Amethyst Jackets and Risers Decommissioning

Environmental Appraisal Report

For Perenco UK Limited

Consultation Version

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ABBREVIATIONS

Abbreviation	Description
As	Arsenic
AIS	Automatic Identification System
Ba	Barium
boepd	Barrels Of Oil Equivalent Per Day
BSL	Benthic Solutions ltd
Cd	Cadmium
CEFAS	Centre For Fisheries and Aquaculture Science
CH_4	Methane
cm	Centimetres
CO	Carbon monoxide
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
CoP	Cessation of Production
Cr	Chromium
Cu	Copper
CV	Coefficient of Variation
DEFRA	Department for Environment, Food & Rural Affairs
DESNZ	The Department for Energy Security and Net Zero
DP	Decommissioning Programme
e.g.	For Example
E	East
EA	Environmental Appraisal
EBS	Environmental Baseline Survey
EC	European Council
ED	External Diameter
EEC	European Economic Council
EF	Emission Factor
EGT	Easington Gas Terminal
EIA	Environmental Impact Assessment
EMS	Environmental Management System
ENVID	Environmental Impacts Identification
ERL	Effects Range Low
ERM	Effect Eange Median
EU	European Union
EUNIS	European Nature Information System

Abbreviation	Description
Fe	Iron
GHG	Green House Gas
GWP	Global Warming Potential
HCS	Hydrocarbon Safe
Hg	Mercury
HLJB	Heavy Lift Jack-up Barge
HM	Heavy Metals
hrs	Hours
HSE	Health and Safety Executive
HSSE	Health, Safety, Security and Environment
i.e.	That is
ICES	International Council for the Exploration of the Sea
ISO	International Organisation for Standardisation
JNCC	Joint Nature Conservation Committee
kg	Kilogram
km	Kilometre
KP	Kilometre Point
LAT	Lowest Astronomical Tide
LOI	Loss on Ignition
m	Metre
MAG	Magnetic Anomaly Gradient
MBES	Multi Beam Echo Sound
MCZ	Marine Conservation Zones
mg	Milligram
mm	Millimetre
MMMU	Marine Mammal Management Units
MoD	Ministry of Defence
MPA	Marine Protected Area
MSV	Multipurpose Support Vessel
M/M	Mass by Mass
N	North
N_2O	Nitrous oxide
ND	No Data
Ni	Nickel
NO_x	Nitrogen oxides
nm	Nautical miles

Abbreviation	Description
NNS	Northern North Sea
NORM	Naturally Occurring Radioactive Material
NSTA	North Sea Transition Authority (formerly Oil and Gas Authority)
OEUK	Offshore Energies UK (formerly Oil and Gas UK)
OPRED	Offshore Petroleum Regulator for the Environment and Decommissioning
OSPAR	Oslo Paris Agreement
PAH	Polycyclic Aromatic Hydrocarbons
Pb	Lead
PL	Pipeline
POMS	PUK Operating Management System
ppm	Parts per million
ppt	Parts per thousand
PSD	Particle Size Distribution
PUK	Perenco UK Limited
ROV	Remotely Operated Vehicle
S	South
SAC	Special Area of Conservation
SCANS	Small Cetacean Abundance of the North Sea
SD	Standard Deviation
SEMS	Safety and Environmental Management System
SNS	Southern North Sea
SOSI	Seabird Oil Sensitivity Index
SO_2	Sulphur dioxide
SPA	Special Protection Area
spp	Species
te	Tonne (UK)
THC	Total Hydrocarbon Content
TOC	Total Organic Carbon
TOM	Total Organic Matter
UK	United Kingdom
UKCS	United Kingdom Continental Shelf
UKOOA	United Kingdom Offshore Operators Association
VOC	Volatile Organic Compound
W	West
w/w	Wet Weight
Zn	Zinc

Abbreviation	Description
µm	Micrometre
^{2}	Square
^{3}	Cubic
"	Inch
°C	Degree Celsius
£	Pound sterling
%	Percentage
%ile	Percentile
>	Greater than
<	Less than
&	And
°	Degree

HOLDS

Section	Hold	
3	1	Provide stakeholder responses

EXECUTIVE SUMMARY

In accordance with the Petroleum Act 1998, Perenco UK Limited (PUK) is applying to the Offshore Petroleum Regulator for Environment and Decommissioning (OPRED) to obtain approval for the decommissioning of the Amethyst Installation A1D, A2D, B1D and C1D jackets and risers.

The Amethyst gas field is centred on the United Kingdom Continental Shelf (UKCS) block 47/14a, extending into blocks 47/13a, 47/9a, 47/8a and 47/15a in the Southern North Sea (SNS), approximately 40km due East (E) of the Humber Estuary and the Easington Gas Terminal (EGT) on the Yorkshire coast. The field consists of several separate gas accumulations; Amethyst E covers the 'A' / 'B' areas and Amethyst West (W) covers the 'C' area. Discovered by the Britoil Public Limited Company in 1970 W field and 1972 E field, Amethyst E and Amethyst W have been producing gas since 1990 via four normally unattended installations.

PUK explored all avenues for continuing production and concluded that due to high operational costs and a reduction of gas production, continued operations were uneconomical. Approval of Cessation Of Production (COP) from the Amethyst fields was granted by the North Sea Transition Authority (NSTA) in June 2020. Since then, all Amethyst pipelines have been flushed clean, filled with seawater, made Hydrocarbon Safe (HCS) and left in situ attached to the subsea jackets, whilst all topsides have been skidded. All Amethyst jackets remain in situ attached to the pipelines and the de-activated powerlines. Additionally, the Helvellyn riser remains connected to the A2D jacket.

In line with legislation and regulatory guidance, this Environmental Appraisal (EA) report has been produced to support the Amethyst Decommissioning Programme (DP) by assessing the potentially significant impacts associated with the preferred decommissioning option.

This EA report sets out to describe, in a proportionate manner, the potential environmental impacts of the proposed activities associated with the Amethyst jackets and risers decommissioning and to demonstrate the extent to which these will be mitigated and controlled to an acceptable level.

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1 INTRODUCTION

1.1 Purpose of Document

This EA report sets out to describe, in a proportionate manner, the potential environmental impacts of the proposed activities associated with the Amethyst jackets and risers decommissioning and to demonstrate the extent to which these will be mitigated and controlled to an acceptable level. The key components and structure of this report are laid out in Table 1-1.

Table 1-1: EA structure

Section	Description
	Executive summary
Section 1	Introduction to the decommissioning project for the Amethyst jackets, pipelines, powerlines and stabilisation materials and a description of the EA report scope and structure.
Section 2	The regulatory context and guidance for undertaking a decommissioning EA.
Section 3	A summary of the stakeholder engagement process and activities carried out by PUK to date.
Section 4	An outline of the options considered for decommissioning, the decision-making process undergone by PUK to arrive at the selected decommissioning strategy and a description of the proposed decommissioning activities.
Section 5	A summary of the baseline sensitivities relevant to the activities taking place and the assessments that support this EA.
Section 6	A summary of the project Environmental Issues Identification process and findings.
Section 7	An outline of the EA method used, review of the potential impacts from the proposed decommissioning activities and justification for scoping potential impacts in or out of assessment in this EA report.
Section 8	Assessment conclusions.
Section 9	Environmental management.
Section 10	References.
Section 11	Appendices.

1.2 PUK Limited

PUK is an independent oil and gas company with operations in 13 countries across the globe, ranging from northern Europe to Africa and from South America to Southeast Asia.

