparse in the area of the pre-decommissioning survey, the fauna most commonly observed included sea pens (*Pennatula phosphorea* and *Virgularia sp.)* and hermit crabs (*Paguridae*) (Fugro, 2022a). This benthic assemblage is representative of the wider area (BEIS, 2022a). Additional fauna included starfish (Asteroidea), anemones (Actiniaria), Norway lobsters (*Nephrops norvegicus*) as well as cryptic faunal signs including tracks and holes. Mobile fauna was also sparse but included flatfish (Pleuronectiformes, including *Pleuronectes platessa*), and hagfish (*Myxine glutinosa*) (Fugro,2022a).

Macrofaunal analysis of samples collected during the pre-decommissioning survey showed that of 239 benthic taxa identified, the dominant taxa were annelids (43.5 %), arthropods (26.4 %), molluscs (21.3 %), and echinoderms (2.9 %). Other phyla (specifically Cnidaria, Enteropneusta, Nemertea, Phoronida, Platyhelminthes and Sipuncula) comprised 5.9 % of the taxa (Fugro, 2022b).

5.5.2.3 Sensitive Habitats and Species

During the pre-decommissioning survey, analysis of seabed photography data was undertaken to establish whether any sensitive habitats or species were present within the survey area. Sea pens and megafauna burrows were identified across the survey area and further investigation concluded that the OSPAR (2010) ‘Sea pen and burrowing megafauna communities’ habitat was widespread across the area. Sea pens were observed at most surveyed stations, with the species *P. phosphorea* identified at all but three sampling stations and classed as ‘frequent' on the superabundant, abundant, common, frequent, occasional, rare (SACFOR) abundance scale at half of the stations (Hiscock, 1996). *Virgularia* sp. was absent at eight stations and classed as ‘occasional’ or ‘frequent’ at the remaining locations. Norway lobster (*Nephrops norvegicus*) burrows were considered ‘common’ at most stations surveyed, and only absent at a few (Fugro, 2022a).

As discussed in Section 5.5.2.1, the PMF broad habitats ‘Burrowed mud’ and ‘Offshore deep-sea muds’, as well as the UKBAP Priority Habitat ‘Mud habitats in deepwater’ and small areas of ‘Subtidal sands and gravel’ are likely to be present within the survey area (Fugro, 2022a).

Juveniles of the OSPAR listed threatened and / or declining species Ocean quahog (*Arctica islandica*) were recorded in macrofaunal samples from all but three stations (Fugro, 2022b). No evidence of live adult A. *islandica* specimens such as siphons were identified across the survey area (Fugro, 2022a).

No other Annex I habitats or Annex II species, OSPAR threatened and / or declining species and habitats, or Scottish biodiversity list species and habitats (OSPAR, 2008; JNCC, 2019) were observed within the survey area.

5.5.3 Fish and Shellfish

More than 330 fish species inhabit the shelf seas of the UKCS (Pinnegar *et al.,* 2010). In the CNS, fish species loosely associated with the seabed tend to be haddock, whiting, herring and plaice. At depths of between 100 – 200 m, the community is characterised by long rough dab, hagfish (*Myxine glutinosa*) and Norway pout. The soft, sandy sediments of the Fladen Ground also provide an important habitat for shellfish species *Nephrops* and *P. borealis* (BEIS, 2022a).

Table 5-2 shows the approximate spawning and nursery times of some of the fish species known to occur in the vicinity of the Chestnut infrastructure (Coull *et al.,* 1998; Ellis *et al.,* 2012; Aires *et al.,* 2014). Individuals of Norway pout (*Trisopterus esmarkii*) were also recorded in the pre-decommissioning survey (Fugro, 2022a). The fish species identified are representative of the wider region. At nursery and spawning grounds, fish aggregate in large numbers and so are particularly vulnerable to disturbance (BEIS, 2022a). Figure 5-7 shows the probability of juvenile fish for some species occurring in the area (Aires *et al.,* 2014). It should be noted that spawning and nursery areas tend to be transient and therefore cannot be defined with absolute accuracy.

Of the fish species identified in the area, anglerfish, blue whiting, cod, herring, horse mackerel, ling, mackerel, Norway pout, sandeel, spurdog (spiny dogfish), and whiting have been assessed by NatureScot and JNCC as PMFs in Scotland (Tyler-Walters *et al*., 2016).

Table 5-2: Summary of spawning, juvenile and nursery activity for fish species in Chestnut area.

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Anglerfish	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ
Blue whiting	N	N	N	N	N	N	N	N	N	N	N	N
Cod[1]	SN	S*N	S*N	SN	N	N	N	N	N	N	N	N
European hake	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ
Haddock	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ
Herring	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ
Horse Mackerel	J	J	J	J	J	J	J	J	J	J	J	J
Lemon sole				S	S	S	S	S	S			
Ling	N	N	N	N	N	N	N	N	N	N	N	N
Mackerel (North Sea)	NJ	NJ	NJ	NJ	S*NJ	S*NJ	S*NJ	SNJ	NJ	NJ	NJ	NJ
Nephrops	SN	SN	SN	S*N	S*N	S*N	SN	SN	SN	SN	SN	SN
Norway pout (shelf)[2]	SNJ	S*NJ	S*NJ	SNJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ
Plaice	N	N	N	N	N	N	N	N	N	N	N	N
Sandeel	SN	SN	N	N	N	N	N	N	N	N	SN	SN
Spotted ray	N	N	N	N	S*N	S*N	S*N	N	N	N	N	N
Spurdog	N	N	N	N	N	N	N	N	N	N	N	N
Whiting	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ

Key: S = Spawning; S* = Peak Spawning; N = Nursery; J = Juveniles (i.e. 0 group fish)
1
2
References: Coull *et al.* 1998; Ellis *et al.* 2012; Aires *et al.* 2014.

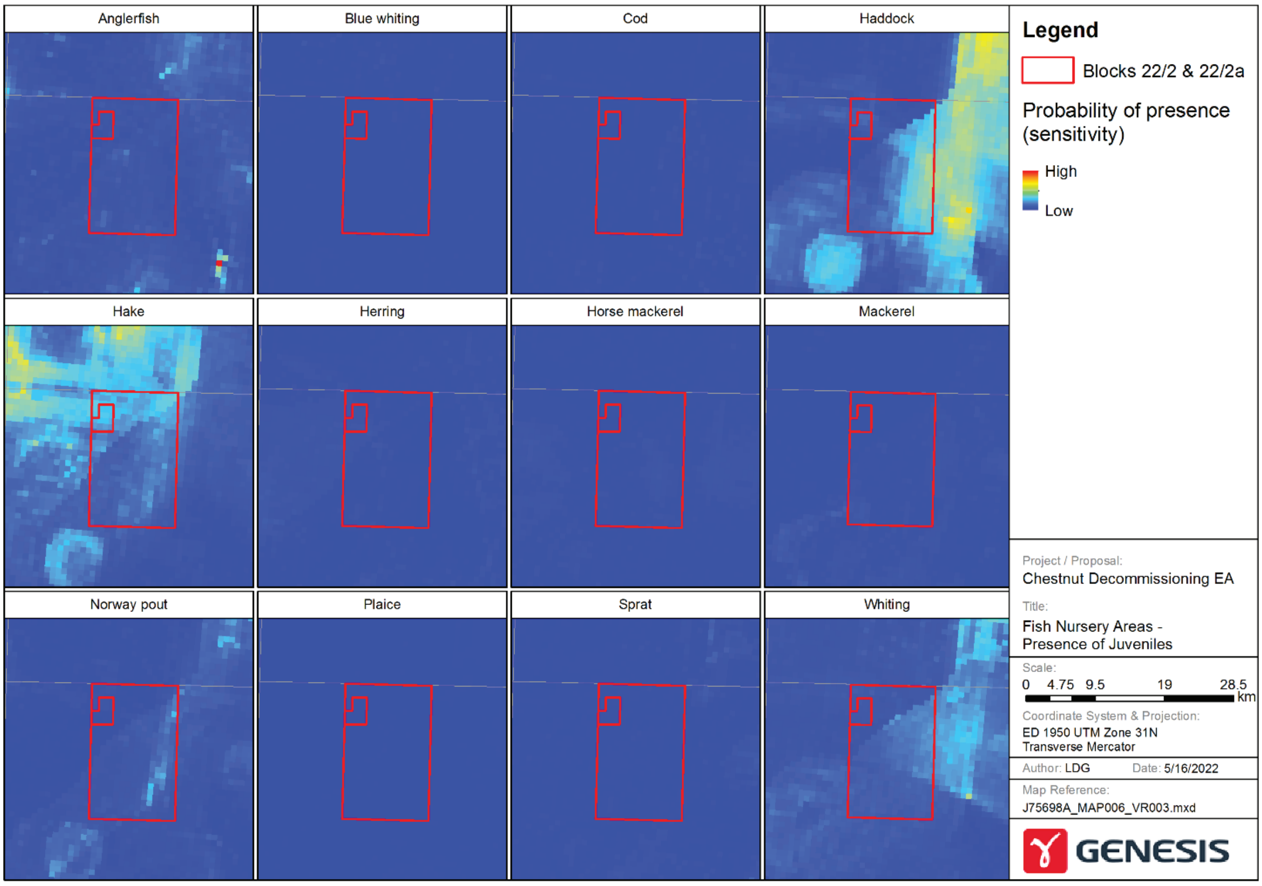


Figure 5-7: Probability of juvenile fish presence in the proximity of Chestnut (Aires *et al.*, 2014).

5.5.4 Marine Mammals

5.5.4.1 Pinnipeds

Two species of seal live and breed in UK waters: the grey seal (*Halichoerus grypus*) and the harbour (also called common) seal (*Phoca vitulina*). Both species are listed as Annex II species under the European Union (EU) Habitats Directive.

The foraging range of the harbour seal is typically within 40 – 50 km of their haul out site. Tracking of individual grey seals has shown that they can feed up to several hundred kilometres offshore, although most foraging tends to be within approximately 100 km (Special Committee on Seals (SCOS), 2013). Telemetry data (1991 - 2012) and count data (1988 - 2012) indicate that seals are very unlikely to be present in the vicinity of the Chestnut infrastructure (Russell *et al.*, 2017).

5.5.4.2 Cetaceans

The JNCC has compiled an Atlas of Cetacean Distribution in Northwest European Waters (Reid *et al.*, 2003), which gives an indication of the annual distribution and abundance of cetacean species in the North Sea. Table 5-3 presents the annual abundance of cetacean species likely to occur in the Chestnut area. The data suggests that moderate to high densities of harbour porpoise, and moderate to low densities of minke whale, white-beaked dolphin, and Atlantic white-sided dolphin have been sighted in the immediate vicinity of the Chestnut infrastructure (Reid *et al.*, 2003).

All cetaceans in UK waters are EPS such that it is an offence to deliberately disturb, capture, injure or kill any of these species. Harbour porpoise is also protected under Annex II of the Habitats Directive.

Table 5-3: Marine mammal seasonal abundance in the vicinity of Chestnut (Reid *et al*., 2003).

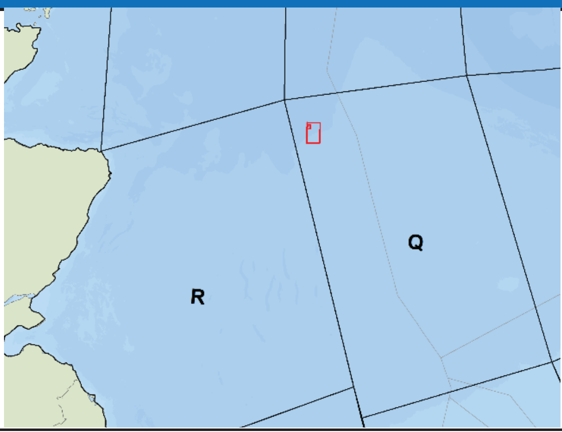
Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minke Whale						3	2	3				
White-beaked Dolphin						2	2				1	
Atlantic White-sided Dolphin						3	2					
Harbour Porpoise						2	1		2			
Key	1	High		2	Moderate		3	Low			No sighting	

A series of Small Cetacean Abundance in the North Sea (SCANS) surveys have been conducted to obtain an estimate of cetacean abundance in North Sea and adjacent waters, the most recent of which is SCANS-III (Hammond *et al.,* 2017).

The Chestnut field is located within SCANS-III Block 'Q'. Aerial survey estimates of animal abundance and densities (animals per km^2) within this area are provided in Table 5-4. The data confirm that some of those species identified by Reid *et al.* (2003), frequent Block Q. However, the SCANS-III survey did not identify White-beaked dolphin or Atlantic white-sided dolphin in Block Q (Hammond *et al.,* 2017).

The JNCC have published the 'regional' population estimates for the seven most common species of cetacean occurring in UK waters (Inter-Agency Marine Mammal Working Group (IAMMWG), 2021). Divided into Management Units (MU), these provide an indication of the spatial scale and the relevant populations at which potential impacts should be assessed. The relevant MU population estimates are also presented in Table 5-4.

Table 5-4: Cetacean Abundance in SCANS-III Survey Block Q.

SCANS-III Block Q	Species	Animal Abundance[1]	Density (animals / km^2)[1]	MU Population[2]
	Harbour porpoise	16,569	0.333	346,601
	Minke whale	348	0.007	20,118

[1] Hammond *et al*., (2017)
[2] IAMMWG (2021)

5.5.5 Seabirds

The North Sea is an internationally important area for breeding and feeding seabirds. Using seabird density maps from European Seabirds at Sea (ESAS) data collected over 30 years, Table 5-5 identifies a number of the bird species (and their predicted maximum monthly abundance) known to occur in the Chestnut area (Kober *et al*., 2010).

The data indicates that a number of seabird species are likely to occur in the area over the summer breeding season and winter months. For all species combined, a maximum of 17 seabirds are predicted to occur per km^2 during the breeding season (April to October), whilst during the winter months (November to March) a maximum of 12 seabirds are predicted to occur per km^2.

Table 5-5: Predicted monthly seabird surface density in the Chestnut area (Kober *et al.*, 2010).