PUK currently produces approximately 450,000 barrels of oil equivalent per day (boepd), of which 250,000 boepd is net to the company. The group is present in world-class exploration basins such as Brazil, Peru, Northern Iraq, Australia and the North Sea. While PUK's growth has been driven by acquisitions, the Group's strategy evolved rapidly towards increasing production and reserves, renewing licenses, and securing additional acreage for new exploration and development opportunities.

In the SNS gas basin, PUK and other operators, manage 17 offshore fields own by PUK, along with associated pipelines and onshore processing facilities including the Bacton and Dimlington Terminals. PUK's gas production in the North Sea is around 72,000 boepd.

PUK operates under a Safety and Environmental Management System (SEMS) which is certified to conform to the International Organisation for Standardisation (ISO) 14001 for environmental management systems (EMS). SEMS provides the framework for PUK to achieve safe and reliable operations and ensures compliance with PUK's Health, Safety, Security and Environment (HSSE) Policy. Further detail on PUK's SEMS is provided in Section 9.

2 Policy & Regulatory Context

The decommissioning of offshore oil and gas installations and pipelines on the UKCS is principally governed through the Petroleum Act 1998 and is amended by the Energy Act 2008.

The United Kingdom (UK) international obligations in relation to decommissioning is principally governed by the 1992 Convention for the protection of the Marine Environment of the Northeast Atlantic (Oslo-Paris Agreement (OSPAR) convention). Agreement in relation to the offshore decommissioning regime was reached at a meeting of the OSPAR commission in 1998 (OSPAR Decision 98/3). As a result, OPRED guidance in relation to offshore decommissioning is aligned.

The primary objection of OSPAR decision 98/3 remains to prevent the dumping of offshore installations at sea, with the default position of full removal. The decision however allows the granting of derogations to leave all or part of a structure in place, subject to a Comparative Assessment process and regulatory approval.

In the context of marine planning and being located in the English offshore waters of the SNS, the pipelines fall within the area of the East Marine Plans [41]. These plans were developed to help ensure sustainable development of the UK marine area; The broad aims and policies outlined in the Marine plan have therefore been considered in this EA report.

The primary guidance for offshore decommissioning [7] details the need for an EA to be submitted in support of the DP. The guidance sets out a framework for the required environmental inputs and deliverables throughout the approval process. It now describes a proportionate EA process that culminates in a streamlined EA report rather than a lengthy Environmental Statement as would be required under the Environmental Impact Assessment (EIA) Directive (Directive 2011/92/EU as amended by Directive 2014/52/EU) [24].

2.1 Field and Infrastructure Description

The Amethyst gas field is centred on UKCS block 47/14a, extending into blocks 47/13a, 47/9a, 47/8a and 47/15a in the SNS, approximately 40km due E of the Humber Estuary and EGT on the Yorkshire coast (see Figure 2-1). The field consists of several separate gas accumulations; Amethyst E covers the 'A' / 'B' areas and Amethyst W covers the 'C' area. Discovered by the Britoil Public Limited Company in 1970 W field and 1972 E field, have been producing gas since 1990 via four normally unattended installations, located as follows:

- Amethyst A1D (47/14a): Latitude: 53° 36′ 38.44″ North (N), Longitude: 0° 43′ 21.38″ E
- Amethyst A2D (47/14a): Latitude: 53° 37′ 21.02″ N, Longitude: 0° 47′ 20.68″ E
- Amethyst B1D (47/15a): Latitude: 53° 33′ 39.64″ N, Longitude: 0° 52′ 38.18″ E
- Amethyst C1D (47/14a): Latitude: 53° 38′ 41.77″ N, Longitude: 0° 36′ 08.24″ E

The infrastructure inventory related to the Amethyst subject to the DP are detailed in Table 4-1

PUK explored all avenues for continuing production and concluded that due to high operational costs and a reduction of gas production, continued operations were uneconomical. Approval of COP from the Amethyst fields was granted by NSTA in June 2020. Since then, all Amethyst pipelines have been flushed clean, filled with seawater, made HCS and left in situ attached to the subsea jackets. All topsides have been skidded following the approval by The Department for Energy Security and Net Zero (DESNZ) on the 1st of July 2020. The remaining platform jackets remain in situ attached to the pipelines and the de-activated powerlines. Additionally, the Helvellyn riser remains connected to the A2D jacket.

As represented in Figure 2-2, C1D is connected to A1D via the gas export Pipeline (PL) 776 and methanol line PL 778, which was then used to feed gas into the main 30" export pipeline PL 649 to EGT. A2D is directly connected to PL 649 and used to receive exports from B1D via PL 775 and methanol line PL 777. Third-party pipelines from Helvellyn and Rose gas fields were also feeding gas to A2D platform. Subsea high voltage power cables connect each platform to the EGT.

In 2020 pre-decommissioning surveys were conducted across the entire Amethyst field, including Environmental Baseline Surveys (EBS), Habitat Assessment Survey [4; 5; 47]. Among other locations, these surveys were undertaken around the four Amathyst platforms (A1D, A2D, B1D and C1D).

Figure 2-1: Overview of Amethyst field layout (highlighted yellow within the scope)