Species	Season	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Northern gannet	Breeding					≤ 1.0	≤ 1.0	≤ 1.0	≤ 1.0	≤ 1.0			
	Winter	≤ 1.0	≤ 1.0	≤ 1.0	≤ 1.0						≤ 1.0	≤ 1.0	≤ 1.0
Black-legged kittiwake	Breeding					5.0 – 10.0	5.0 – 10.0	5.0 – 10.0	5.0 – 10.0	5.0 – 10.0			
	Winter	5.0 – 10.0	5.0 – 10.0	5.0 – 10.0	5.0 – 10.0						5.0 – 10.0	5.0 – 10.0	5.0 – 10.0
European storm-petrel	Breeding						≤ 1.0	≤ 1.0	≤ 1.0	≤ 1.0	≤ 1.0		
Lesser black-backed gull	Breeding					≤ 1.0	≤ 1.0	≤ 1.0	≤ 1.0				
Great black-backed gull	Breeding				≤ 1.0	≤ 1.0	≤ 1.0	≤ 1.0	≤ 1.0				
	Winter	≤ 1.0	≤ 1.0	≤ 1.0						≤ 1.0	≤ 1.0	≤ 1.0	≤ 1.0
Razorbill	Breeding					≤ 1.0	≤ 1.0						
Great skua	Breeding					≤ 1.0	≤ 1.0	≤ 1.0	≤ 1.0				
	Winter	≤ 1.0	≤ 1.0	≤ 1.0	≤ 1.0					≤ 1.0	≤ 1.0	≤ 1.0	≤ 1.0
Little auk	Winter	5.0 – 10.0	5.0 – 10.0	5.0 – 10.0								5.0 – 10.0	5.0 – 10.0
Herring gull	Winter	≤ 1.0	≤ 1.0	≤ 1.0						≤ 1.0	≤ 1.0	≤ 1.0	≤ 1.0
Arctic skua	Breeding					≤ 1.0	≤ 1.0	≤ 1.0	≤ 1.0				
Arctic tern	Breeding					≤ 1.0	≤ 1.0	≤ 1.0	≤ 1.0				
Glaucous gull	Winter	≤ 1.0	≤ 1.0	≤ 1.0							≤ 1.0	≤ 1.0	≤ 1.0
Common guillemot	Breeding					10.0 - 15.0	10.0 - 15.0						
	Additional								1.0 – 5.0	1.0 – 5.0			
	Winter	1.0 – 5.0	1.0 – 5.0	1.0 – 5.0	1.0 – 5.0						1.0 – 5.0	1.0 – 5.0	1.0 – 5.0
Atlantic puffin	Breeding				1.0 – 5.0	1.0 – 5.0	1.0 – 5.0	1.0 – 5.0					
	Winter	≤ 1.0	≤ 1.0	≤ 1.0					≤ 1.0	≤ 1.0	≤ 1.0	≤ 1.0	≤ 1.0
All species combined	Breeding				15.0 - > 20.0	15.0 - > 20.0	15.0 - > 20.0	15.0 - > 20.0	15.0 - > 20.0	15.0 - > 20.0	15.0 - > 20.0		
	Summer							15.0 - > 20.0	15.0 - > 20.0				
	Winter	10.0 - 15.0	10.0 - 15.0	10.0 - 15.0								10.0 - 15.0	10.0 - 15.0

Key: Maximum number of individuals per km²	Not recorded	≤ 1.0	1.0 – 5.0	5.0 – 10.0	10.0 - 15.0	15.0 - > 20.0

Seabirds are generally not at risk from routine offshore oil and gas production operations. However, they may be vulnerable to pollution from less regular offshore activities such as accidental hydrocarbon spills.

The vulnerability of seabirds to surface oil in the blocks and surrounding areas has been assessed according to the Seabird Oil Sensitivity Index (SOSI). The purpose of this index is to identify areas where seabirds are likely to be most sensitive to oil pollution by considering factors that make a species more or less sensitive to oil-related impacts.

The SOSI combines the seabird survey data with individual seabird species sensitivity index values. These values are based on a number of factors which are considered to contribute towards the sensitivity of seabirds to oil pollution, and include:

- Habitat flexibility (the ability of a species to locate to alternative feeding grounds);
- Adult survival rate;
- Potential annual productivity; and
- The proportion of the biogeographical population in the UK (classified following the methods developed by Certain *et al.*, (2015).

The combined seabird data and species sensitivity index values were then subsequently summed at each location to create a single measure of seabird sensitivity to oil pollution. The mean sensitivity SOSI data for the area is shown in Table 5-6. For blocks with 'no data', an indirect assessment has been made (where possible) using JNCC guidance (JNCC, 2017). The sensitivity of birds to surface oil pollution within the Chestnut Decommissioning Project area ranges from low to medium throughout the year.

Table 5-6: SOSI or indirect assessment for Block 22 / 2 (including adjacent Blocks; JNCC, 2017).

Block	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
16 / 26	5*	5	5*	5*	5	5	5	5	5	5*	N	N
16 / 27	5*	5	5	4*	4	5	5	5	5	5*	N	N
16 / 28	N	5*	5	3*	3	5	5	5	5	5*	N	N
22 / 1	5*	5	5*	5*	5	5	5	5	5	5*	N	N
22 / 2	5*	5	5*	4*	4	5	5	5	5	5*	N	N
22 / 3	5*	5	5	3*	3	5	5	5	5	5*	N	N
22 / 6	5*	5	5	5*	5*	5	5	5	5	5*	N	N
22 / 7	4	5	5	5*	5*	5	5	5	5	5*	N	4*
22 / 8	4	5	4	4*	5*	5	5	5	5	5*	N	4*
Key	1 Extremely High	2 Very High	3 High	4 Medium	5 Low							
	Indirect Assessment – Data gaps have been populated following guidance provided by JNCC (JNCC, 2017). * Data gap filled using data from the same Block in adjacent months. Note where no data available, cells have been left blank with "N".											

5.6 Marine Protected Areas

A network of Marine Protected Areas (MPAs) are in place to aid the protection of vulnerable and endangered species and habitats through structured legislation and policies. These sites include Special Areas of Conservation (SAC) and Special Protection Areas (SPA), which were designated in the UK under the EU Nature Directives (prior to January 2021) and are now maintained and designated under the Habitats Regulations for England and Wales, Scotland and Northern Ireland. Amendments to the Habitats Regulations mean that the requirements of the EU Nature Directives continue to apply to how European sites (SACs and SPAs) are designated and protected. The Habitats Regulations also provide a legal framework for species requiring strict protection, e.g. EPS. Nature Conservation Marine Protected Areas (NCMPAs) are designated under the Marine (Scotland) Act 2010 and the Marine and Coastal Access Act 2009.

The protected sites in closest proximity to the Chestnut field are illustrated in Figure 5-8, and summarised in Table 5-7. The nearest protected sites are the Norwegian Boundary Sediment Plain NCMPA (*c.* 26 km east) and the Scanner Pockmark SAC (*c.* 36 km north west).

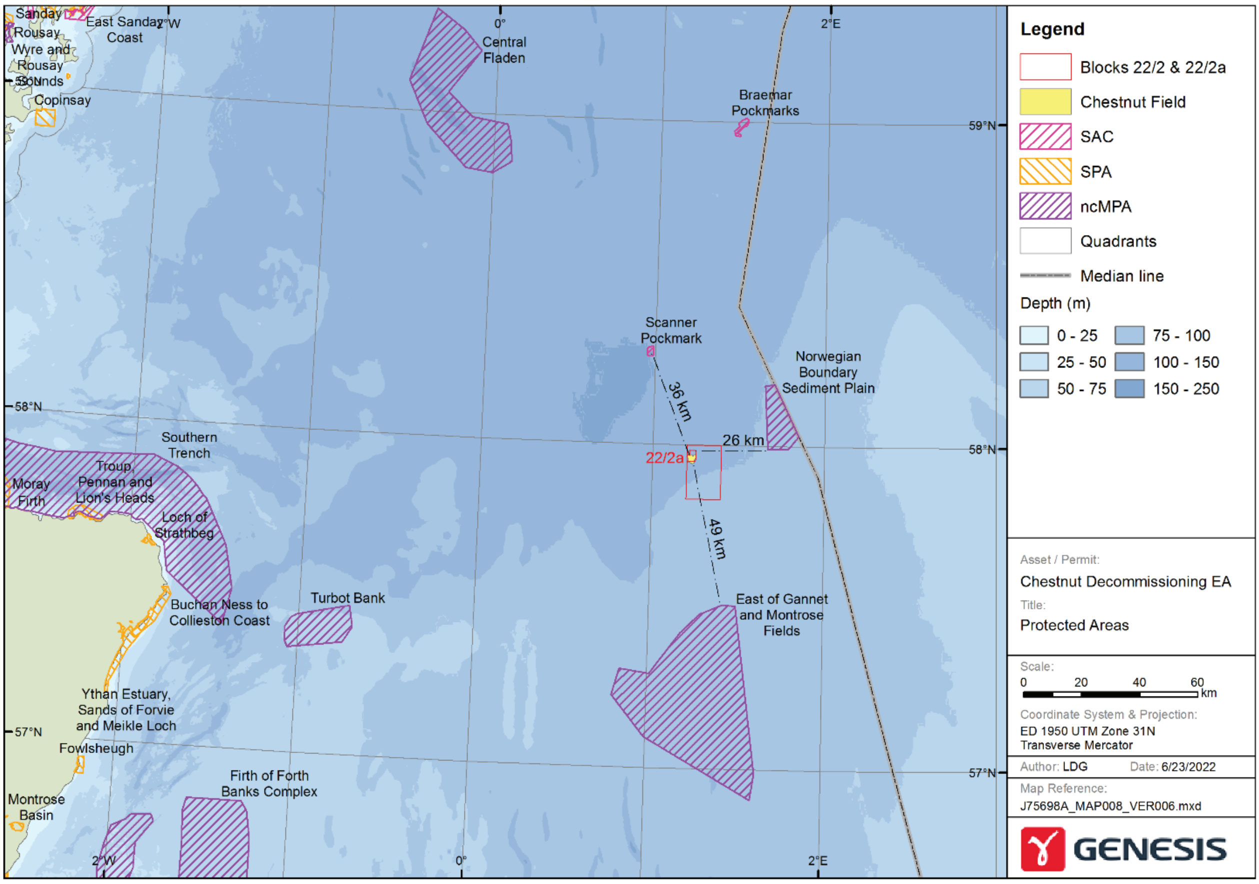


Figure 5-8: Location of the Chestnut field in relation to protected areas.

Table 5-7: Protected areas within 40 km of the Chestnut field.

Area	Qualifying Features	Approximate distance to Chestnut field (km)
Norwegian Boundary Sediment Plain NCMPA	Ocean quahog aggregations (including sands and gravels as their supporting habitat).	26
Scanner Pockmark SAC	Submarine structures made by leaking gases.	36

5.7 National Marine Plan

The Chestnut field falls within the Scottish National Marine Plan (NMP) area, which comprises plans for Scotland's inshore (out to 12 nm) and offshore waters (12 to 200 nm) as set out under the Marine (Scotland) Act 2010 and the Marine and Coastal Access Act 2009. The plan represents a framework of Scottish Government policies for the sustainable development of marine resources and is underpinned by strategic objectives:

- Achieving a sustainable marine economy;
- Ensuring a strong, healthy and just society;
- Living within environmental limits;
- Promoting good governance;
- Using sound science responsibly.

These objectives are to be achieved through the application of 21 'General Planning Principles'. Table 5-8 identifies which of these 21 Principles are considered relevant to the proposed decommissioning activities.

Table 5-8: Scottish NMP's General Planning Principles

Scotland's National Marine Plan Principles
GEN 1 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 this Plan. *The proposed project is the decommissioning of an existing field. The EA assesses the impacts to the environment and to other sea users.*
GEN 4 Co-existence: Proposals which enable coexistence with other development sectors and activities within the Scottish marine area are encouraged in planning and decision making processes, when consistent with policies and objectives of this Plan. *Spirit Energy will ensure that any potential impacts on other sea users associated with the decommissioning operations will be kept to a minimum.*
GEN 5 Climate change: Marine planners and decision makers must act in the way best calculated to mitigate, and adapt to, climate change. *Vessel movements and therefore associated fuel use will be minimised.*
GEN 9 Natural heritage: Development and use of the marine environment must: a) Comply with legal requirements for protected areas and protected species. b) Not result in significant impact on the national status of Priority Marine Features. Protect and, where appropriate, enhance the health of the marine area. *Spirit Energy have commissioned an environmental survey in the area. Decommissioning activities will take account of this survey.*
GEN 12 Water quality and resource: Developments and activities should not result in a deterioration of the quality of waters to which the Water Framework Directive, Marine Strategy Framework Directive or other related Directives apply. *Discharges to sea resulting from the proposed decommissioning activities have been identified and assessed. The proposed activities will not result in any measurable deterioration of water quality in the area.*
GEN 13 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. *There will be no piling or explosive use associated with the proposed activities. Vessel noise is not expected to significantly impact on the receptors in the area.*
GEN 14 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. *Given the offshore location, impacts of vessel emissions are not considered significant and will be minimised through project planning.*
GEN 21 Cumulative impacts: Cumulative impacts affecting the ecosystem of the marine plan area should be addressed in decision making and plan implementation. *Cumulative impacts are considered in the EA and are considered proportionate to the size of the project. Cumulative impacts will be limited to impacts on climate change and those associated with the potential deposit of rock. Project planning will minimise the use of vessels.*

5.8 Oil and Gas Sector Specific Policies

In addition to the above general policies, the Chestnut Decommissioning Project will align with the relevant specific oil and gas Marine Planning Policies, shown in Table 5-9.

Table 5-9: Oil and Gas Marine Planning Policies.

Oil and Gas Marine Planning Policies
Oil and Gas 1 – Environmental Risks and Impacts (noise, discharges and habitat change): The Scottish Government will work with BEIS, the Oil and Gas Authority 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 Best Available Technology (BAT) and Best Environmental Practice (BEP). Consideration will be given to key environmental risks including the impacts of noise, oil and chemical contamination and habitat change.
Oil and Gas 2 – Decommissioning (re-use or removal of decommissioned assets): 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.
Oil and Gas 3 – Other Users of the Sea (environmental and socio-economic constraints): Supporting marine and coastal infrastructure for oil and gas developments, including for storage, should utilise the minimum space needed for activity and should take into account environmental and socio-economic constraints.
Oil and Gas 5 – Potential Environmental Risks and Hazards: 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.
Oil and Gas 6 – Risk Reduction Measures: 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 and the Offshore Safety Directive.

6. SOCIO-ECONOMIC BASELINE

6.1 Introduction

This section describes the socio-economic activities in the vicinity of the Chestnut field, which primarily include fishing, shipping and oil and gas operations.

6.2 Fishing

The Chestnut field occurs within International Council for the Exploration of the Sea (ICES) rectangle 44F1. Data provided by the Scottish Government indicate that seine nets and trawl gear are used in this rectangle, emphasising the importance of ensuring a safe seabed as part of the proposed decommissioning project (Marine Scotland, 2021a). Fishing effort (vessel days), value and quantity data for UK vessels ≥ 10 m in length are presented in Table 6-1 and Table 6-2.

The data suggests that ICES rectangle 44F1 encompasses an area that is of relatively low importance to the UK fishing industry, such that fishing activity in the area can be considered low.

Table 6-1: Fishing effort (days) in ICES rectangle 44F1 (2016-2020) (Marine Scotland, 2021a).

Year	Monthly Fishing Effort (1)												44F1 Total (2)	UK Total	44F1 as % of UK
	J	F	M	A	M	J	J	A	S	O	N	D			
2016	30	23	D	49	0	D	D	9	10	83	112	36	351	131,590	0.3
2017	5	D	45	5	D	9	12	62	3	35	17	D	192	125,831	0.2
2018	20	0	D	D	D	D	D	24	20	17	24	D	104	124,844	0.1
2019	12	77	19	28	D	39	67	10	45	53	23	D	373	126,353	0.3
2020	31	9	D	29	78	41	18	8	27	44	23	9	317	103,918	0.3
Mean													267	122,507	0.2

Notes:
[1] Monthly effort data are shown where five or more UK vessels over 10 m undertook fishing activity in a given year. Where less than five such vessels undertook fishing activity in a given month, the data are "disclosive" (D) and not shown.
[2] Includes disclosive days.
Note: The measure of the fishing activity of vessels includes the time spent travelling to fishing grounds as well as the time spent fishing.

Table 6-2: Landings (by species type) in ICES rectangle 44F1 (2020) (Marine Scotland, 2021a).

Species Type	Weight (te)			Value (£)		
	UK Total	44F1 Total	% of UK	UK Total	44F1 Total	% of UK
Demersal	115,897.7	978.9	0.8	184,520,801.27	1,202,716.72	0.7
Pelagic	329,965.1	2.1	0.0	283,309,284.75	1,676.46	0.0
Shellfish	72,517.9	66.4	0.1	176,825,551.54	161,234.90	0.1
Total	**518,380.7**	**1,047.4**	**0.002**	**644,655,637.6**	**1,365,628.08**	**0.002**

6.3 Shipping Activity

Shipping densities in the North Sea are categorised by the NSTA to be either: negligible; very low; low; moderate; high; or very high. As can be seen in Figure 6-1, the shipping activity around the Chestnut field is considered low, whilst it is moderate in adjacent blocks to the west.

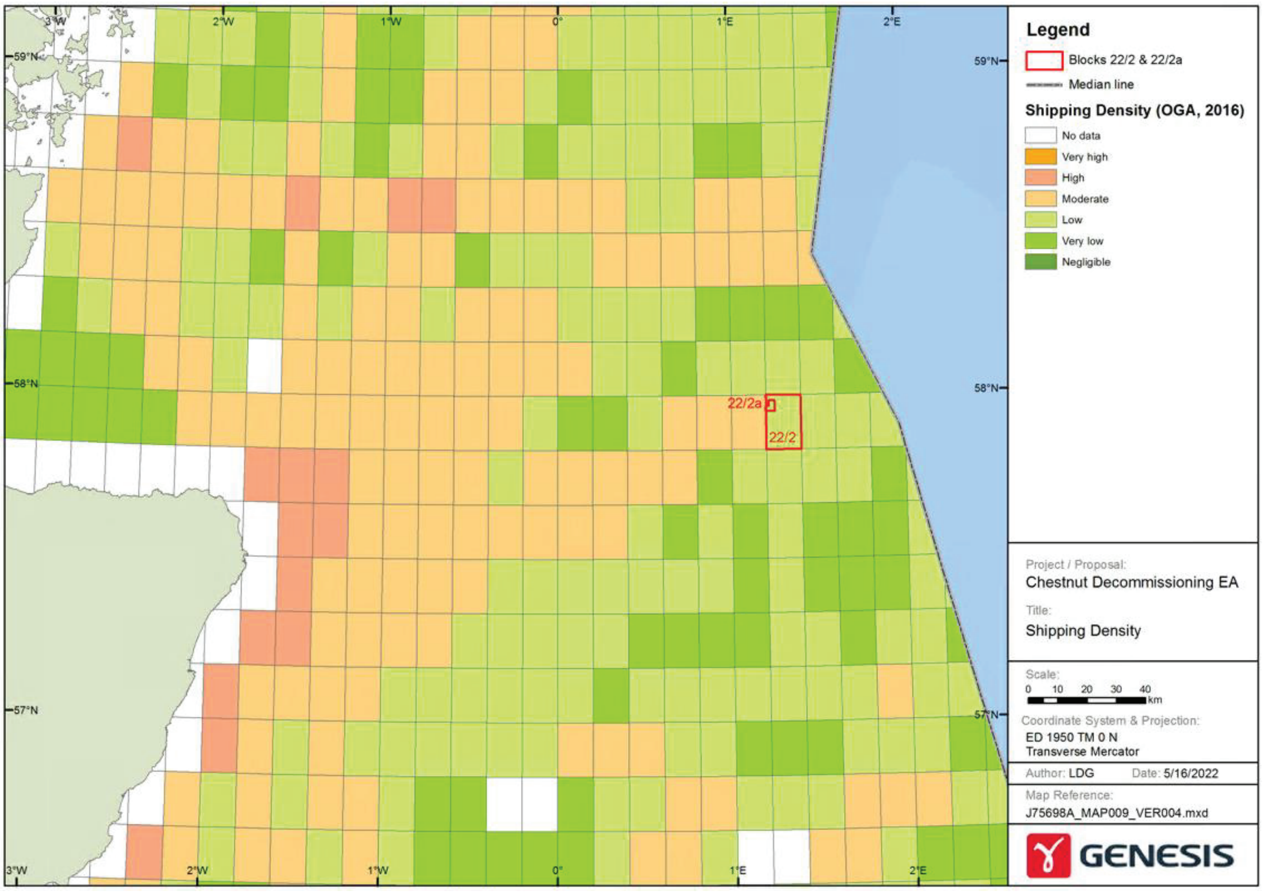


Figure 6-1: Shipping density in the vicinity of Chestnut as categorised by the NSTA (OGA, 2016).

6.4 Other Users of the Sea

The Chestnut field is situated in an area of the North Sea that is well-developed with oil and gas infrastructure. Figure 6-2 illustrates those installations in closest proximity to the Chestnut field and corresponding distances are provided in Table 6-3.

Figure 6-3 illustrates other users of the sea in closest proximity to the Chestnut field. There are no active offshore wind farm developments in the vicinity of the Chestnut field (Crown Estate Scotland, 2022). There is an Offshore Wind Innovation and Targeted Oil and Gas Decarbonisation (INTOG) area, INTOG E-a, located *c.* 4.8 km southeast of the Chestnut field. INTOG areas form part of a new Sectoral Marine Plan (SMP) for offshore wind energy, specifically for smaller innovation projects and projects targeting the electrification of oil and gas infrastructure in Scottish waters (Marine Scotland, 2022). The nearest Sectorial Marine Plan (SMP) Offshore Wind Energy 2020 Area, E2, is situated *c.* 78 km southwest of the Chestnut field. Area E2, also a ScotWind option agreement offer area, is an open government license for the future development of commercial-scale offshore wind energy in Scotland (Marine Scotland, 2021b).

There are a number of wrecks located across the CNS area. The closest wrecks to the proposed decommissioning activities are *c.* 10 km northwest, 13 km northwest, 12 km southwest, and 14 km northeast of the Chestnut field (Figure 6-3).

The closest telecommunications line is located approximately 15 km south of Block 22 / 2a (Figure 6-3). There are no military exercise areas in the vicinity of Chestnut (Scottish Government NMPi).

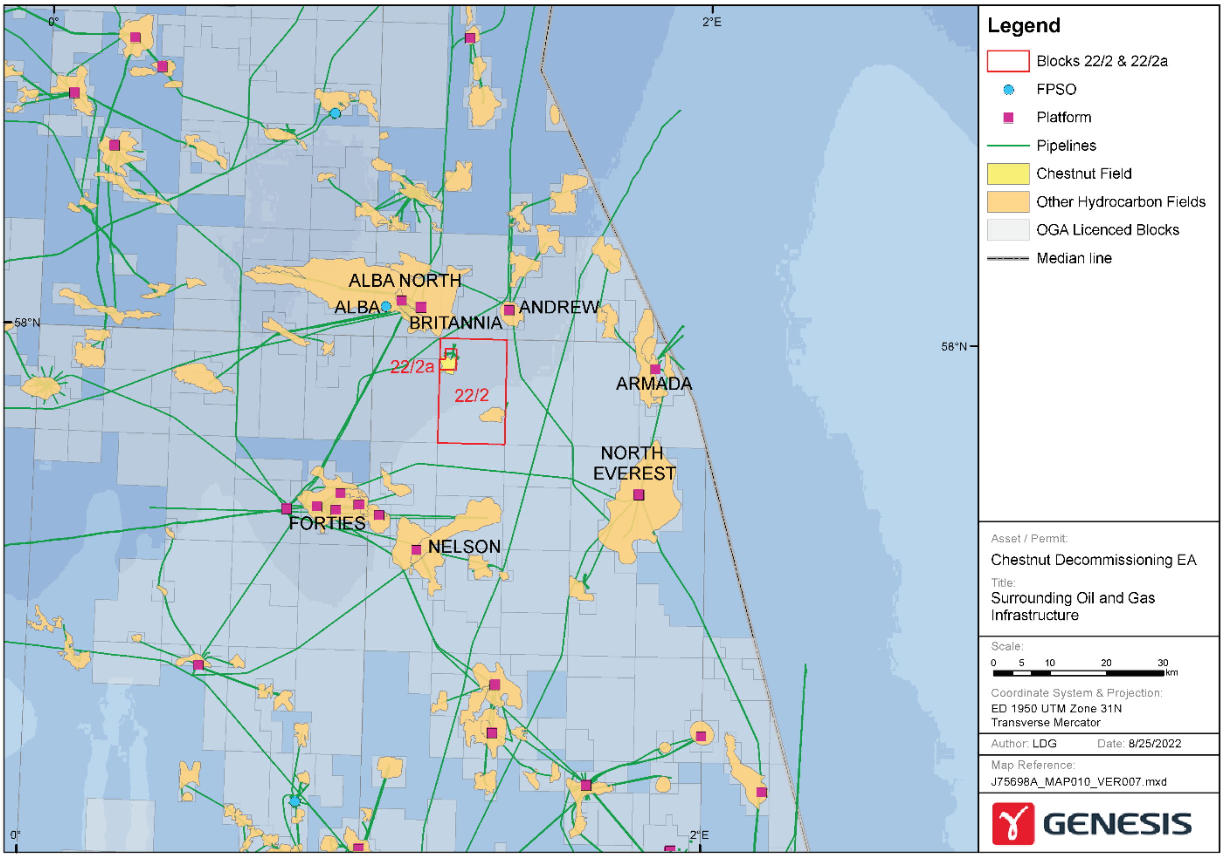


Figure 6-2: Other oil and gas infrastructure in the vicinity of the Chestnut area.

Table 6-3: Approximate distance / direction to oil and gas installations surrounding Chestnut.

Installation Name	Type of Installation	Approximate distance and direction from Chestnut field (km)
Andrew	Platform	12 km northeast
Armada	Platform	35 km east
North Everest	Platform	39 km southeast
Britannia	Platform	10 km northwest
Alba North	Platform	12 km northwest
Alba	FPSO	14 km northwest
Forties Alpha	Platform	30 km southwest
Nelson	Platform	33 km southwest

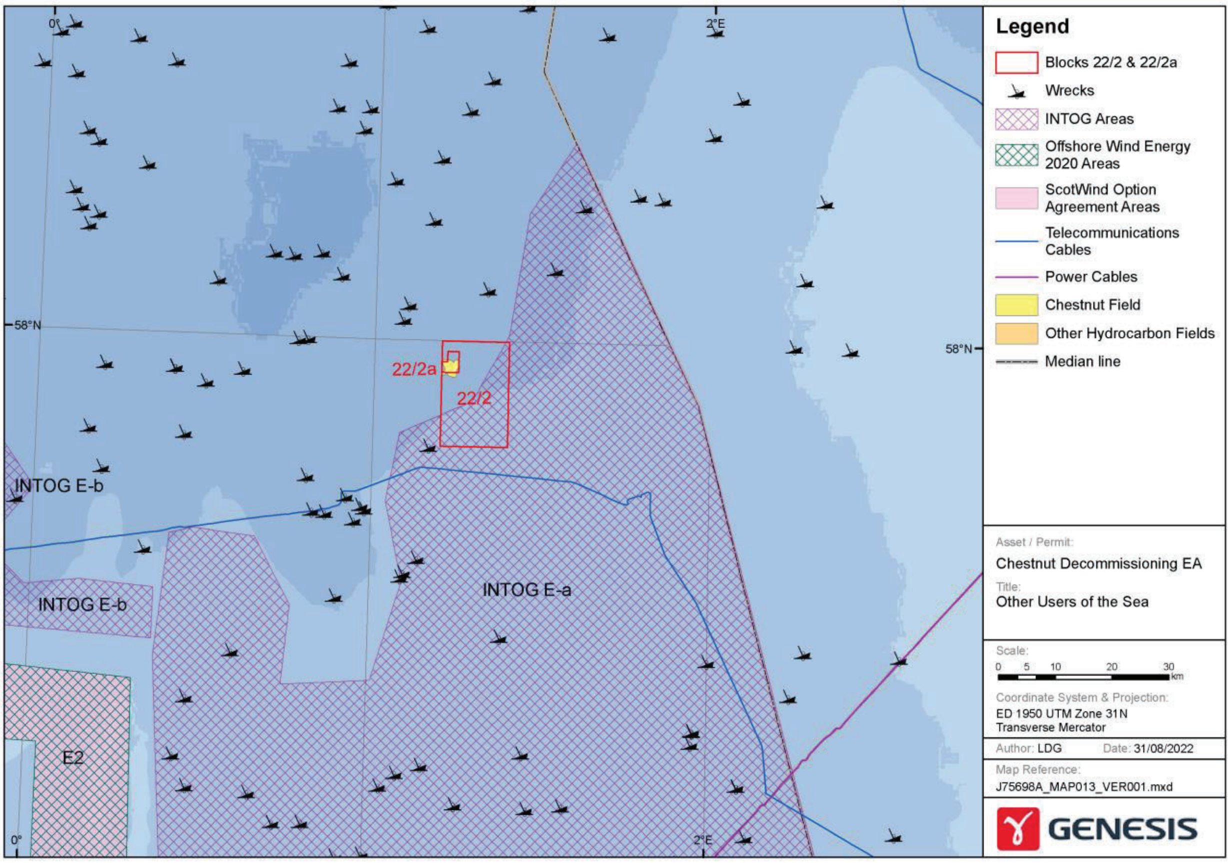


Figure 6-3: Other users of the sea in the vicinity of the Chestnut area[1].

[1] References: Scottish Government NMPi; Crown Estate Scotland, 2022; Marine Scotland, 2022; Marine Scotland, 2021b

7. SCOPING OF POTENTIAL ENVIRONMENTAL AND SOCIO-ECONOMIC IMPACTS

7.1 Method

To determine the severity of the potential impacts associated with the proposed decommissioning activities, an ENVID workshop was undertaken in accordance with Spirit Energy's Impact Assessment Procedure as described in Appendix A and summarised here.

The workshop identified the key environmental and socio-economic sensitivities, discussed all the sources of potential impact and ultimately highlighted those impacts which required further assessment within the EA. The decision on which impacts required further assessment was reinforced by a review of industry experience of decommissioning impact assessment.

The activities / project elements involved in the Chestnut decommissioning were divided into nodes for consideration during the ENVID. This can be planned or unplanned (accidental) events.

The ENVID nodes considered were as follows:

1. Vessel use.
2. Decommissioning of flowlines, umbilicals, tie-in spools and umbilical jumpers.
3. Decommissioning of subsea installations (WHPS, riser bases, and choke skid / manifold).
4. Decommissioning of protection and stabilisation features.
5. Over-trawl trials.
6. Legacy impacts.
7. Accidental events.

Using a detailed description of the activities, and information describing its baseline receiving environment, the ENVID process systematically reviewed all aspects of project activities which could interact with the environment (including its socio-economic and political dimensions). Environmental aspects from both planned activities and unplanned events (accidental and emergency) were considered. Where relevant, the aspects considered in the ENVID included:

- Physical presence;
- Resource use;
- Atmospheric emissions;
- Sound and vibration;
- Seabed disturbance;
- Discharges (and small releases) to sea;
- Large releases to sea; and
- Waste production

The following environmental receptors were considered in the ENVID for each aspect:

- Air quality;
- Water quality;
- Plankton;
- Fish;
- Seabirds;
- Resource availability (landfill and fuel);
- Shipping;
- Climate;
- Sediment quality;
- Benthic communities;
- Marine mammals;
- Designated areas; and
- Fisheries.

During the ENVID, the severity ('low', 'medium', or 'high') of the environmental / socio-economic impact of planned activities on each of the susceptible receptors was derived by considering the 'extent' in relation to the 'duration' (recovery time) of the aspect. Impacts were assessed assuming 'routine' industry standard control and mitigation measures will be in place (including those required by legal mandate) using the Spirit Energy Environmental Impact Assessment Matrix (in CEU-HSEQ-GEN-GUI-0026 Guidance for Environmental Management in Capital Projects). The impact matrix is designed to address the impacts from point source activities and is provided in Appendix A.

The environmental and socio-economic risk (of impact) from unplanned (accidental and emergency) aspects followed a similar process. Following assessment of the potential impact, the risk of impact was evaluated by factoring in the likelihood of the aspect and impact occurring using the Spirit Energy HSES Risk Assessment Matrix (Appendix A). Again, the risk score was translated to ‘low’, ‘medium’ or ‘high’.