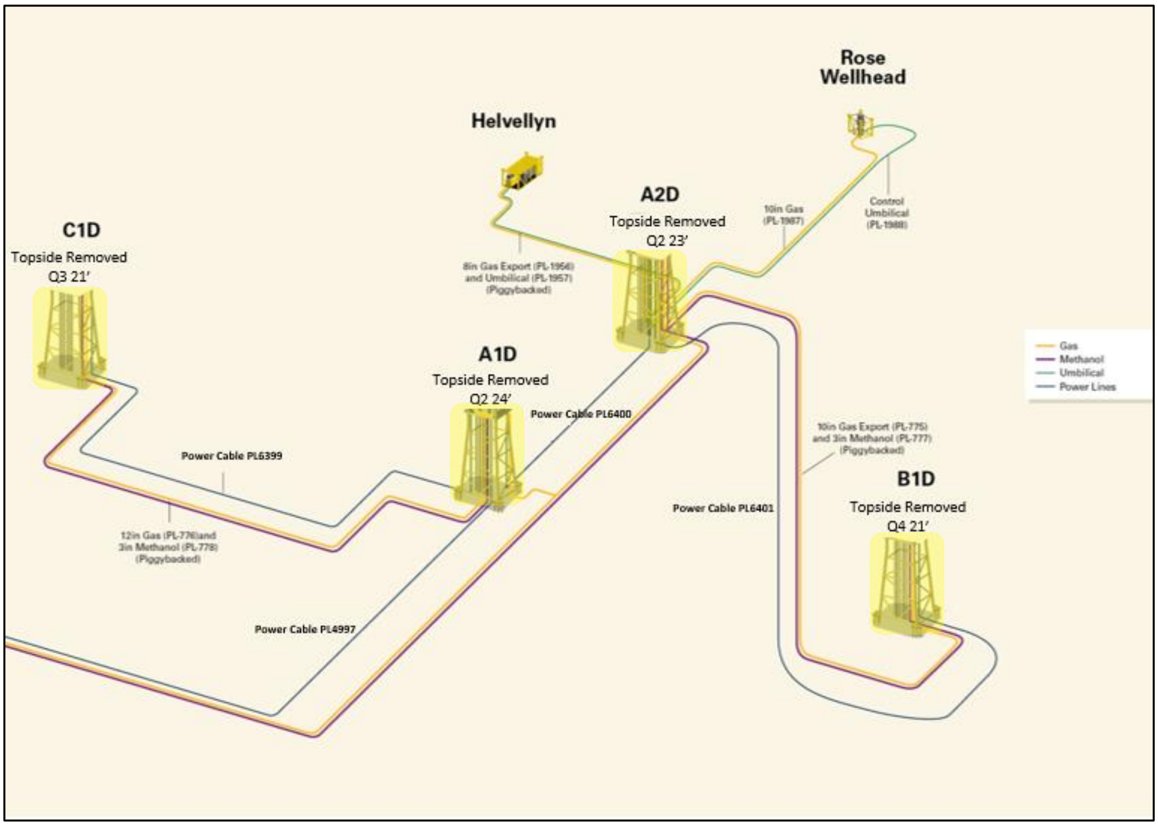
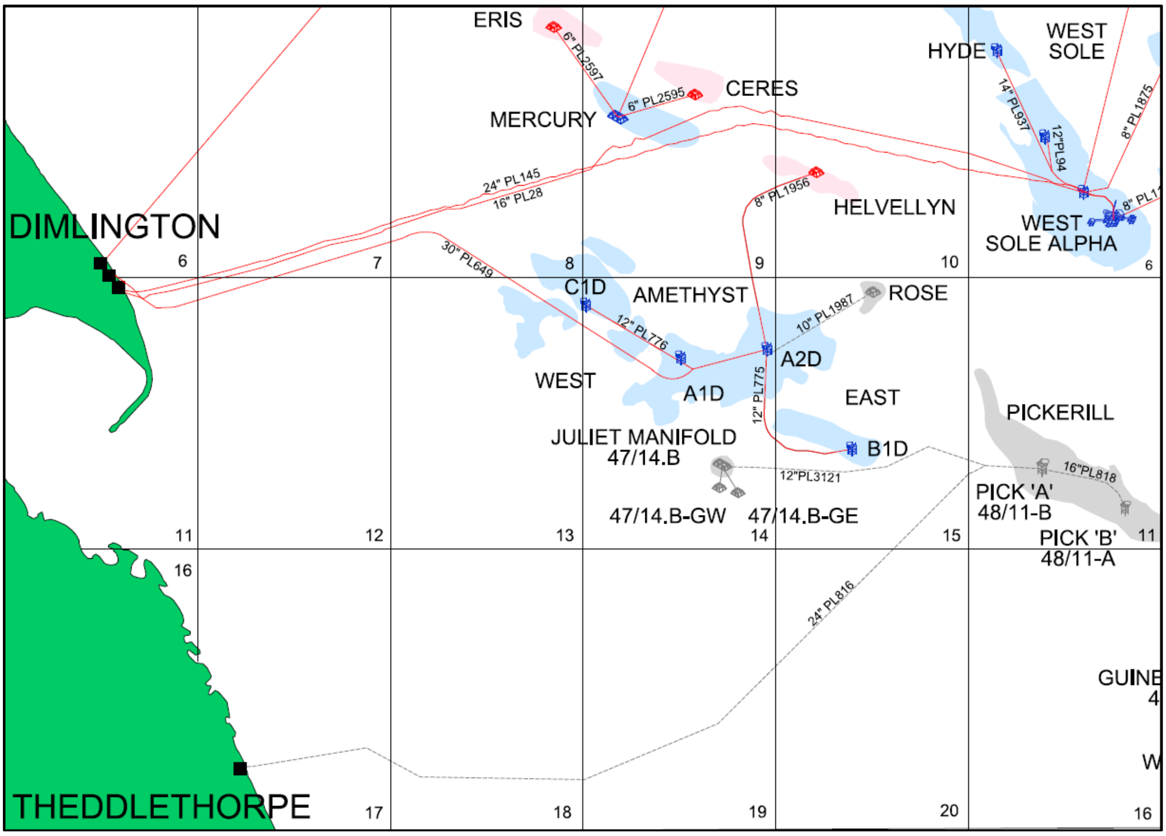


Figure 2-2: Amethyst assets and surrounding fields within SNS



3 Consultee Responses

Table 3-1 provides details of stakeholder responses (**HOLD 1**).

Table 3-1: Stakeholder responses

Stakeholder	Response	PUK comment
NSTA		
Joint Nature Conservation Committee (JNCC)		
Centre for Environment, Fisheries and Aquaculture Science (CEFAS)		
Natural England		
Global Marine Systems Limited		
National Federation of Fishermen's Organisations		
Defence Infrastructure Organisation		

4 Decommissioning Activities & Parameters

This section details the infrastructure being decommissioned and provides details on the selected decommissioning method with timings.

4.1 Relevant Infrastructure inside DP/EA scope

The Amethyst A1D, A2D and C1D jackets are located within the UKCS block 47/14, and Amethyst B1D jackets in the UKCS block 47/15 in the SNS (Figure 2-2).

Table 4-1 provides details on the infrastructure relevant to the Amethyst Installation DP and EA. The Helvellyn pipeline and umbilical system (PL1956 and PLU1957) riser sections that are attached to the A2D jacket are included in this EA.

Table 4-1: Amethyst platform jackets and risers subject to the Amethyst DP/EA

Jackets no.	Water depth	Materials	Legs no.	Weight (te) Note1	Piles specification	Status
A1D	27m	Steel	4	2285te [2136te]	Four piles fitted through legs, 1372mm External Diameter (ED), thickness 63.5mm, length 92m.	The jacket remains in dismantlement interval phase since quarter 2 2024, with the pipeline riser, powerlines, and associated spool pieces attached to the jacket.
A2D	22m	Steel	4	2098.67te [1902.67te]	Four piles fitted through legs, 1372mm ED, thickness 63.5mm, length 92m.	The jacket remains in dismantlement interval phase since April 2023, with the powerlines, pipeline riser, and associated spool pieces attached to the jacket. The Helvellyn riser and umbilical section remains connected to the A2D jacket.
B1D	18m	Steel	4	1711te [1562te]	Eight piles (2 per leg) fitted through skirt pile sleeves, fitted through legs, 1372mm ED, thickness 35mm, length 39m.	The jacket remains in dismantlement interval phase since December 2021, with the powerline, pipeline riser, and associated spool piece attached to the jacket.
C1D	18m	Steel	4	1938te [1660te]	Four piles fitted through legs, 1372mm ED, thickness 63.5mm, length 66m.	The jacket remains in dismantlement interval phase since July 2021 with the powerline, pipeline riser and associated spool piece attached to the jacket.

NOTE 1: Jacket weights include piles, risers and marine growth weights. For A2D it also includes Helvellyn riser and Umbilical Weight in brackets [*] represent the total weight, except marine growth.

Pile weights: A1D=635te, A2D=563te, B1D=169te, and C1D=409te.

Marine growth weight: A1D= 149.21te, A2D=196.02te, B1D=149.04te, and C1D= 278.39te

4.2 Relevant Infrastructure outside the DP/EA scope

4.2.1 Pipelines, Powerlines and Stabilisation Material

The Amethyst pipelines PL 775, PL 776, PL 777, and PL 778 are out of use, flushed clean, and flooded with seawater (HCS verified). PL 649 and PL 650 are also flushed clean but flooded with inhibited seawater to preserve the pipeline for potential future re-use (HCS verified). The powerlines PL 4997, PL 6399, PL 6400 and PL 6401 are currently attached to the Amethyst jacket and deactivated. All Amethyst pipelines, cables and associated stabilisation materials are excluded from this DP and will be subject to a separate DP at the appropriate time.

4.3 Decommissioning activities and methodology

PUK has assessed options for extending the producing life of the Amethyst platforms, but none proved commercially viable. At present, dismantling of the Amethyst jackets at an onshore disposal facility is considered the most likely disposal option. However, PUK will continue to review, the installation's equipment inventories to assess the potential for adding to their existing asset portfolio spares inventory or for resale to the open market.

4.3.1 Preparatory works

Decommissioning of the Amethyst jackets and risers installation are anticipated to commence from quarter 2 2025.

Preparatory work has been carried out in order to enable the proposed decommissioning activities. COP documentation was submitted to the NSTA in February 2020 and approved in June 2020.

The Amethyst topsides A1D, A2D, B1D and C1D were removed from quarter 3 2021 to quarter 2 2024 as a part of an independent decommissioning campaign.

All Amethyst pipelines have been flushed clean, rendered HCS and remain attached to the relevant jackets. PL 649/ PL 650 have been left filled with filtered seawater dosed with a preservation chemical. The infield pipelines PL 775, PL 776, PL 777 and PL778 have been left open to the sea.

All the power cables (PL 4997, PL 6399, PL 6400, and PL 6401) are deactivated and remain attached subsea to the jackets. The main power cable PL 4997 was cut at A1D tee and made safe for possibility of reuse.

The Rose field comprised of a single subsea well (47/15b-6W) and was tied back to the A2D via pipeline PL1987. The Rose subsea well, owned by Spirit Energy Resources Limited (Spirit), ceased production and both the subsea structure and pipelines were subsequently decommissioned in 2015. PL1987 has been flushed, cut and the entire riser section together with the umbilical section within the J-tube at A2D has been fully removed. Therefore, no considerations to the Rose risers will be made in this EA.

The Helvellyn development, owned by Waldorf Petroleum Resources Limited (Waldorf) since 2001 consists of a single subsea well, tied back to A2D via pipeline PL1956. Helvellyn development is the responsibility of Waldorf and is covered under a separate DP. However, the section of the Helvellyn riser (PLU1956) and umbilical (PLU1957) attached to the A2D platform is covered by this EA.

4.3.2 Pipeline and Powerline cutting campaign

Prior to decommissioning all Amethyst jackets, PUK will conduct a pipeline/powerline cutting campaign to facilitate Amethyst jackets removal. It is estimated a total of 38 subsea cuts will be required, generally at the bottom riser and distributed across all Amethyst 500m exclusion zones. This will include cuts on the Helvellyn pipeline and the umbilical at A2D. Potential mattress lifting operations will be required at A2D 500m exclusion zone, to locate and recover a STATS plug within the Helvellyn PL 1956.

The proposed pipelines cut end sections currently have two mattresses over them. During this campaign, mattresses will be temporarily moved, the pipeline cut below the seabed, reburied following cutting, and covered with repositioned mattresses. There will be no deposition of additional material.

This campaign is expected to require the use of a single Multipurpose Support Vessel (MSV) with cutting by hydraulic shears on PL 1956.

4.3.3 Jackets Decommissioning overview

The leg piles will be cut to a target depth of at least 3m below the mean seabed level. As the seabed around the Amethyst field is expected to vary significantly over time and for each jacket location, PUK will investigate the opportunities to perform deeper internal cuts of the piles, subject to surveys to verify the piles are free of internal blockages. As such, cutting of the piles is anticipated to be executed by internal cutting equipment. However, if this proves unfeasible it would be necessary to excavate the seabed around the piles to enable external cutting. Where required, cleaning will be carried out at the dismantling site for recycling, as appropriate.

The pile cuts will be made below the seabed level at such a depth to ensure that any remains are unlikely to become uncovered.

A single lift removal option using a suitable 6-leg Heavy Lift Jack-up Barge (HLJB) and transportation ashore for cleaning, break up and recycling is considered the most likely removal methodology currently.

The riser sections and umbilical section attached to the jackets will be removed with the jacket, an assessment will be completed as part of the detailed design to confirm the umbilical’s can remain in place during removal.

As a result, the following EA has been prepared based on the preferred decommissioning option described above.

4.3.4 Schedule

Table 4-2: Schedule of Amethyst jackets decommissioning activities

Year	2024				2025				2026				2027				2028				2029			
Quarter	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Decommissioning Programme																								
Submission of DP																								
Consultation																								
Approval of DP																								
Campaign																								
A1D Jacket Removal																								
A2D Jacket Removal																								
B1D Jacket Removal																								
C1D Jacket Removal																								
Post Decommissioning Activities and Surveys																								
Post Decommissioning Surveys																								
Close Out Letter																								

LEGEND	
	Earlist date task could be completed
	Period in which the task expected to be completed

5 Environmental and Societal Baseline

5.1 Introduction

As part of the EA process, it is important that the main physical, biological and societal sensitivities of the receiving environment are well understood. As such, this section describes the main characteristics of the physical and biological environment, identifies the other users of the sea present in and around the Amethyst development, and highlights any key sensitivities therein.

This environmental baseline description draws upon a number of data sources including published papers on scientific research in the area, industry wide surveys (for example (e.g.) the OSEA3 and OSEA4 programmes) and site-specific investigations commissioned as part of the exploration and development processes and pre-decommissioning survey work carried out at the Amethyst field.

5.1.1 Amethyst Pre-Decommissioning Surveys [4; 5]

In 2020, PUK commissioned N-Sea, supported by Benthic Solutions Limited (BSL) to carry out a pre-decommissioning environmental baseline and habitat assessment survey conducted along the Amethyst export and interfield pipelines PL 649, PL 775 and PL 776 connecting Amethyst platforms A1D, A2D, B1D and C1D located in UKCS block 47/14 of the SNS.

A geophysical survey along the Interfield pipelines was performed using a vessel-mounted Multibeam Echosounder (MBES) obtaining bathymetry and backscatter data to aid in the habitat investigation of the site. Environmental seabed sampling and video assessment was carried out at a total of fourteen stations at intervals along each pipeline with a further three reference stations sampled further afield to provide a regional understanding of the different habitats encountered. Data was acquired through sampling of the seabed using a Hamon grab sampler while seabed video footage was acquired using a BSL MOD4 camera system with a freshwater lens adaption.

The survey included characterisation of the benthos, and investigation of the sediment physico-chemistry to provide an understanding of the baseline conditions prior to commencing decommissioning activities.

The main objectives of the environment baseline survey and habitat investigation were to:

- Provide high resolution still images and corresponding video at specific points in a cruciform pattern around the platform;
- Acquire baseline data of sediment physico-chemical and biological characteristics, including in the vicinity of structures to be decommissioned;
- Establish a baseline against which the environmental impact of future decommissioning operations can be assessed.
- To identify habitats of potential conservation interest defined as those listed in Annex I of the European Council (EC) Habitats Directive, the OSPAR List of Threatened and/or Declining Species and Habitats, and the UK Biodiversity Action Plan Priority Habitat descriptions, and;
- Ground-truth the selected sites for the presence or absence of sensitive habitats, such as biogenic reef and sandbanks using seabed imagery (stills and video).

Grab sampling and seabed video acquisition was undertaken at a total of 17 stations (Figure 5-1). Five sampling stations were located at intervals of at least 10km along PL 649 (outside the current DP), five stations at 2km intervals along PL 775 and four stations at 2km intervals along PL 776. The remaining three environmental stations (AMS_REF_01, AMS_REF_02, AMS_REF_03) were sampled further afield, at approximately 5km from any seabed assets, to provide a regional understanding of the different habitats encountered.