7.2 Scoping

The results from the ENVID workshop are presented in Table 7-1. Applying the industry standard mitigation measures, the severity of impact of each of the planned activities was considered to be ‘low’ such that any environmental and socio-economic impacts are considered to be negligible. Table 7-1 provides a justification for not assessing further the majority of the aspects identified in the EA, with the exception of:

- Seabed disturbance (Section 8); and
- Legacy impacts on the environment and on other sea users (Section 9).

The potential impact of a loss of diesel inventory resulting for example from a vessel collision or fire was also considered in the ENVID. The severity of impact of a release of diesel inventory from one of the vessels was considered to be ‘medium’, such that the impact is tolerable but to be managed to ‘as low as reasonably practicable’. The likelihood of such an event was considered to be ‘very unlikely’, in that it was recognised that a similar event has occurred elsewhere but is unlikely to occur during this project with the application of current industry standard practices. Combining the severity of impact with the likelihood, results in an overall Low environmental risk. In line with Subsection 12.4 of the OPRED Decommissioning Guidance (OPRED, 2018), the impacts of accidental events are not assessed further in the EA.

Table 7-1: ENVID results and justification for selecting / deselecting the impact for further assessment in the EA.

Aspect	Project Activity / Source of Impact	Receptor(s)	Potential Impacts on Receptors	Existing Mitigation	Ranking: Planned Activities: Effect	Ranking: Planned Activities: Duration	Ranking: Planned Activities: Impact	Ranking: Unplanned Activities: Consequence	Ranking: Unplanned Activities: Likelihood	Ranking: Unplanned Activities: Risk Level	Justification for selecting / deselecting the aspect for further assessment in the EA	Assessed further in the EA (Yes / No)
Node 1: Vessel Use												
Physical Presence	Vessels on location and transiting from and to port. Vessels dynamically positioned on location.	Fisheries Shipping	Potential for navigation hazard and interference with shipping / fishing activities.	All vessels will comply with standard marking conditions. Notice to Mariners prior to operations commencing. Kingfisher Bulletins issued prior to operations commencing. Collision Risk Management. Vessel communication systems. Follow Spirit Energy's Marine Assurance Standard. SIMOPS plan will be in place if required.	1	2	2	N / A			Given the relatively short duration of the activities and the fact that a number of the activities will take place within existing 500 m safety zones, the severity of impact of the presence of vessels on fishing activity during the proposed activities is considered low and is not considered further in the EA.	No
		Marine Mammals Fish Seabirds	Behavioural changes in marine mammals, fish and seabirds.	Most activities will take place within existing 500 m safety zones (4 of) currently in place (Hummingbird Spirit FPSO, Chestnut well P1, well P4 and WI well locations). Note that the 500 m safety zones of the FPSO and well P1 overlap slightly. The majority of activities will take place within these 500 m safety zones, and therefore no additional impact compared to	1	2	2	N / A			The UKCS is a busy shipping area and has well developed fishing and oil and gas industries, such that marine mammals, fish and sea birds in the region are habituated to the presence of vessels. The severity of impact on marine mammals, fish and sea birds is therefore considered to be low and is not discussed further in the EA.	No

Aspect	Project Activity / Source of Impact	Receptor(s)	Potential Impacts on Receptors	Existing Mitigation	Ranking: Planned Activities: Effect	Duration	Impact	Ranking: Unplanned Activities: Consequence	Likelihood	Risk Level	Justification for selecting / deselecting the aspect for further assessment in the EA	Assessed further in the EA (Yes / No)
				current restrictions for majority of activities. Note: Exception is the free span area where decommissioning activities may be necessary.								
Resource Use	Energy consumption. Use of diesel for fuel.	Resource Availability	Impact on climate change and reduction of resources of hydrocarbons.	Vessel planning to limit time spent in field and number of journeys required.	1	2	2	N / A			The estimated total fuel use by the vessels required to complete the proposed decommissioning activities is *c.* 1,068 te (Table 3-4). Spirit Energy recognise that hydrocarbon-based fuel is a finite resource, however given relatively short duration of activities and use of MARPOL compliant vessels the impact severity of fuel use is considered low and is not discussed further in the EA.	No
Atmospheric Emissions	Fuel combustion emissions (CO_2, CO, SOx, NOx, etc.) from vessel engines.	Air Quality Climate Change	Localised deterioration of air quality for duration of operations and contribution to Greenhouse Gases (GHG).	UK Air Quality Standards not exceeded. Spirit Energy will carry out vessel assurance. Time vessels spend in the field will be optimised, with a SIMOPS plan in place.	2	2	4	N / A			The proposed decommissioning activities will result in *c.* 3,746 te of Carbon Dioxide equivalent (CO_2e) emissions[1]. When compared against total CO_2e emissions from upstream oil and gas activities in the UK in 2020 (17,060,000 te) (OEUK, 2021), this equates to 0.022 %. Spirit Energy acknowledges that the atmospheric emissions associated with the use of vessels will contribute to climate change. However, the relatively short duration of the vessel campaign means the incremental increase in emissions to the atmosphere as a result of the proposed activities is not considered significant. Due to the offshore location of the project area and distance from any populated areas, the impact severity of atmospheric emissions from vessels is	No

[1] CO_2e calculation based on Global Warming Potentials (GWPs) defined on a 100-year horizon according to the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (2014) as required by the United Nations Framework Convention on Climate Change (UNFCCC) and in line with the United Kingdom's National Inventory Report (NIR) (BEIS, 2022b).

Aspect	Project Activity / Source of Impact	Receptor(s)	Potential Impacts on Receptors	Existing Mitigation	Ranking						Justification for selecting / deselecting the aspect for further assessment in the EA	Assessed further in the EA (Yes / No)
					Planned Activities			Unplanned Activities				
					Effect	Duration	Impact	Consequence	Likelihood	Risk Level		
											considered low and is not discussed further in the EA.	
Sound and Vibration	Noise generated from engine and thrusters (vessels dynamically positioned).	Fish Marine Mammals	Potential behavioural changes in fish and marine mammals due to increase in background marine noise levels.	Optimise vessel use. A SIMOPS plan for vessel activity in the field will be put in place.	2	2	4	N / A			A number of marine mammals and fish are known to occur in the Chestnut area, many of which are PMFs. The North Sea has well developed fishing and energy industries and is a busy shipping area, such that marine mammals and fish in the region are habituated to the underwater noise associated with vessels. Over the duration of the removal and recovery, and survey activities the total vessel days associated with the proposed activities is estimated to be *c.* 74 (Section 3.2.8). Any impacts from vessel noise will be behavioural rather than physical, such that they may cause marine mammals or fish to vacate the area, however they would be expected to return once the vessels have left the field. The impact severity of underwater noise on marine mammals and fish is therefore considered to be low and is not discussed further in the EA.	No
Discharges (and small releases) to Sea	Vessels on location and transiting from and to port discharging sewage (grey and black waste water macerated to < 6 mm prior to discharge) / ballast water / biofouling.	Water Quality Plankton Fish Marine Mammals	Water quality in immediate vicinity of discharge may be reduced. Possible introduction of invasive species. Bio-invasions as a result of biofouling.	Operating in line with IMO regulations; International Regulations for the Prevention of Collisions at Sea (COLREGS) (IMO, 1972) and MARPOL regulations. All discharges monitored and records maintained. Audit procedures ensure that contracted vessels ballasting procedures are in line with IMO Convention. All discharges of ballast water will be monitored,	1	2	2	N / A			All vessels will be IMO and MARPOL compliant such that impact severity of any vessel sewage, ballast water or biofouling is considered low and is not discussed further in the EA.	No

Aspect	Project Activity / Source of Impact	Receptor(s)	Potential Impacts on Receptors	Existing Mitigation	Ranking						Justification for selecting / deselecting the aspect for further assessment in the EA	Assessed further in the EA (Yes / No)
					Planned Activities			Unplanned Activities				
					Effect	Duration	Impact	Consequence	Likelihood	Risk Level		
				and records maintained. Only vessels adhering to IMO 2011 Guidelines for the Control and Management of Ships' Biofouling will be used. All member states of IMO are signed up to these guidelines.								
Waste Production	Waste from vessels being taken back onshore.	Landfill resources	Use of landfill resource and landfill resource take.	Vessel assurance and adherence to IMO standards. WMP (Waste Management Plan).Onshore treatment will take place at waste management site with appropriate permits and licenses. UK waste disposal sites will be used where practicable.	1	5	5	N / A			Spirit Energy recognise landfill sites as a finite resource, however, as the vessels will have WMPs in place that will adhere to the waste hierarchy principle of reduce, reuse recycle, the impact severity on the availability of landfill sites is considered low. Also given that Section 12.8 of OPRED's Guidance Notes (OPRED, 2018) advises that an assessment of wastes returned to shore is not required in the EA (as it is not relevant to the impacts in the marine environment), the onshore impacts associated with vessel waste is not discussed further in the EA.	No
Node 2: Decommissioning of Pipelines, Umbilicals, Associated Tie-in Spools, and Pipeline-related Structures												
Resource Use	Return of surface laid pipelines / umbilicals to shore for recycling.	Resource Availability	Positive impact as returning steel and copper for recycling.	Returned materials will be managed in line with the waste hierarchy.	Positive Impact			N / A				No
Sound and Vibration	Cutting and possible deposit of spot rock at cut ends of the flowlines. Disconnection of flowlines	Fish Marine Mammals	Behavioural changes in fish and marine mammals due to increase in background	Operations will draw on standard methods and equipment. Noise generated from cutting operations will be present for a short duration. No explosives used.	1	1	1	N / A			Any underwater noise associated with the proposed activates is expected to have a minimal impact on marine mammal or fish behaviour. Pangerc *et al.*, (2016) reported that the noise from underwater diamond wire cutting during the severance of a 0.76 m diameter conductor at a platform in the North Sea was barely discernible above background noise levels, including the noise of associated vessel	No

Aspect	Project Activity / Source of Impact	Receptor(s)	Potential Impacts on Receptors	Existing Mitigation	Ranking						Justification for selecting / deselecting the aspect for further assessment in the EA	Assessed further in the EA (Yes / No)
					Planned Activities			Unplanned Activities				
					Effect	Duration	Impact	Consequence	Likelihood	Risk Level		
	from flanges and sever flowline ends using hydraulic shears and diamond wire cutting.		marine noise levels.								presence. There is no published information on the response of marine mammals or fish to sound generated by underwater cutting. However, reported source levels are relatively low compared with those generated by vessels such that any noise generated from cutting operations is not likely to cause significant disturbance to marine fauna. The impact severity of underwater sound and vibration on marine mammals and fish is therefore considered to be low and is not discussed further in the EA.	
Seabed Disturbance	Removal and recovery of surface laid flowline sections, tie-in spools and umbilicals (total length *c.* 1,151 m). Excavation required at transition points to reach cut point. Removal and recovery of pipeline-related structures, including 3 riser bases and 1 choke skid / manifold.	Sediment Quality Benthic Communities	Minimal impact to seabed as only exposed sections removed and recovered. Increased suspended sediments in the water column and dilution / dispersion before settling on seabed.	Optimised work procedures. Cutting and lifting procedures in place. Activities which may lead to seabed disturbance planned, managed, and implemented in such a way that disturbance is minimised. A Marine License will be in place for any planned operational disturbance.	2	1	2	N / A			Effect ranked 2 based on protected seabed habitats identified (Fugro, 2022a; Fugro, 2022b). However, it is a very small area and therefore overall impact is considered to be low. However, to allow an assessment of the cumulative seabed disturbance across all activities, the impact severity of seabed disturbance resulting from these activities is discussed further in the EA.	Yes

Aspect	Project Activity / Source of Impact	Receptor(s)	Potential Impacts on Receptors	Existing Mitigation	Ranking						Justification for selecting / deselecting the aspect for further assessment in the EA	Assessed further in the EA (Yes / No)
					Planned Activities			Unplanned Activities				
					Effect	Duration	Impact	Consequence	Likelihood	Risk Level		
	Installation of rock deposits for remediation activities.	Sediment Quality Benthic Communities	Potential smothering of benthic fauna and change in communities .	Where possible Spirit Energy will reprofile existing rock deposits.	1	5	5	N / A			Effect ranked 1 as although there are protected seabed habitats identified (Fugro, 2022a; Fugro, 2022b), the area impacted is very small in comparison to the row above. Duration ranked 5 as deposited rock will be there indefinitely. Overall impact is considered to be low, however, to allow an assessment of the cumulative seabed disturbance across all activities, the impact severity of seabed disturbance resulting from these activities is discussed further in the EA.	Yes
Discharges to Sea	Disconnection of flowlines from flanges, discharge of residual hydrocarbons. Discharge of flowline and umbilical contents during removal and recovery of exposed line lengths.	Water Quality Plankton Benthic Communities Fish	Water quality impact and potential seabed deposition. Impact on marine flora and fauna. Localised Impacts.	All discharges will be permitted under applicable UK legislation. Umbilical cores contain water-based hydraulic fluids. Flushing activities (taken place previously under Phase 1 of decommissioning) have followed BAT / BEP approach to minimise oil remaining in the flowlines to a target of 30 mg / L. Therefore, residual amounts of oil remaining in the production flowlines will be minimal.	1	1	1	N / A			Given that the lines have been flushed and cleaned to BAT / BEP such that hydrocarbon content has been reduced to ALARP and given the current contents of the flowlines and umbilicals, the impact severity of any discharges during cutting / recovery activities is considered low and is not considered further in the EA.	No
	Swarf (shavings) resulting from cuttings activities.	Water Quality Sediment Quality Plankton Benthic Communities Fish	Shavings temporarily suspended in water column before settling on seabed. Potential to temporarily	Work procedures in place. Cuts will be made using diamond wire saw or hydraulic shears. The use of hydraulic shears would not result in any shavings to be released into the water column.	1	1	1	N / A			Given that the quantity of shavings discharged will be minimal and the use of hydraulic shears would not result in any shavings, the impact severity of any discharges during cutting activities is considered low and is not considered further in the EA.	No

Aspect	Project Activity / Source of Impact	Receptor(s)	Potential Impacts on Receptors	Existing Mitigation	Ranking						Justification for selecting / deselecting the aspect for further assessment in the EA	Assessed further in the EA (Yes / No)
					Planned Activities			Unplanned Activities				
					Effect	Duration	Impact	Consequence	Likelihood	Risk Level		
			impact on water quality and may be ingested by fauna in the water column before settling on the seabed.									
Waste Production	Material returned to shore for disposal. Includes pipelines contaminated with Naturally occurring radioactive material (NORM).	Landfill Resources.	Use of landfill resource and landfill resource take.	Any material returned to shore will be treated in line with the waste hierarchy, thereby minimising material to landfill.	1	5	5	N / A			Based on production records to date, NORM is expected. Tests for NORM will be undertaken offshore, and any NORM encountered will be dealt with and disposed of in accordance with guidelines and company policies. Spirit Energy recognise landfill sites as a finite resource, however, considering the mitigation measures and relatively small quantity of material to be returned, the severity of impact on the availability of landfill sites is considered low. Also given that Section 12.8 of OPRED's Guidance Notes (OPRED, 2018) advises that an assessment of wastes returned to shore is not required in the EA (as it is not relevant to the impacts in the marine environment), the onshore impacts associated with waste is not discussed further in the EA.	No
Node 3: Decommissioning of Subsea Installations (WHPS)												
Resource Use	Return of subsea installations to shore for recycling.	Resource Availability	Positive impact as returning steel and copper for recycling.	Returned materials will be managed in line with the waste hierarchy.	Positive Impact			N / A				No