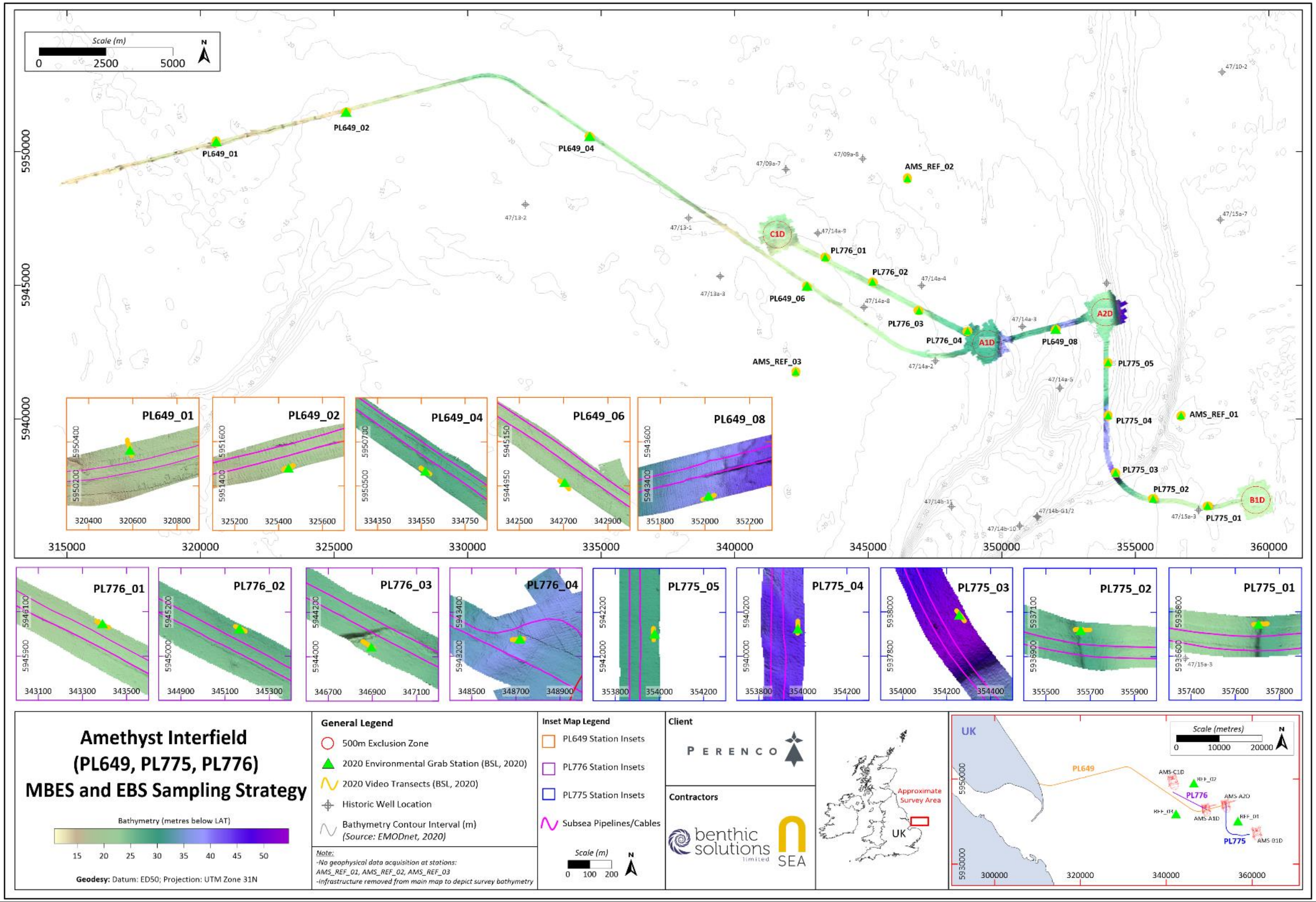
The MBES bathymetry and backscatter datasets were reviewed as required to identify areas of potential interest, including changes in acoustic reflectivity which may indicate sediment/habitat change. No further grab sample stations were deemed necessary as the predetermined cruciform stations were considered to provide adequate coverage of the expected variation in seabed sediments across the survey area. All benthic stations underwent the following sampling/sub-sampling:

- 2 x 0.1m2 macro-invertebrate replicate samples processed over a 1000µm aperture sieve;
- 1 x 0.1m2 physico-chemical replicate, subsampled for Particle Size Distribution (PSD), Total Organic Carbon (TOC), Total Organic Matter (TOM), moisture, heavy and trace metals (HM), and hydrocarbons at a single surface depth of 0-2cm.

Camera transects of at least 50m length were conducted at each sampling station for the acquisition of video and stills data, and to investigate changes in habitats and potential Annex I habitats. Survey operations were carried out using a BSL MOD4 camera system with a freshwater lens adaption mounted within a BSL camera sled equipped with lamps.

The environmental grab stations were named according to the station intersect represented by the gas infield pipeline. Due to the proximity of the powerlines lying parallel to the gas infield and the methanol infield pipelines piggybacked, it is considered that the results obtained from BSL environmental baseline and habitat assessment survey are representative for each Amethyst interfield transect.

Figure 5-1: MBES Bathymetry Data and Environmental Sampling - Amethyst pre-decommissioning survey



5.1.2 N-Sea Decommissioning Seabed Surveys [47]

In combination with BSL benthic surveys, PUK contracted N-Sea to conduct geophysical/geotechnical seabed surveys in the Amethyst area. The work scope included:

- Decommissioning seabed surveys in the Amethyst area;
- For Amethyst platforms, identification of potential hazards to a future jack-up platform within the 1km x 1km area centred on the platform location, utilising MBES data, backscatter imaging and magnetometry.
- For Amethyst pipelines (PL 649, PL 775 and PL 776) establishing areas of pipeline exposures and freespans, sections of rock covering and scour for future decommissioning plans. The survey aimed to document the seabed topography and, existing infrastructure, as well as significant debris and potential hazards along the pipeline route, utilising MBES and backscatter imaging data.

The area surveyed consisted of four platforms (Amethyst A1D, Amethyst A2D, Amethyst B1D and Amethyst C1D) and three pipelines (PL 649, PL 775 and PL 776).

Table 5-1: Seabed surveys scope

Assets	Area/Length	Survey Sensor(s)
Amethyst A1D	1km x 1km	MBES [bathymetry & backscatter] + Magnetic Anomaly Gradient (MAG)
Amethyst A2D	1km x 1km	MBES [bathymetry & backscatter] + MAG
Amethyst B1D	1km x 1km	MBES [bathymetry & backscatter] + MAG
Amethyst C1D	1km x 1km	MBES [bathymetry & backscatter] + MAG
PL649	48km	MBES [bathymetry & backscatter]
PL775	12km	MBES [bathymetry & backscatter]
PL776	9km	MBES [bathymetry & backscatter]

The geophysical data acquired by N-Sea was reviewed onboard by BSL, and camera transects were selected to target any habitats and selected habitat boundaries across the survey area, with particular attention paid to the investigation of potential Annex I habitats protected under the European Council (EC) Habitats Directive.

5.1.3 Bathymetry

The SNS extends from the Flamborough front in the South (S) to N of the Dover Strait in the S, with a transition from North Sea water to Atlantic water. This region is shallow (generally 0-50m), with a predominantly sandy seabed [6]. Mapped information [40] indicates that the SNS generally comprises of sand and muddy sand with significant areas of coarse sediment, especially closer to shore.

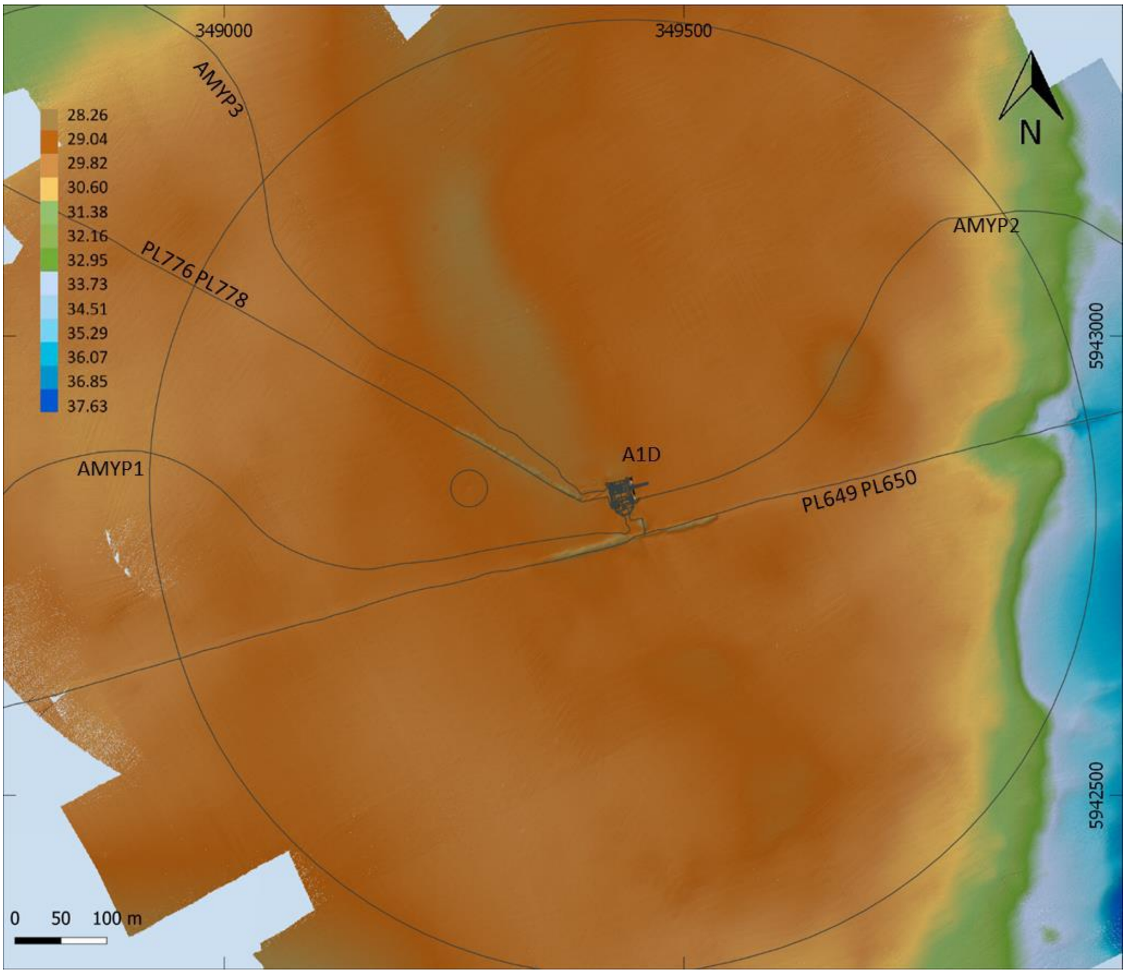
The SNS has many extensive sandbanks features present at less than 25m depth; these include areas which have been designated under the EU Habitats Directive (92/43/EEC) such as Dogger Bank Special Area of Conservation (SAC) and the North Norfolk Sandbanks SAC [6].

A1D

Water depths in the survey area range from 27.0m to 39.7m LAT. Water depth at Amethyst A1D is 27m Lowest Astronomical Tide (LAT) (Figure 5-2).

The seabed is relatively flat lying, at the exception of the channel at the eastern part of the area with slopes reaching 5 to 10° and depths rapidly increasing from 29m to 39.7m LAT. Most of the area is comprises sandy gravel seabed. The eastern part of the area, a N-S orientated channel, is composed of gravelly sand. An anchor was also observed during the Remotely Operated Vehicle (ROV) visual inspection.

Figure 5-2: Overview of A1D bathymetry



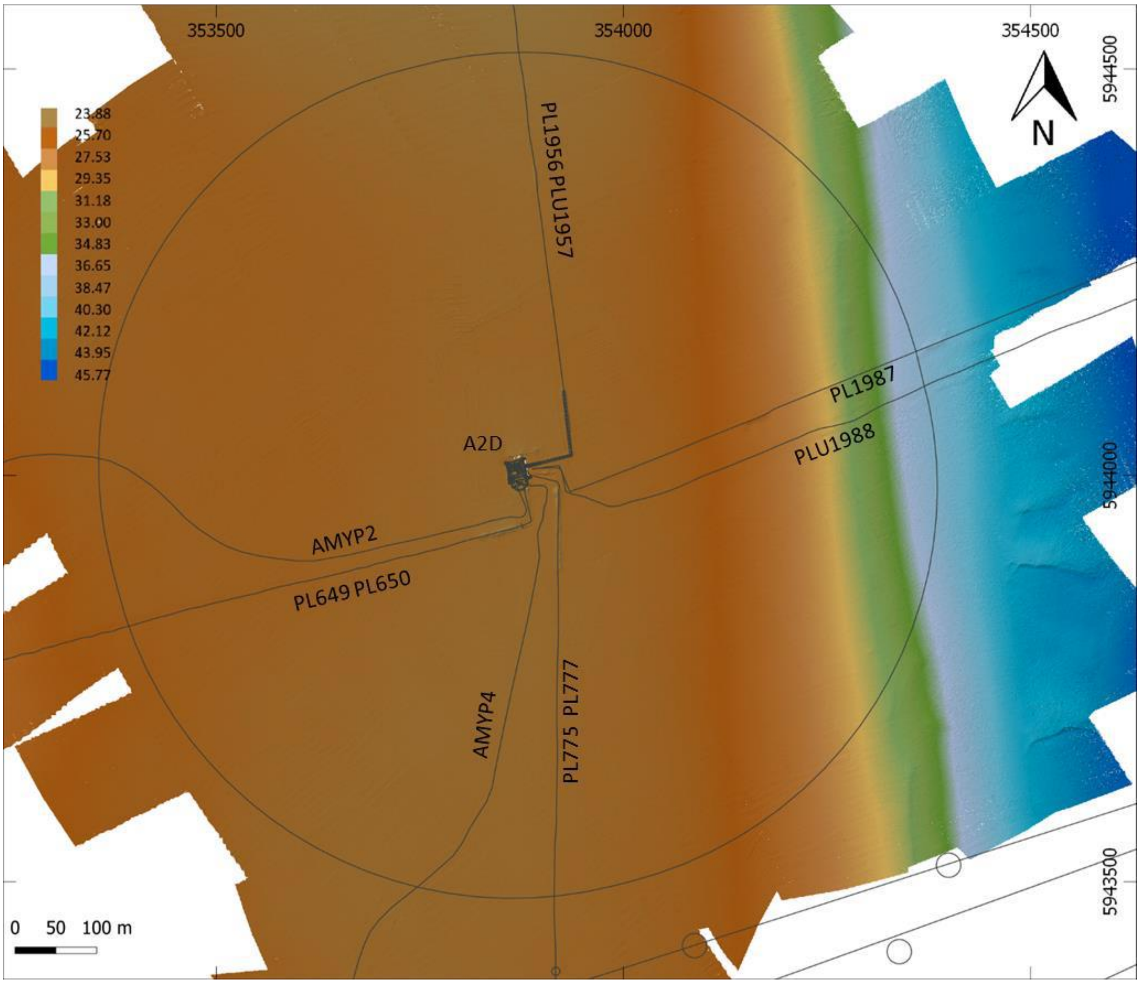
A2D

Water depths in the survey area range from 22m to 50.5m LAT. Water depth at the platform is 22m LAT (Figure 5-3).

Across the western and central parts of the survey area, the seabed is relatively flat lying while on the eastern side the edge of an N-S orientated channel was observed. The slope reaches 2° with depths rapidly increasing beyond 50m eastward.