Aspect	Project Activity / Source of Impact	Receptor(s)	Potential Impacts on Receptors	Existing Mitigation	Ranking						Justification for selecting / deselecting the aspect for further assessment in the EA	Assessed further in the EA (Yes / No)
					Planned Activities			Unplanned Activities				
					Effect	Duration	Impact	Consequence	Likelihood	Risk Level		
Sound and Vibration	Cutting and lifting of subsea installations (including cutting of piles associated with well P1 WHPS).	Fish Marine Mammals	Behavioural changes in fish and marine mammals due to increase in background marine noise levels.	Operations will draw on standard methods and equipment. Noise generated from cutting operations will be present for a short duration. No explosives used. Internal cutting prioritised over external cutting.	1	1	1	N / A			Any underwater noise associated with the proposed activates is expected to have a minimal impact on marine mammal or fish behaviour. Studies indicate that there is no significant impact from the noise generated by cutting operations. The impact severity of underwater sound and vibration on marine mammals and fish is therefore considered to be low and is not discussed further in the EA.	No
Seabed Disturbance	Removal and recovery of the subsea installations. All subsea installations will be completely removed. Includes 4 WHPS.	Water Quality Sediment Quality Plankton Benthic Communities Fish	Increased suspended sediments in the water column and dilution / dispersion before settling on seabed. Seabed will begin to recover once infrastructure has been removed and recovered.	Activities which may lead to seabed disturbance planned, managed, and implemented in such a way that disturbance is minimised. Lifting procedures in place that will minimise disturbance. Structure weights within lifting capacity of standard vessels. Small number of structures and they can be removed and recovered with a single lift, thus minimising the area of seabed disturbed.	2	1	2	N / A			Seabed will begin to recover once infrastructure has been removed and recovered. Effect ranked 2 based on protected seabed habitats identified (Fugro, 2022a; Fugro, 2022b). However, it is a very small area and therefore overall impact is considered to be low. However, to allow an assessment of the cumulative seabed disturbance across all activities, the impact severity of seabed disturbance resulting from these activities is discussed further in the EA.	Yes
Discharges to Sea	Swarf (shavings) resulting from cuttings activities.	Water Quality Sediment Quality Plankton Benthic Communities Fish	Shavings temporarily suspended in water column before settling on	Work procedures in place. Expected that most of the structures will be removed and recovered with a single lift, such that offshore cuttings activities will be minimised.	1	1	1	N / A			Given that the quantity of shavings discharged will be minimal and the use of hydraulic shears would not result in any shavings, as well as most structures being removed and recovered with a single lift, the impact severity of any discharges during cutting activities is considered low and is not considered further in the EA.	No

Aspect	Project Activity / Source of Impact	Receptor(s)	Potential Impacts on Receptors	Existing Mitigation	Ranking						Justification for selecting / deselecting the aspect for further assessment in the EA	Assessed further in the EA (Yes / No)
					Planned Activities			Unplanned Activities				
					Effect	Duration	Impact	Consequence	Likelihood	Risk Level		
			seabed. Potential to temporarily impact on water quality and may be ingested by fauna in the water column before settling on the seabed.									
Waste Production	Material returned to shore for disposal. Includes structures which are contaminated with NORM from the internal pipework.	Landfill Resources.	Use of landfill resource and landfill resource take.	Any material returned to shore will be treated in line with the waste hierarchy, thereby minimising material to landfill.	1	5	5	N / A			Based on production records to date, NORM is expected. Tests for NORM will be undertaken offshore, and any NORM encountered will be dealt with and disposed of in accordance with guidelines and company policies. Spirit Energy recognise landfill sites as a finite resource, however, considering the mitigation measures and relatively small quantity of material to be returned, the severity of impact on the availability of landfill sites is considered low. Also given that Section 12.8 of OPRED's Guidance Notes (OPRED, 2018) advises that an assessment of wastes returned to shore is not required in the EA (as it is not relevant to the impacts in the marine environment), the onshore impacts associated with waste is not discussed further in the EA.	No
Node 4: Decommissioning of Protection and Stabilisation Features												
Seabed Disturbance	Removal and recovery of mattresses and grout bags. All mattresses	Water Quality Plankton Benthic Communities Fish	Increased suspended sediments in the water column and dilution /	Operations will draw on standard methods and equipment. Lifting procedures in place. Optimised work	2	1	2	N / A			Seabed will begin to recover once protection and stabilisation features have been removed and recovered. Effect ranked 2 based on protected seabed habitats identified (Fugro, 2022a; Fugro, 2022b). However, it is a very small area and therefore overall severity of impact is considered to	Yes

Aspect	Project Activity / Source of Impact	Receptor(s)	Potential Impacts on Receptors	Existing Mitigation	Ranking						Justification for selecting / deselecting the aspect for further assessment in the EA	Assessed further in the EA (Yes / No)
					Planned Activities			Unplanned Activities				
					Effect	Duration	Impact	Consequence	Likelihood	Risk Level		
	and grout bags on approaches to other wells, riser bases and manifolds will be fully removed.		dispersion before settling on seabed.	procedures. Marine growth on mattresses and grout bags is expected to be minimal due to the length of time mattresses have been deployed.							be low. However, to allow an assessment of the cumulative seabed disturbance across all activities, the impact of seabed disturbance resulting from these activities is discussed further in the EA.	
Waste Production	Removal and recovery of all exposed concrete mattresses and gout bags to onshore for re-use, recycling or disposal.	Landfill Resources.	Use of landfill resource and landfill resource take.	Inventory of waste in place. Treatment as per waste hierarchy to minimise resource take.	1	1	1	N / A			Spirit Energy recognise landfill sites as a finite resource, however, considering the mitigation measures and relatively small quantity of material to be returned, the severity of impact on the availability of landfill sites is considered low. Also given that Section 12.8 of OPRED's Guidance Notes (OPRED, 2018) advises that an assessment of wastes returned to shore is not required in the EA (as it is not relevant to the impacts in the marine environment), the onshore impacts associated with waste is not discussed further in the EA.	No
Node 5: Over-trawl Trials												
Seabed Disturbance	Seabed disturbance associated with over-trawl trial of *in situ* infrastructure. Over-trawl survey using fishing vessel and chain mat.	Water Quality Benthic Communities Fish	Localised physical seabed disturbance. Community change. Temporary sediment suspension before settling on the seabed. Expected	Minimise disturbance to seabed from over-trawl through liaison with fishing organisations and regulator. Where possible non-intrusive methods will be used to show clear seabed. Consider side scan sonar or echo sounder survey.	2	1	2	N / A			As a worst case, a trawl sweep using a chain mat will be required to demonstrate a safe seabed. Ranking is based on worst case where over-trawl trial required the full length of lines with a 100 m corridor and within full 500 m safety zones. Fishing in the area is considered low, however, gear type most commonly used in 44F1 is bottom trawl gear, and thus the impact of an over-trawl trial is not expected to be more significant that the impact of the demersal trawl gear associated with the wider area. Impact severity is scored low. However, to allow an assessment of the cumulative seabed disturbance across all activities, the impact of	Yes

Aspect	Project Activity / Source of Impact	Receptor(s)	Potential Impacts on Receptors	Existing Mitigation	Ranking						Justification for selecting / deselecting the aspect for further assessment in the EA	Assessed further in the EA (Yes / No)
					Planned Activities			Unplanned Activities				
					Effect	Duration	Impact	Consequence	Likelihood	Risk Level		
			that the ecosystem will begin recovery as soon as activities are completed.								seabed disturbance resulting from these activities is discussed further in the EA	
Node 6: Legacy Impacts												
Physical Presence	Surrendering of existing 500 m safety zones.	Commercial fisheries.	Return of area for alternative uses (shipping, fishing, windfarms, dredging).	N / A	Positive Impact			N / A			To assess overall legacy impact on other sea users, the impact severity of surrendering the existing 500 m safety zones will be considered further in the EA.	Yes
	Infrastructure decommissioned *in situ*, and any additional rock that may be added for remediation activities. Long-term 1 te grout bags and mattresses remaining *in situ* as buried under rock.	Commercial fisheries.	Infrastructure remaining on or in the seabed could present a snagging hazard for fishing gear.	Independent verification of a safe seabed will be obtained. Post-decommissioning pipeline status survey will be carried out. The 1 te grout bags have been used to fill in a free span and therefore do not protrude above seabed.	1	5	5	N / A			Duration ranked 5 as infrastructure decommissioned *in situ* will be there indefinitely. Effect ranked 1 as very small area. Impact severity is scored low. Given stakeholder interests with respect to a safe seabed, the decommissioning of the buried flowlines and umbilicals, protection and stabilisation features, and deposited rock (existing and any potential rock added for remediation activities) will be considered further in the EA.	Yes
Discharges (and small releases) to Sea	Degradation over time of flowlines and umbilicals	Sediment Quality Water Quality	Following eventual degradation of the	The flowlines and umbilicals decommissioned *in situ* are buried under the	1	5	5	N / A			All infrastructure decommissioned *in situ* will be trenched and buried such that impacts of degradation will be contained within a limited area around the flowlines and umbilicals. As the lines	Yes

Aspect	Project Activity / Source of Impact	Receptor(s)	Potential Impacts on Receptors	Existing Mitigation	Ranking						Justification for selecting / deselecting the aspect for further assessment in the EA	Assessed further in the EA (Yes / No)
					Planned Activities			Unplanned Activities				
					Effect	Duration	Impact	Consequence	Likelihood	Risk Level		
	decommissioned *in situ* (metal and plastic flowline and umbilical coatings, mattresses). There will be *c.* 9.2 km of lines decommissioned *in situ*.	Benthic communities	flowlines and umbilicals, the current line contents will leak out into the sediment / water. Potential impact on benthic marine flora and fauna within sediment.	seabed with a good depth of cover, and rock cover such that following eventual degradation, expected the disintegrated line components and contents will be restricted to their current location and will not make it into the water column. No direct pathways to the water column are expected. Flowlines and tie-in spools will be flushed and filled with seawater prior to disconnection. Flushing activities will follow BAT / BEP approach to minimise oil remaining in the flowlines to a target of 30 mg / L. Therefore, residual amounts of oil remaining in the production flowlines will be minimal.							corrode the contents will 'seep' into surrounding sediments, however the effect on biota is not considered significant as the lines contain only filtered seawater or water-based hydraulic fluid. During the gradual breakdown there will be a release of metals and plastics into the sediment. As degradation will take place over decadal or centurial timescales it is not expected that metal concentrations in the sediment will accumulate significantly. Duration ranked 5 as infrastructure decommissioned *in situ* will be there indefinitely. Impact severity is scored low. Given stakeholder interests with respect to a safe seabed, the decommissioning of the buried flowlines and umbilicals will be considered further in the EA.	
Node 7: Accidental Events												
Seabed Disturbance	Dropped objects during lifting activities.	Benthic Communities.	Localised physical seabed disturbance which may cause mortality of individual benthic animals.	Experienced contractors will be used. Lifting operations will be planned to manage the risk. Approved work procedures in place. All items will be securely stowed. Removal and recovery of any dropped objects. Debris survey will	1	1	1	1	3	3	There would be no live lines in the area that could be impacted. In addition, the dropped object would be removed and recovered. Incident log / register. Dropped object reporting as per Petroleum Operations Notice 2 (PON2) requirements. Assessed assuming dropping of pipeline end, subsea installation, or a mattress / grout bag. In line with Subsection 12.4 of the OPRED Decommissioning Guidance (OPRED, 2018), the impacts of accidental events are not assessed in the	No

Aspect	Project Activity / Source of Impact	Receptor(s)	Potential Impacts on Receptors	Existing Mitigation	Ranking: Planned Activities – Effect	Ranking: Planned Activities – Duration	Ranking: Planned Activities – Impact	Ranking: Unplanned Activities – Consequence	Ranking: Unplanned Activities – Likelihood	Ranking: Unplanned Activities – Risk Level	Justification for selecting / deselecting the aspect for further assessment in the EA	Assessed further in the EA (Yes / No)
				be carried out.							EA.	
Discharges (and small releases) to Sea	Leak of hydraulic fluid from cutting equipment.	Water Quality Marine Flora and Fauna	Damage to aquatic environment, impact on marine flora and fauna. Minor localised impacts.	Follow Spirit Energy's Marine Assurance Standard. Pre-deployment checks and awareness. Spill volumes expected to be low.	1	1	1	1	4	4	Effect ranked 1 as protected species are on seabed and not in water column. In line with Subsection 12.4 of the OPRED Decommissioning Guidance (OPRED, 2018), the impacts of accidental events are not assessed in the EA.	No
	Unintentional releases of fuel or other fluids (e.g., diesel, hydraulic oil, lubricants, or chemicals) during day-to-day operations (including re-fuelling).	Water Quality Marine Flora and Fauna	Potential to cause localised toxic effects on marine fauna and flora and localised pollution, which may impact local marine wildlife and rafting seabirds on the sea surface.	Vessel contactors will have procedures for fuel bunkering that meet Spirit Energy's standards. Where practicable, re-fuelling will take place during daylight hours only. All contracted vessels will have a SOPEP in place. Agreed arrangements in place with oil spill response organisation mobilising resources in event of a spill. Existing field OPEP in place to reduce the likelihood of hydrocarbon release and define spill response in place. Spirit Energy Marine Standard will be adhered to.	1	1	1	1	4	4	Effect ranked 1 as protected species are on seabed and not in water column. In line with Subsection 12.4 of the OPRED Decommissioning Guidance (OPRED, 2018), the impacts of accidental events are not assessed in the EA.	No

Aspect	Project Activity / Source of Impact	Receptor(s)	Potential Impacts on Receptors	Existing Mitigation	Ranking: Planned Activities: Effect	Ranking: Planned Activities: Duration	Ranking: Planned Activities: Impact	Ranking: Unplanned Activities: Consequence	Ranking: Unplanned Activities: Likelihood	Ranking: Unplanned Activities: Risk Level	Justification for selecting / deselecting the aspect for further assessment in the EA	Assessed further in the EA (Yes / No)
Large Releases to Sea	An emergency incident (e.g., vessel collision), leading to loss of fuel inventory.	Water Quality Marine Flora and Fauna Marine mammals Seabirds	Potential total loss of containment of entire inventories of diesel, utility fuels and chemicals from vessels causing significant hydrocarbon and chemical pollution. Potential impacts on water quality and marine wildlife in the affected area.	Spirit Energy's Marine Standards will be adhered to. All contracted vessels will have a SOPEP in place.	4	2	8	2	2	4	Scoring based on Chestnut field OPEP. Consequence and duration ranked 2 given it is offshore and diesel will evaporate. In line with Subsection 12.4 of the OPRED Decommissioning Guidance (OPRED, 2018), the impacts of accidental events are not assessed in the EA.	No

8. SEABED DISTURBANCE

When assessing the impact of the proposed activities during the ENVID workshop (Section 7), none of the identified seabed impacts were considered to result in a significant environmental impact. However, it is acknowledged that the activities were assessed separately and therefore those activities resulting in seabed disturbance are considered further here to allow for a cumulative assessment to be completed.

8.1 Project Activities (Source of Impact)

The following activities will, or may, disturb the seabed:

- Removal and recovery of the subsea installations and associated structures, surface laid ends of the flowlines and umbilicals, tie-in spools, umbilical jumpers, pipeline-related structures, mattresses and grout bags;
- Potential additional deposited rock to remediate the excavations required for the cutting of the well P1 WHPS piles, and to remediate any excavations or removal of concrete mattresses associated with the PL2422 free span;
- Potential over-trawl trials.

Note: It is recognised that not all of these activities will necessarily be undertaken (e.g., deposit of additional rock or over-trawl trials), however, they have been fully assessed in this section to ensure the potential 'worst case' impact is considered.

Table 8-1 presents the estimated total area of temporary disturbance associated with the potential decommissioning activities (estimated at 0.04 km^2), other than those associated with the over-trawl trials.

With regards to the exposed cut ends of the flowlines and umbilicals to be decommissioned *in situ*, *c*. 15 te of additional rock may be required in total to remediate the ends. If rock is required to backfill the excavations made to cut the well P1 WHPS piles, the estimated quantity of rock required would be 635 te per pile excavation (total 2,541 te). If the concrete mattresses associated with the PL2422 free span are found to be partially exposed (base case) and are considered to present a snagging hazard, four mattresses will be removed and recovered to shore and replaced with deposited rock (*c*.121 te). The total potential quantity of rock to be deposited for all decommissioning activities is 2,587 te. Assuming each tonne has a permanent footprint of 1 m^2, this would equate to a maximum permanent seabed footprint of 0.00259 km^2.

If over-trawl trials are required to demonstrate a safe seabed, the area covered will include the footprint of activities captured within Table 8-1. The area impacted by the over-trawl trial is estimated to be *c*. 2.94 km^2 (Figure 8-1). Table 8-2 shows the worst case assumptions used to calculate this area of (seabed) disturbance.

Spirit Energy will explore the use of a side scan sonar / multibeam sonar surveys or similar to demonstrate a safe seabed, and therefore minimise the area of temporary seabed disturbance.

Table 8-1: Estimated areas of temporary and permanent seabed disturbance.

Project Activity Source of Impact	Items / materials and assumptions made	Area of Temporary Disturbance (km^2)	Area of Permanent Disturbance (km^2)
Removal and recovery of subsea installations and pipeline-related structures*	• Well P1 WHPS: 16 m (W) x 16 m (L) • Three other WHPS: 5.7 m (W) x 5.7 m (L) • Four WHPS Anode Skids: 1.8 m (W) x 2 m (L) • Production riser base: 4.9 m (W) x 4.93 m (L) • WI riser base: 4.9 m (W) x 4.93 m (L) • Control riser base: 6.5 m (W) x 6 m (L) • Choke skid / manifold and protection structure: 3 m (W) x 3.5 m (L) As a worst case, temporary disturbance out to 5 m on each side of each structure is assumed. Note that this will possibly be less for many of the smaller structures e.g., the anode skids and could be more for the well P1 WHPS (piled structure), however this assumption is expected to be representative across all structures.	0.003	-
Removal and recovery of surface laid flowlines, umbilicals, and tie-in spools	The total length of surface laid flowlines, umbilicals, tie-in spools and umbilical jumpers to be removed and recovered is *c*. 1,151 m (PL2421 – 45 m; PL2422 – 7 m; PLU2423 – 167 m; PLU2544 – 130 m; PL2545 – 347 m; and PL2546 – 155 m, PL4706 – 150 m, PL4707 – 150 m). As a worst case, temporary disturbance corridor of 5 m is assumed along the length of each line.	0.006	-
Removal and recovery of mattresses	• 170 mattresses measuring 6 m (L) x 3 m (W) to be removed and recovered. As a worst case, temporary disturbance out to 2 m on each side of each mattress is assumed.	0.012	-
Removal and recovery of 1 te grout bags	• 11 x 1 te grout bags to be removed and recovered. As a worst case, temporary disturbance of 3 m^2 is assumed for removal and recovery of every 1 te grout bag.	0.00003	-
Removal and recovery of 25 kg grout bags	• 4,982 x 25 kg grout bags to be removed and recovered. As a worst case, temporary disturbance of 1 m^2 is assumed for removal and recovery of every 25 kg grout bag.	0.005	-
Potential deposit of rock	• To remediate exposed line ends, *c*. 15 te of additional rock may be required. • To remediate excavations at well P1 WHPS, a total of *c*. 2,541 te of additional rock may be required (635 te per pile excavation). • To remediate removal and recovery of four mattresses associated with PL2422 free span, *c*.121 te of additional rock may be required. Total for all activities: 2,587 te. As a worst case, permanent disturbance of 1 m^2 is assumed for every 1 te of rock, and temporary disturbance of 2 m^2 is assumed for every 1 te of rock.	0.00517	0.00259
Total		0.031	0.00259
*Note that pipeline-related structures have been considered alongside subsea installations for the purposes of seabed disturbance calculations. Area of disturbance calculated for each line item will overlap with other line items in a number of instances such that the area calculated is a worst case estimate.			

Table 8-2: Estimated area impacted by over-trawl trials.

Project Area	Assumptions Made	Area of Temporary Disturbance (km^2)
Existing 500 m safety zones	Assumes over-trawling of three 500 m safety zones currently in place at well P1, well P4 and at the WI well. Area of one safety zone (i.e. 500 m radius) is 0.79 km^2.	2.36
Flowline and umbilical routes	Assumes over-trawling of a 100 m corridor along the full flowline and umbilical lengths out with the 500 m safety zones at.	0.58
Total		2.94
Note: Area of disturbance calculated for each line item will overlap with other line items in a number of instances such that the area calculated is a worst case estimate.		

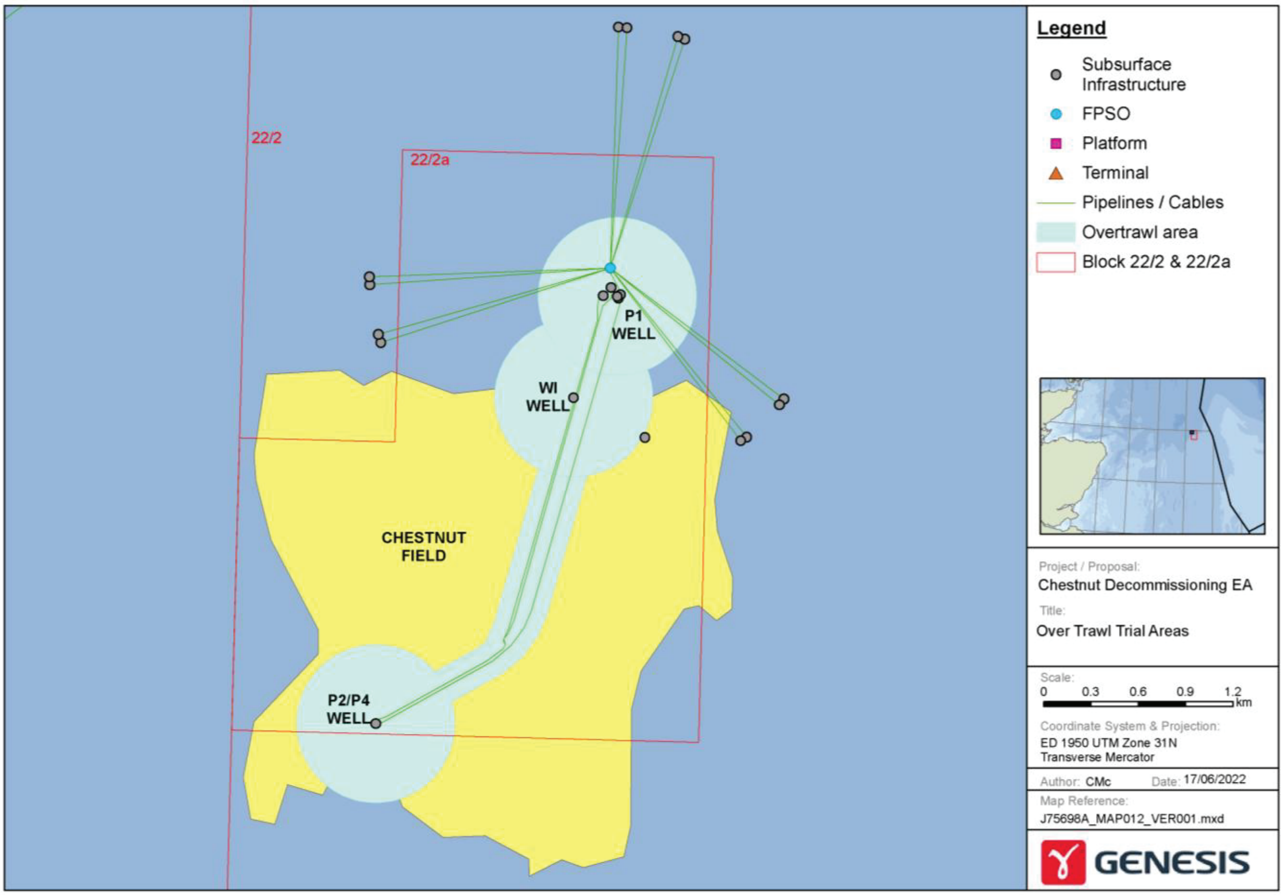


Figure 8-1: Maximum area expected to be covered by the potential over-trawl trials.

8.2 Impact on Receptors

The maximum area of temporary seabed disturbance associated with the worst case proposed decommissioning activities is 2.94 km^2. However, this relates to an area impacted by the over-trawl trials and would be significantly less if side scan sonar or multibeam sonar surveys are used to obtain evidence of a safe seabed. Impacts on this seabed area are considered temporary because, following completion of activities, the seabed will begin to recover.

The seabed area considered to be impacted permanently is limited to the areas where additional rock could be deposited. For this assessment, worst case is the potential deposit of *c.* 2,587 te additional rock in total for all activities, with a maximum seabed footprint of 0.00259 km^2.

Given the nature of the sediment in the area it is possible that disturbed sediment particles may be transported via tidal currents for resettlement over adjacent seabed areas. Sessile epifaunal species may be particularly affected by increases in suspended sediment concentrations as a result of potential clogging or abrasion of sensitive feeding and respiratory apparatus (Nicholls *et al.,* 2003). In the case of filter feeders, such as sea pens (*P. phosphorea* and *V. mirabilis*) and juvenile Ocean quahog (*A. islandica)*, an increased suspended sediment concentration could impact the ability to feed. Larger, more mobile animals, such as crabs and fish, are expected to be able to avoid areas of deposition and elevated suspended solid concentrations.

As discussed in Section 5.5.2, the OSPAR listed threatened and / or declining habitat 'sea pens and burrowing megafauna communities' may occur in the area. No adult specimens of the Scottish PMF *A. islandica* were identified, although juveniles were recorded in macrofaunal samples from all but three stations sampled during the pre-decommissioning survey of the Chestnut area. The survey area was also classified as the EUNIS biotope complex 'deep circalittoral mud' (A5.37), which falls within the broad PMF habitats 'burrowed mud' and 'offshore deep-sea muds', as well as the UK BAP Priority Habitat 'mud habitats in deep water' (Fugro, 2022a; Fugro, 2022b).

The Feature Activity Sensitivity Tool (FeAST) (Marine Scotland) reports that burrowed mud habitats (and the species that it supports, such as sea pens) show a medium sensitivity to sub-surface abrasion / penetration and surface abrasion, which may be caused by the over-trawl trials. Experimental studies have shown that sea pens recover rapidly from displacement and removal from the seabed, i.e., *P. phosphorea and F. quadrangularis* were found to right themselves when dislodged, and *V. mirabilis* was found to withdraw into its burrow rapidly (in 30 seconds) and could not be uprooted by dragged creels (fishing gear) (Eno *et al*., 2001; Ambroso *et al.,* 2013). In long-term experimental trawling, Tuck *et al.* (1998) found no effect on *V. mirabilis* populations and Kinnear *et al.* (1996) found that sea pens were quite resilient to being dragged or uprooted (by creels). *V. mirabilis* is able to withdraw into the sediment, which may provide it with some protection from dislodgement (Hughes, 1988). *P. phosphorea* recovered within 72 – 96 hours after experimental smothering by pot or creel for 24 hours, and recovered within 96 – 144 hours after smothering for 48 hours (Kinnear *et al.* 1996; Eno *et al*. 2001).

The proposed decommissioning activities may therefore impact on the 'sea pens and burrowing megafauna communities' habitat, however this impact is not expected to be significant due to the very localised nature of the operations and the results of the studies cited.

A. islandica have a thick, solid and heavy shell, and are considered to be highly sensitive to sub-surface abrasion/penetration. Damage is related to body size with larger specimens being more affected than smaller ones (Klein and Witbaard, 1993). As they burrow into the sediment, they are thought to be less sensitive to surface abrasion, however, they use a short inhalant siphon which sits above the sediment surface for feeding and respiration. If this is damaged then there may be an adverse effect on the organism, but the potential for this to happen is uncertain. It remains possible that individuals of this species may be directly impacted by seabed disturbance as a result of decommissioning activities, potentially resulting in individual mortality. Despite this, laboratory tests by Powilleit *et al.,* (2009) exposed *A. islandica* to sediment depths of up to 40 cm and found that the organism was able to burrow to the surface. Based on this evidence, Tyler-Walters and Sabatini (2017) conclude that a deposit of 30 cm of fine material is unlikely to have a negative impact on *A. islandica*. Therefore, though the proposed activities will result in the settling of suspended sediments over an extended area, the area over which burial depths exceeds 30 cm is expected to be localised such that the impact of the proposed activities on *A. islandica* is not expected to be significant.

Any impacts from compression (caused for example by potential remedial rock deposits) and sediment re-suspension are expected to be short-lived since most of the smaller sedentary species associated with the area (such as polychaete worms) have short life cycles and recruitment of new individuals from outside the disturbed area will be rapid. Recolonisation of the impacted areas can take place in a number of ways, including mobile species moving in from the edges of the area (immigration), juvenile recruitment from the plankton, and burrowing species digging back to the surface (Collie *et al.*, 2000).

Recovery times for soft sediment faunal communities are difficult to predict, although some recent studies have attempted to quantify timescales. Hiddink *et al.,* (2017) have estimated seabed recovery rates from changes in the biomass and numbers of biota across areas disturbed by bottom trawling. The study found that seabed recovery times ranged from 1.9 to 6.4 years, depending on trawl penetration depth, trawling frequency, levels of primary production in the area, and gravel content in the sediment. Communities on sediments with a higher gravel content were found to be more sensitive to trawling as they often have a greater proportion of larger, long-lived, and sessile epifauna.

Collie *et al.,* (2000) concluded that sandy sediment communities were able to recover rapidly from disturbance by bottom-towed fishing gear, although this was dependent upon the spatial scale of the impact. It was estimated that recovery from a small-scale impact, such as a fishing trawl, could occur within about 100 days assuming that recolonisation was through immigration into the disturbed area rather than from settlement or reproduction within the area. Studies by Hiddink *et al.,* (2017) and Lambert *et al.,* (2014) have also found that seabed recovery was quicker where trawled areas are closer to less impacted areas from which individuals can recruit or migrate. Recovery through immigration would be expected to take longer for the more extensive trawled areas, thus larval recruitment or local reproduction by surviving individuals may be more important determining factors in this scenario (Collie *et al.,* 2000).

Given the relatively small area of temporary seabed disturbance resulting from Chestnut decommissioning activities and the evidence for recovery from small-scale impacts, the severity of the environmental impact of the proposed activities on benthic communities is considered low.

The loss of habitat and smothering of benthos associated with the potential deposit of rock creates habitats for benthic organisms that live on hard substrates, leading to a change in the local seabed community. As described in Section 5.6.2, there are existing areas of rock deposits along the Chestnut flowlines (4,635 te), as well as two larger objects identified as boulders (Fugro, 2022a: Fugro, 2022b). Therefore, the addition of limited quantities of rock deposits to the area will not be introducing a new hard substrate to the area, rather it will be increasing the footprint of existing hard substrate. The severity of the environmental impact of any additional rock deposits is therefore considered to be low.