The western and central parts of the survey area are composed of a relatively flat and featureless sandy-gravelly seabed. The channel on the eastern side of the area is composed of a muddy-sandy-gravelly seabed, appearing occasionally disturbed at the bottom of the channel

Figure 5-3: Overview of A2D bathymetry



B1D

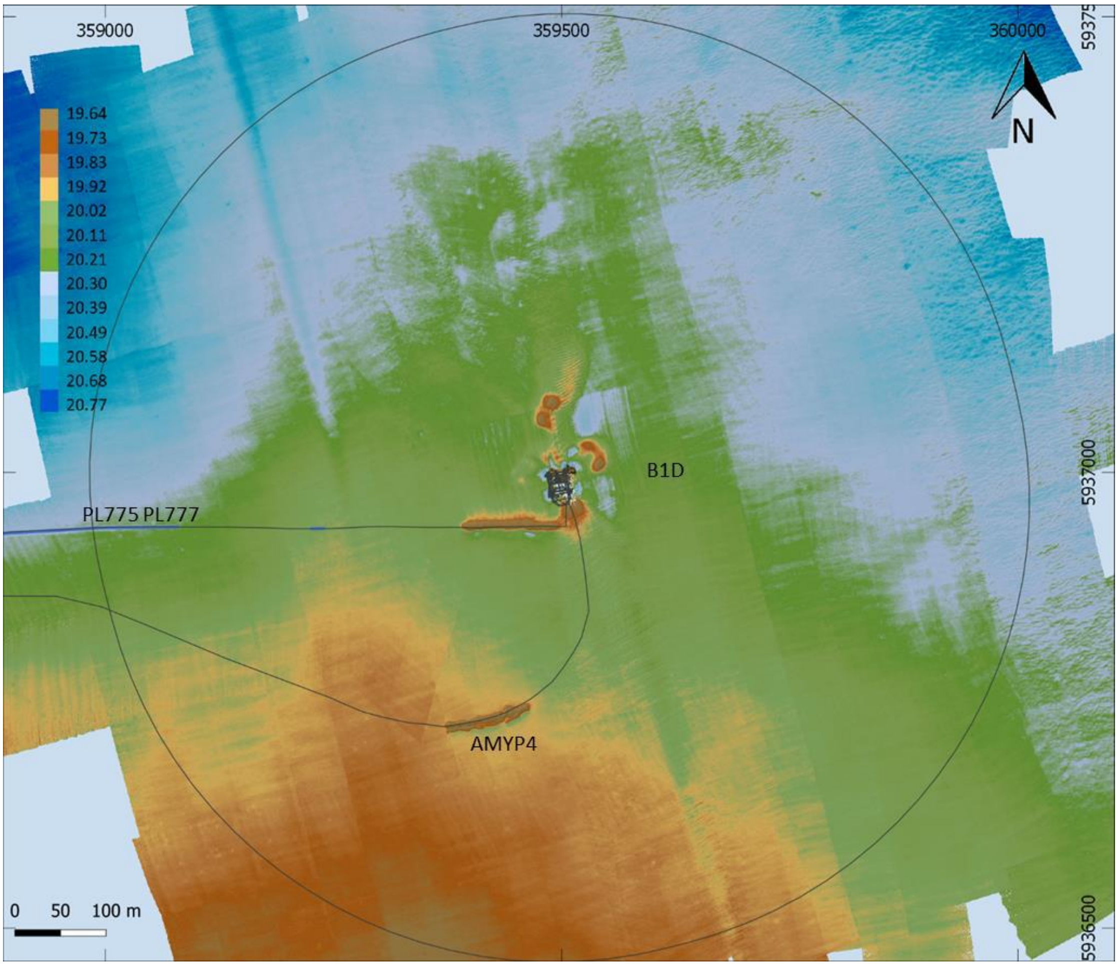
Water depths in the survey area range from 18m to 21.0m LAT. Water depth at Amethyst B1D is 18m LAT (Figure 5-4).

The seabed is relatively flat lying, with a small increasing gradient from S to N, showing a 0.06° slope.

The entire eastern side of the area shows large areas of megaripples with a wavelength of up to 5m and 0.3m high. A smaller area of mega ripples runs N from the platform for around 220m with a wavelength of up to 5m and 0.4m high.

Most of the area is characterised by a medium reflectivity sandy seabed.

Figure 5-4: Overview of B1D bathymetry



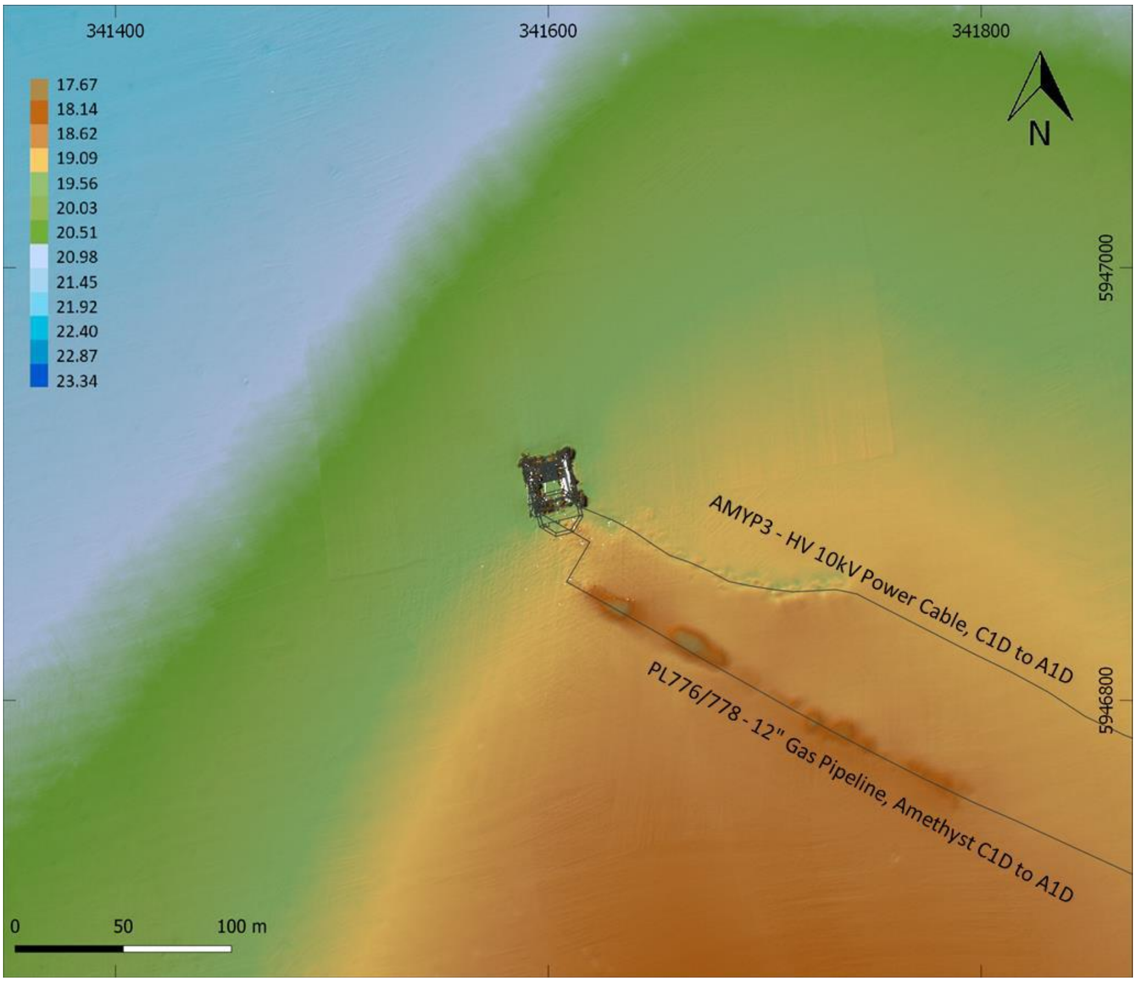
C1D

Water depths in the survey area range from 16.7m to 23.5m LAT. Water depth at Amethyst C1D is 18m LAT (Figure 5-5).