Evidence suggests that the sensitivity of fish to suspended sediments varies greatly between species and their life history stages and depends on sediment composition (particle size and angularity), concentration and the duration of exposure (Newcombe and Jensen, 1996). Being the major organ for respiration and osmoregulation, gills are directly exposed to, and affected by, suspended solids in the water. If sediment particles are caught in or on the gills, gas exchange with the water may be reduced leading to oxygen deprivation (Essink 1999; Clarke and Wilber, 2000). This effect is greatest for juvenile fish as they have small easily clogged gills and higher oxygen demand (FeBEC, 2010). As described in Section 5.5.3, a number of fish species recognised as PMFs occur in the Chestnut area, and it is possible that suspended sediments in the water column resulting from the removal and recovery activities could impact on individual fish including PMFs. However, given the short duration of the activities, any impacts on fish in the area will be at an individual level such that the environmental impact is considered low.

The Chestnut infrastructure lies in an area that is targeted by demersal fishing gear (such as bottom trawls) and the temporary impacts of the decommissioning activities are considered to be low when compared to the impacts associated with these gear types.

8.3 Transboundary and Cumulative Impacts

The Chestnut field is located approximately 34 km from the UK / Norway jurisdictional median line. Given the relatively small scale and local nature of the proposed decommissioning activities, no transboundary seabed impacts are anticipated.

The cumulative impact associated with the temporary seabed disturbance is negligible when seabed disturbance associated with demersal fishing in the area is taken into account.

Any additional permanent rock deposits required for remedial activities will be located outwith a designated area. Compared to existing rock deposits and boulders in the vicinity, the environmental impact of any cumulative impacts is still considered low.

8.4 Mitigation Measures

The following mitigation measures are proposed to minimise the environmental impacts related to seabed disturbance the Chestnut Phase 2 Decommissioning Project:

- Cutting and lifting procedures will be in place.
- With respect to remediation of the exposed ends of the buried flowlines and umbilicals, excavated back-filled material will be prioritised over adding rock deposits.
- If rock deposits are required, volumes will be minimised.
- Rock deposit profiles will align with industry standards with respect to size of rock.
- Preference will be given to the use of side scan sonar / multibeam sonar surveys (or similar) to determine a safe seabed.

8.5 Conclusions

The majority of decommissioning activities associated with the Chestnut Field Phase 2 Decommissioning Project will result in localised short-term disturbance to the seabed. Permanent disturbance is limited to the areas where additional rock could be deposited to remediate exposed ends of lines.

Over-trawl trials used to confirm a safe seabed will result in the largest area of impact, and Spirit Energy will investigate the use of side scan sonar / multibeam sonar surveys (or similar) to determine a safe seabed and therefore remove this impact.

Should rock deposits be added for remediation activities, it is expected that any impacts will not be significant given the small scale of the additional rock cover and the presence of existing rock substrates.

Considering the scope of activities and the receptors in the area, the severity of the environmental impact of disturbing the seabed is considered Low. In addition, the activities assessed in this Chapter will not contradict the NMP objectives (Section 5.8) and as the project progresses Spirit Energy will aim to comply with the NMP policies. In addition, the project will aim to comply with the oil and gas marine planning policies (Section 5.9).

9. LEGACY IMPACTS

When assessing the impact of the proposed activities during the ENVID workshop (Section 7), none of the legacy impacts were considered to result in a significant environmental impact. However, given that the legacy impacts could change over time, they are considered further here.

9.1 Project Activities (Source of Impact)

The following activities will, or may, result in a legacy impact:

- Cutting of Well P1 WHPS piles (leaving pile 'stumps' *in situ*);
- Decommissioning of the trenched and buried sections of flowlines and umbilicals *in situ*;
- Decommissioning of the existing deposited rock and buried concrete mattresses and grout bags *in situ*; and
- Potential deposit of additional rock to remediate exposed cut ends of flowlines and umbilicals to be decommissioned *in situ*, and to remediate excavations for the well P1 WHPS piles, and to remediate any required excavations or removal of concrete mattresses associated with the PL2422 free span.

In line with the results of the CA, Spirit Energy proposes to decommission the trenched and buried sections of the flowlines and umbilicals *in situ*. As described in Section 4, the preference is that after cutting, removing and recovering the surface laid sections of the lines, the exposed cut ends will be protected by backfilling / reprofiling of previously excavated material, however, the contingency of additional rock deposits exists should any difficulties be encountered. This could result in a total quantity of *c*. 15 te being deposited on the seabed. If rock is therefore required to backfill the excavations made to cut the well P1 WHPS piles, the estimated quantity of rock required would be 2,541 te. If the four concrete mattresses associated with the PL2422 free span are considered to present a snagging hazard they will be removed and recovered to shore and replaced with *c*.121 te of deposited rock. The total potential quantity of rock to be deposited for all decommissioning activities is 2,857 te.

The environmental and socio-economic legacy impacts of decommissioning the buried sections of flowlines, umbilicals, buried mattresses and 1 te grout bags, existing deposited rock and any additional rock deposits *in situ* are discussed here.

9.2 Environmental Impact of Infrastructure to be Decommissioned *In Situ*

9.2.1 Buried Flowlines and Umbilicals

Over time the trenched and buried sections of flowlines and umbilicals will break down. Analysis by Atkins indicates that the process of deterioration of rigid steel pipelines in saltwater environments may take from 220 to 600 years (Atkins, 2012) and OEUK suggests that steel structures below the seabed will corrode at rates in the region of 0.01 to 0.02 mm / year (OEUK, 2013). It is expected that the deterioration of plastics within the flowlines and umbilicals will take significantly longer (Dames *et al.,* 1999).

A dataset compiled by Solan *et al.* (2019), based on a literature review of papers published since 1864, found that the mixed sediment depth (bioturbation depth) in the North Sea is up to 25 cm. This means that any material remaining in the seabed sediments at a depth greater than this is unlikely to have any interaction with benthic organisms, provided that it remains buried to this depth.

9.2.1.1 Flowline and Umbilical Contents

The flowlines to be decommissioned *in situ* will be flushed and filled with seawater prior to disconnection, whilst the umbilical cores contain either seawater or water-based hydraulic fluids (Spirit Energy, 2022a).

As the lines corrode, their contents will be slowly released into the surrounding sediments.

Given that:

- The release will be gradual;
- The flowlines have been flushed to reduce the oil contents to 'as to a level that is low as reasonably practicable';
- Following flushing the lines were filled with filtered seawater (i.e. on chemicals added);
- The chemical cores within the umbilicals have been flushed: and
- The hydraulic fluids remaining with the umbilical are water-based,

the severity of the impact of these discharges is considered to be Low.

9.2.1.2 Metals

The steel (*c*. 419 te) and non-ferrous metals (*c*. 17 te) (Spirit Energy, 2022d) associated with the flowlines and umbilicals to be decommissioned *in situ* will over time become exposed to the surrounding sediment as they degrade. Some metals have the potential to exert toxic effects in biota and can bioaccumulate through the food web (Neff, 2002). Within benthic animals, accumulated metals may act as enzyme inhibitors, adversely affect cell membranes, damage reproductive and nervous systems, cause changes in metabolic and respiratory efficiency, affect growth and behaviour or act as carcinogens (Kennish, 1997; and Ansari *et al*., 2004). Taking account of:

- The buried nature of the lines; and
- The slow anticipated rate of degradation;

The severity of the long-term environmental impact of the metals associated with the lines decommissioned *in situ* is considered Low.

9.2.1.3 Plastics

The flowlines and umbilicals to be decommissioned *in situ* have a total of *c*. 197 te of plastic associated with them (Spirit Energy, 2022d). The production and nitrogen injection flowlines are coated with 3-Layer Polypropylene (3LPP), a thermoplastic polymer coating used for carbon steel pipelines and pipework. The main length of the WI flexible flowline (PL2422; 2,400 m) contains Eltex® TUB172; a medium-density polyethylene (MDPE) copolymer designed for the extrusion of pressure pipes for gas applications (Spirit Energy, 2022b).

The sea is a very complicated environment for the degradation of plastics because animals, microorganisms, salt, sunlight, fluctuations of water, etc. all play a part in the degradation process (Krasowska *et al*., 2015).

The degradation of plastics can take hundreds to thousands of years. There are four mechanisms by which plastics degrade in the natural environment: photodegradation (action of light, usually sunlight), thermooxidative degradation (reaction with oxygen at moderate temperatures), hydrolytic degradation (reaction with water), and biodegradation (action by microorganisms). In seawater, hydrolytic degradation is usually not a significant mechanism (Andrady, 2011).

The slow degradation process generally begins with photodegradation, where ultraviolet (UV) light from the sun provides the activation energy required to initiate the reaction with oxygen (thermooxidative degradation) (Webb *et al.,* 2012). As the plastic weakens and becomes brittle, mechanical forces such as wind, wave action, and abrasion with sediment can contribute to breaking the plastic into progressively smaller particles (Oliveira *et al.,* 2020). The plastic eventually becomes small enough to be metabolised by microorganisms (biodegradation) (Webb *et al.,* 2012).

When a plastic item is between 5 mm and 1 µm in size, it is defined as microplastic. Plastic items between 1 nm to 1 µm in size are defined as nanoplastics (GESAMP, 2015). Microplastic and nanoplastic contamination is considered a global environmental problem in the marine ecosystem. Due to their small size, they are easily ingested by a wide range of marine species from high to low trophic levels, particularly those who feed from the water column (e.g., zooplankton and fish) (Wright *et al.,* 2013). Microplastic ingestion can impede food intake, block the digestive tract, and cause physiological stress (e.g., immune responses, metabolism disorders, energy depletion, behavioural alterations, growth prevention, and reproduction disturbance) (GESAMP, 2015; Bai *et al*., 2021). Plastics can then be transferred up the food chain when the zooplankton and fish etc. are ingested as prey by larger organisms (e.g., marine mammals) (Anderson, *et al*., 2016).

Microplastics can also serve as a vector, transferring toxicants through the food chain (Mei *et al*., 2020; Rodrigues *et al.,*2019). Firstly, the chemicals incorporated into plastics during production to improve its properties can leach out of weathered plastic debris. Many of these chemicals have endocrine disruptor activity and can lead to detrimental effects in marine biota (Gunaalan *et al.,* 2020). Secondly, microplastics may adsorb hazardous compounds from the water column, such as persistent organic pollutants (POP), due to their large surface area to volume ratio and hydrophobicity (water-repelling nature) (Rodrigues *et al.,* 2019).

In the marine environment, 90% of UV light from the sun is absorbed in the upper 50 m of the water column (Tedetti and Sempéré, 2006). At the seabed, the lack of UV light to initiate the degradation process, as well as lower temperatures and lower oxygen concentration makes extensive degradation far less likely compared to debris floating on the sea surface, or those on the beach (Andrady, 2011). As a result, the longevity of plastic debris increases with increasing depth. Although benthic plastics will eventually degrade via action by microorganisms (biodegradation), the process will be significantly slower than photodegradation (Chamas *et al.,* 2020). This is especially true for plastics buried in seabed sediment. Burial is an additional inhibitor of plastics degradation on the seafloor. The overlying sediment would, in addition to the water column itself, shield the plastics from UV light and warm temperatures, possibly leading to preservation of plastics in the sediment (Barrett *et al.,* 2020).

Physical forces such as heating / cooling or seabed movements could also cause mechanical damage such as the cracking of polymeric materials, however, this is not expected to impact on the Chestnut flowlines and umbilical. Plastic components of the flowlines and umbilicals could be degraded and released into the sediments by mechanisms such as biodegradation. he growth of microorganisms within the sediment can also cause small-scale swelling and bursting of plastics (Krasowska *et al.,* 2015).

As the sections of flowlines and umbilicals to be decommissioned *in situ* are buried with a good depth of cover, it can be expected that the majority of the degradation sources described above (such as UV light and high temperatures), will not be relevant. In addition, given the buried status of the lines, any plastics degraded via biodegradation would be contained within the sediment and prevented from reaching the water column.

Taking account of:

- The buried nature of the lines;
- The slow anticipated rate of degradation;
- The low mechanical forces predicted to be acting on the lines; and
- The fact that much of the eventual plastic contaminants produced will be contained within the sediment and prevented from reaching the water column;

the long term severity of the environmental impact of the plastics associated with the lines decommissioned *in situ* is considered low.

9.2.2 Existing Protection and Stabilisation Features and Additional Rock Deposits

As described in Section 3.2.6, buried protection and stabilisation features (base case of three concrete mattresses and 30 x 1 te grout bags) will be decommissioned *in situ*. Note that if the four mattresses associated with the free span on PL2422 are found to present a snagging hazard, they will be removed and recovered to shore for recycling and replaced with deposited rock.

The concrete mattresses and grout bags decommissioned *in situ* are expected to degrade over centuries given that they are buried under rock. The degradation products will be the aggregates (sand and gravel) used in the concrete and grout, and the reacted cement compounds, predominantly calcium carbonate. These degradation products are relatively chemically inert and are likely to result only in a slight increase in the coarse sediment in the area.

There is also a very small quantity of metal and plastic associated with the mattresses and grout bags, the potential impacts of which are described in Sections 9.2.1.2 and 9.2.1.3.

The severity of impacts on benthic fauna are therefore expected to be low, whilst there are no anticipated impacts on the water column.

Approximately 4,635 te of deposited rock exists at various locations across the Chestnut field (Section 3.2.6). The rock deposits are intermittent along the length of WI pipeline system PL2422 and production pipeline system PL2545, covering a total combined length of 575 m (Spirit Energy, 2022b). The purpose of the rock is to mitigate against UHB and any shallow depth of cover at time of installation. Some of this rock has been in place for a number of years, creating a habitat for benthic organisms that live on hard substrate.

As with the existing rock, in the event that any rock cover is laid (assuming a worse case whereby up to 2,587 te additional rock deposits are required for remediation activities) this additional rock will create a habitat for benthic organisms that live on hard substrate. As described in Section 5.6.2, there are areas of boulders across the Chestnut field that also form a habitat for these species, such that addition of limited volumes of rock deposits to the area will not be introducing a new hard substrate, rather it will be increasing the footprint of existing hard substrate. Therefore, it is unlikely that the decommissioning of existing rock or the introduction of any additional rock will have a significant impact on the benthic species that occur in the area. The severity of the environmental impact of decommissioning existing rock *in situ* or depositing new rock for remediation purposes is therefore considered low.

9.3 Socio-Economic Impacts of Infrastructure to be Decommissioned *In Situ*

As described in Section 6.2, demersal fishing gear (such as bottom trawls) is used in the area of the Chestnut field and therefore has the potential to interact with any infrastructure or rock remaining on the seabed. The sections of buried flowlines and umbilicals to be decommissioned *in situ* have a depth of lowering / cover in general of over 0.6 m and are situated in an area where the seabed is stable. Trawl gear currently working in the area will have regularly traversed the sections without any interaction.

In the event that any rock cover is laid (assuming a worse case whereby additional rock deposits are required for remediation activities), the rock size and profiles selected will be in accordance with industry best practice such that demersal trawl gear would be expected to be able to access the area.

As described in Section 3.2.4.1, cutting of the piles associated with the removal and recovery of the Well P1 WHPS will require the excavation of a shallow-sided depression around each pile. Following completion of activities, the excavated area will be remediated using the spoil heap or additional rock deposits. The post-decommissioning survey will provide verification of a safe seabed. Should anything be considered a hazard on the seabed, further remediation options will be discussed with OPRED.

Following decommissioning activities, independent verification of the seabed state will be obtained and evidence of a safe seabed will be provided to all relevant governmental and non-governmental organisations.

As part of the DP, Spirit Energy will commit to a post-decommissioning survey strategy (agreed with OPRED) to monitor the burial status of the lines and stability of the rock profiles.

Three 500 m safety zones currently in place at Chestnut well P1, well P4 and the WI well will be removed following completion of the proposed decommissioning activities. This will allow access to areas that have been excluded to other sea users over the operational life of the field. The removal of the 500 m safety zones in the Chestnut area and opening access to this area can be considered a positive legacy impact.

Therefore taking:

- The current buried condition of the lines into account;

- The stability of the seabed;
- The use of industry preferred rock size and profiles;
- Demonstration of a safe seabed;
- A post-decommissioning survey strategy; and
- The positive impact of surrendering existing 500 m safety zones;

the socio-economic impact of the infrastructure to be decommissioned *in situ* is considered Low.

9.4 Transboundary and Cumulative Impacts

Given the distance from the nearest transboundary line (*c*. 34 km), there are no transboundary impacts anticipated as a result of the activities captured in this Section.

As all surface laid infrastructure will be removed and recovered, and any additional rock deposits will be minimised, the cumulative impact of the proposed activities in relation to other activities in the area is not considered significant.

9.5 Mitigation Measures

The following mitigation measures are proposed to minimise the environmental and socio-economic impacts associated with the infrastructure to be decommissioned *in situ* and any additional rock deposits.

- All surface laid infrastructure will be removed and recovered.
- A clean seabed will be achieved as part of the decommissioning activities.
- Preference will be given to backfilling / reprofiling previously excavated material to remediate the exposed flowline and umbilical ends.
- Lines decommissioned *in situ* have been flushed to reduce hydrocarbons and chemicals to 'as low as reasonably practicable'.
- If used, additional rock deposits will be optimised and carefully managed. Size of rock and rock profiles will be in accordance with industry practice.
- Locations of remaining materials will be marked on FishSAFE.
- Adherence to a post-decommissioning survey strategy agreed with OPRED.

Spirit Energy's commitment to adhering to the mitigation measures identified means that the environmental and socio-economic impact significance of decommissioning the buried flowlines, umbilicals, existing rock and any new rock *in situ* is considered low.

The activities assessed in this chapter will not contradict the NMP objectives (Section 5.8) and as the project progresses, Spirit Energy will aim to comply with the NMP policies. In addition, the Project will aim to comply with the oil and gas marine planning policies (Section 5.9).

10. ENVIRONMENTAL MANAGEMENT

Spirit Energy are committed to conducting activities in compliance with all applicable legislation and in a manner that will minimise impacts on the environment. The proposed Chestnut decommissioning project will be delivered in compliance with the Spirit Energy Health, Safety, Environment and Security (HSES) Policy (Figure 10-1) and the Spirit Energy Environmental Management System, which has been developed in line with the principles of the International Standard for Environmental Management Systems (ISO14001:2015).

HEALTH, SAFETY, ENVIRONMENT AND SECURITY POLICY

At Spirit Energy creating an incident free workplace is our top priority. All employees and business partners are required to comply with this policy and our commitments outlined below.

We are committed to:

- **Assessing**, understanding and managing our HSES risks and impacts
- **Enabling** the creation of a positive culture holding each other accountable, helping us to: achieve our HSES goals; support business growth; and realise our vision of an incident free workplace
- **Proactively** supporting employee health and safety, seeking ways to protect the environment, including the prevention of pollution, efficient use of resources and the reduction of waste and carbon emissions
- **Empowering and encouraging** personnel to work in a safe way
- **Intervening** if we believe that the work environment or task is unsafe or may cause environmental damage, or we see an unsafe act
- **Learning** from our successes and incidents, and freely sharing lessons with business partners
- **Working with stakeholders**, suppliers and business partners in the pursuit of good practice in HSES
- **Continually improving** and setting measurable objectives and targets in business plans to enhance HSES performance
- **Developing** and testing prioritised incident response and recovery plans to protect our people, the environment and minimize business impact
- **Ethically conducting our business** and complying with regulatory and other applicable requirements

Our HSES management system enables the delivery of these policy commitments, is structured in line with recognised good practice, and is routinely assured. Independent certification to ISO 14001 shall be maintained for our environmental material operations.

Our performance is reviewed regularly and relevant results published.

Chris Cox
CEO
August 2018

SPIRIT ENERGY

Figure 10-1: Spirit Energy HSES Policy

11. CONCLUSIONS

Spirit Energy and its co-venturer, Dana Petroleum, are decommissioning the Chestnut field, with activities spanning two broad project phases, each of which has its own DPs. Phase 1, the main execution of which has been completed, encompasses the disconnection and sailaway of the Hummingbird Spirit FPSO. Phase 2, the subject of this assessment, encompasses the decommissioning of all remaining subsea installations', and subsea pipeline systems', infrastructure.

This EA has been prepared under the Petroleum Act 1998, in support of the DP that is being submitted to OPRED to seek approval for Phase 2.

Phase 2 includes the removal and recovery of the surface laid ends of the flowlines and umbilicals, tie-in spools and umbilical jumpers, and all exposed mattresses and grout bags on approaches. The trenched and buried sections of flowlines and umbilicals will be decommissioned *in situ* with the exposed cut ends remediated to ensure they are not a snagging risk. Preference will be given to protecting the exposed ends by backfilling / reprofiling previously excavated material, however, the contingency of additional rock deposits is considered a suitable remediation option should any difficulties be encountered. The base case is to decommission 30 1 te buried grout bags and four buried mattresses located at the free span remedial works, as well as three rock covered mattresses on approaches *in situ*. Should planned surveys show any of these protection and stabilisation features to be a snagging hazard, they will be remediated either by removal and recovery, or by the deposit of additional rock as cover.

Following a detailed review of the project activities, the environmental sensitivities of the project area, and industry experience with decommissioning activities, it was determined that further assessment of the following issues was required in order to properly define the potential impact of the proposed decommissioning activities:

- Seabed disturbance impacts:
  - During removal and recovery of infrastructure, potential deposit of rock as cover, and potential use of over-trawl trials.
- Legacy impacts:
  - The release of chemicals, metals, and plastic as infrastructure (including its component materials and contents) degrades.
  - The snagging hazard presented to other sea users by the physical presence of the infrastructure decommissioned *in situ*.

A review of each of these potentially significant environmental aspects has been completed and, considering the mitigation measures that will be built into the decommissioning project activities, there is expected to be no significant impact on receptors. As part of this review, transboundary and cumulative impacts were assessed and determined to be not significant.

The potential impact on protected sites in the wider vicinity has been considered in the assessment. The protected sites in closest proximity to the Chestnut field are the Norwegian Boundary Sediment Plain NCMPA and the Scanner Pockmark SAC, which are located *c*. 26 km east and *c*. 36 km northwest respectively from the field. Having assessed the impact of the decommissioning activities, there is not expected to be a significant impact on any protected sites.

The EA has considered the objectives and marine planning policies of the Scottish NMP across the range of policy topics including biodiversity, natural heritage, cumulative impacts and oil and gas. Spirit Energy considers that the proposed decommissioning activities are in broad alignment with such objectives and policies. Similarly, Spirit Energy considers that the proposed activities are aligned with the oil and gas specific marine planning policies.

Based on the findings of this EA and the identification and subsequent application of the mitigation measures identified for each potentially significant environmental and societal impact, it is concluded that the proposed Chestnut field decommissioning activities will result in no significant environmental or societal impacts.

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A APPENDIX A: IMPACT AND RISK ASSESSMENT METHOD

This appendix presents Spirit Energy's Impact Assessment Procedure used to determine the impact of the planned activities and unplanned events associated with the project.

A.1 Nodes

The ENVID nodes considered were as follows:

1. Vessel use.
2. Decommissioning of pipelines, umbilicals, and associated tie-in spools.
3. Decommissioning of subsea installations (WHPS, riser bases, and choke skid/ manifold).
4. Decommissioning of protection and stabilisation features.
5. Over-trawl trials.
6. Legacy impacts.
7. Accidental events.

A.2 Identification of Environmental Aspects

The procedural ENVID process involved a structured approach, as per general industry practice.

Using a detailed description of the activities, and information describing its baseline receiving environment, the assessment systematically reviewed all aspects of project activities which could interact with the environment (including its socio-economic and political dimensions).

Environmental aspects from both planned activities and unplanned events (accidental and emergency) were considered.

Environmental aspects considered include:

- Physical presence
- Resource use
- Atmospheric emissions
- Sound and vibration
- Seabed disturbance
- Discharges (and small releases) to sea
- Large releases to sea
- Waste production.

A.3 Evaluation of Environmental Impacts

Impacts were assessed assuming 'routine' industry standard control and mitigation measures are in place (including those required by legal mandate) using the Spirit Energy Environmental Impact Assessment Matrix (in CEU-HSEQ-GEN-GUI-0026 Guidance for Environmental Management in Capital Projects). The impact matrix is designed to address the impacts from point source activities and is provided in Section 0.

The scale of environmental impact was evaluated as a function of its estimated extent and duration (recovery time). From here, the severity ranking was determined as 'low', 'medium' or 'high'.

A.4 Evaluation of Environmental Risks (Potential Impacts)

The environmental and socio-economic risk (of impact) from unplanned (accidental and emergency) aspects followed a similar process. Following assessment of the potential impact (as described in Section 0), the risk of impact was evaluated by factoring in the likelihood of the aspect and impact occurring using the Spirit Energy Health, Safety, Environment, and Social Economics (HSES) Risk Assessment Matrix (Section 0). Again, the risk score was translated to 'low', 'medium' or 'high'.

A.5 Elimination or Reduction of Environmental Impacts and Risks

Controls are measures to 'prevent' adverse effects and include avoidance and offsetting. Mitigation measures are those that reduce the severity of negative impacts. The hierarchy of control and mitigation measures is to preferentially avoid, then minimise, then restore and finally offset adverse impacts to reduce them to a level that is 'ALARP' in line with Spirit Energy's Environmental Policy.

If, following the environmental assessment process, impacts and risks are ranked as 'medium' or 'high' severity, they should be reviewed and additional project-specific control and mitigation measures considered to eliminate or reduce, where possible, negative impacts to a level that is ALARP. This can be by considering the selection of BAT and the implementation of BEP, such that:

All 'high'- ranked environmental impacts and risks (i.e. those falling within the red region of the matrices), if they cannot be eliminated entirely, would be reclassified as 'medium' or 'low' ranking (and therefore fall within, respectively, the yellow, or green regions of the matrices) following the implementation of BAT / BEP.

All 'medium' - and 'low' - ranked residual environmental impacts and risks are a) minimised 'so far as is reasonably practicable' and, b) subject to further reduction efforts on a continual basis. For an impact or risk to be 'ALARP', it must be possible to demonstrate that the cost involved in reducing the risk further would be grossly disproportionate to the benefit gained.

A.6 Environmental Impact Assessment Matrix

							Benefit	Duration of harmful effect / recovery (c. 80% of damage rectified)				
Land and air								within 1 month	within 1 year	≤3 years	>3 years or >2 growing seasons	>20 years
Surface water (any harm of drinking water source or ground water would be cat 4 or above)								Immediate	< 1 month	≤1 years	>1 year	>10 years
Reinstatement of Built Environment - Can be repaired								immediately	in <1 year	in <3 years	in >3 years	Cannot be rebuilt
Recovery for Societal - Decrease in the availability or quality of a resource								Access immediately	Short term decrease	Medium term decrease	Medium to long term decrease	Long term decrease
Habitats / Species	**Air**	**Soil or sediment**	**Water**	**Built Environment**	**Societal**		+1	1	2	3	4	5
Large area of habitat and/or large number or proportion of population or species impacted.	Large increase in contaminants in the air exceeding quality limits	Large area with contamination resulting in hazardous soil to humans (e.g. skin contact) or the living environment, remediation available (but difficult).	Drinking water standards breached for a large number of properties. Large groundwater body effected. Large water body exceeds a water quality guideline or objective.	Complete destruction of an area of built importance	Large population with high dependence on the impacted resource or large loss for other users.	5	-	5 Minor	10 Moderate	15 Significant	20 Major	25 Catastrophic
Moderate area of habitat and/or moderate number or proportion of population or species impacted.	Moderate increase in contaminants in the air exceeding quality limits.	Moderate area with contamination sufficient to be environmental damage[4] or in alignment with contaminated land legislation.	Drinking water standards breached for a moderate number of properties. Moderate groundwater body effected. Moderate water body exceed a water quality guideline or objective.	Loss of integrity to an area of built importance or nationally registered building leading to de-registering / categorisation with a need for remedial / restorative work.	Moderate population with moderate dependence on the impacted resource or moderate loss for other users.	4	-	4 Negligible	8 Minor	12 Moderate	16 Significant	20 Major
Small area of habitat impacted and/or small number or proportion of population or species impacted.	Small Increase in contaminants in the air exceeding quality limits	Contamination not leading to environmental damage	Drinking water standards breached for a small number of properties. Small groundwater body effected. Small water body exceed a water quality guideline or objective.	Loss of integrity to an area of built importance or nationally registered building with a need for remedial / restorative work.	Small population with small dependence on the impacted resource or small loss for other users.	3	-	3 Negligible	6 Minor	9 Minor	12 Moderate	15 Significant
Change is within scope of existing variability (or acceptable mixing zone) but potentially detectable or all within the site boundary / 500m zone (78.5 hectares).				Loss of integrity to an area of built importance or nationally registered building need for remedial / restorative work.	A small population with some dependence on the impacted resource. Negligible loss to other users.	2	-	2 Negligible	4 Negligible	6 Minor	8 Minor	10 Moderate
Effects are unlikely to be noticed or detectable.						1	-	1 Negligible	2 Negligible	3 Negligible	4 Negligible	5 Negligible

Low	Impact broadly acceptable and considered 'as low as reasonably practicable'	High	Impact intolerable without control and mitigation measures required to be reduce impacts to 'as low as reasonably practicable'
Medium	Impact is tolerable but to be managed to 'as low as reasonably practicable'	P	Positive – Positive or beneficial impact

A.7 Risk Assessment Matrix

The translation for the impact table to the severity scale is as shown below.

Scale of Impact	Severity ranking in myHSES (High, Medium, and Low)	Severity Scale (Risk Assessment Matrix)	Environmental Description (From the Risk Matrix) Note: Not Applicable to Built Environment or Societal
25	H	Catastrophic	Catastrophic environmental impact which is widespread or affects a highly sensitive valuable environment requiring long term remediation.
20	H	Major	Major environmental impact to regional or high value environment requiring protracted remediation.
15-16	H	Significant	Significant environmental impact on local area. Long term natural recovery or moderate remediation intervention.
10-12	M	Moderate	Moderate environmental impact in neighbouring area. Longer term natural recovery or minor remediation intervention.
6-9	M	Minor	Minor environmental impact on site or to lower value environment with short term natural recovery.
1-5	L	Negligible	Negligible environmental impact.

Risk Assessment Matrix		Frequency (per year) and Likelihood					
		$\leq 1x10^{-5}$	$>1x10^{-5}$ to $1x10^{-4}$	$>1x10^{-4}$ to $1x10^{-3}$	$>1x10^{-3}$ to $1x10^{-2}$	$>1x10^{-2}$ to $1x10^{-1}$	$> 1x10^{-1}$
		Highly Unlikely	Very Unlikely	Unlikely	Possible	Moderately Likely	Likely
Consequences – Environment (E)		1	2	3	4	5	6
Catastrophic environmental impact which is widespread or affects a highly sensitive / valuable environment requiring long term remediation.	6	6	12	18	24	20	36
Major environmental impact to regional or high value environment requiring protracted remediation.	5	5	10	15	20	25	30
Significant environmental impact on local area. Long term natural recovery or moderate remediation intervention.	4	4	8	12	16	20	24
Moderate environmental impact in neighbouring area. Longer term natural recovery or minor remediation intervention.	3	3	6	9	12	15	18
Minor environmental impact on site or to lower value environment with short term natural recovery.	2	2	4	6	8	10	12
Negligible environmental impact.	1	1	2	3	4	5	6