The seabed is relatively flat lying, with a small increasing gradient from NW to SE, showing a 0.03° slope from 23.2m in the N to 17.9m in the S.

Most of the area is characterised by a high reflectivity sandy-gravelly seabed, generally featureless

Figure 5-5: Overview of C1D bathymetry



5.1.4 Habitat Classification

The following European Nature Information System (EUNIS) seabed classifications have been identified in the vicinity of the Amethyst jackets (Figure 5-9) [10; 6].

A5.14: Circalittoral coarse sediment.
A5:15: Infralittoral coarse sediment.
A5:25/A5:26: Circalittoral sand.
A5:44: Circalittoral mixed sediments.
A5:45: Offshore circalittoral mixed sediment.
A4:27: Faunal communities on deep moderate energy circalittoral rock.

A5.14 Circalittoral coarse sediment - Tide-swept circalittoral coarse sands, gravel, and shingle generally in depths of over 15-20m. This habitat may be found in tidal channels of marine inlets, along exposed coasts and offshore. This habitat, as with shallower coarse sediments, may be characterised by robust infaunal polychaetes, mobile crustacea and bivalves. Certain species of sea cucumber (e.g. *Neopentadactyla*) may also be prevalent in these areas along with the lancelet (*Branchiostoma lanceolatum)*.

A5:15: Offshore circalittoral course sediment - Offshore (deep) circalittoral habitats with coarse sands and gravel or shell. Such habitats are quite diverse compared to shallower versions of this habitat and generally characterised by robust infaunal polychaete and bivalve species. Animal communities in this habitat are closely related to offshore mixed sediments and in some area's settlement of *Modiolus modiolus* larvae may occur and consequently these habitats may occasionally have large numbers of juvenile *M. modiolus.* In areas where the mussels reach maturity their byssus threads bind the sediment together, increasing stability and allowing an increased deposition of silt leading to the development of the biotope *Modiolus modiolus* beds with *Chlamys varia*, sponges, hydroids, and bryozoans on slightly tide-swept very sheltered Atlantic circalittoral mixed substrata.

A5.25/A5.26 Circalittoral sand - Circalittoral clean fine sands with less than 5% silt/clay in deeper water, or either on the open coast or in tide-swept channels of marine inlets in depths of over 15-20m or non-cohesive muddy sands with the silt content of the substratum typically ranging from 5% to 20% generally found in water depths of over 15-20m. This habitat is generally more stable than shallower, infralittoral sands and consequently supports a more diverse community. This habitat extends offshore, while very little information is available on these, they are likely to be more stable than their shallower counterparts. This habitat is characterised by a range of taxa including polychaetes, bivalve molluscs, and amphipod crustacea.

A5.44: Circalittoral mixed sediments - Mixed (heterogeneous) sediment habitats in the circalittoral zone (generally below 15-20m) including well mixed muddy gravelly sands or very poorly sorted mosaics of shell, cobbles and pebbles embedded in or lying upon mud, sand, or gravel. Due to the variable nature of the seabed a variety of communities can develop which are often very diverse. A wide range of infaunal polychaetes, bivalves, echinoderms, and burrowing anemones such as *Cerianthus lloydii* are often present in such habitat and the presence of hard substrata (shells and stones) on the surface enables epifaunal species to become established, particularly hydroids such as Nemertesia Species (spp) and *Hydrallmania falcata*. The combination of epifauna and infauna can lead to species rich communities.

Coarser mixed sediment communities may show a strong resemblance, in terms of infauna, to biotopes within the A5.1. However, infaunal data for this habitat type is limited to that described under the biotope A5.43, and so are not representative of the infaunal component of this habitat type.

A5.45 - Deep circalittoral mixed sediments

Offshore (deep) circalittoral habitats with slightly muddy mixed gravelly sand and stones or shell. This habitat may cover large areas of the offshore continental shelf although there is relatively little data available. Such habitats are often highly diverse with a high number of infaunal polychaete and bivalve species. Animal communities in this habitat are closely related to offshore gravels and coarse sands and in some areas populations of the horse mussel *Modiolus modiolus* may develop in these habitats (see A5.622).

A4.27 - Faunal communities on deep moderate energy circalittoral rock

These communities populate hard substrata with low hydrodynamics and strong sedimentation.

During the 2020 Habitat Assessment Surveys [4], habitats were identified using a combination of field observations, detailed review of video footage and still images. On the whole, the seabed sediments surrounding the jackets and pipelines were characterised as sandy gravel.

Amethyst A1D field revealed a generally uniform seabed consisting of muddy sandy gravel with an occasionally significant sand component and generally low fines content throughout the survey area. Cobbles were observed across the survey area in varying frequencies along with occasional boulders. As a result of the coarse sediment within the main A1D the survey area, only one habitat was identified, which conformed to the EUNIS A5.44 classification of 'Circalittoral mixed sediment.

Within the Amethyst B1D survey area, only one major habitat was identified, which conformed to the EUNIS A5.14 classification of 'Circalittoral coarse sediment. Video and still photographic ground-truthing from nine transects within the Amethyst B1D survey area and three reference stations sampled further afield (5km from any asset) confirmed the presence of a two subtly different sediment types, consisting of gravelly sand and sandy gravel with mosaics of pebbles, cobbles, relic shell debris (predominantly Modiolus modiolus) and sporadic boulders (Figure 5-7).

C1D survey area revealed a generally uniform seabed consisting of sandy gravel with an occasionally significant sand component and minimal fines content throughout. Cobbles were observed across the survey area in varying frequencies, while shell debris often composed of relic *Modiolus modiolus* was observed along most transects. As a result of the coarse sediment within the survey area, only one habitat was identified, which conformed to the EUNIS A5.14 classification of 'Circalittoral Coarse Sediment'. The habitat is dominated by coarse sands intermixed with gravel and pebbles and extensive areas of shell debris were also observed (Figure 5-7).

A2D revelled a muddy sand and gravel substrate typical from a Circalittoral Corse Sediment (EUNIS A5.14), changing to Gravelly Sand towards the W edge of the surveyed area. Video transects revealed seabed gravel and sand density ranging between 60 – 80%.

With regards to Amethyst pipeline routes, the seabed within the survey area was deemed to include two main EUNIS habitat types: A5.44 'Circalittoral mixed sediment' and A5.14 'Circalittoral coarse sediment'. The mixed sediment habitat, which encompassed the majority of the survey area, was characterised by muddy sandy gravels with various accumulations of pebbles, cobbles and occasional boulders. Habitats within these areas exhibited a degree of resemblance to the habitats A5.444 '*Flustra foliacea* and *Hydrallmania falcata* on tide swept circalittoral mixed sediment' and A5.141 '*Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles'. However, a lack of full conformance meant these areas were best described by the overarching A5.44 habitat type.

The circalittoral coarse sediment habitat type which was observed along the camera transects at PL776_03, PL775_03, PL775_04 and the three reference stations was characterised by coarse sands interspersed with mosaics of cobbles, pebbles, gravel and relic shell debris including *Modiolus modiolus*. In some areas the sediment was sandier (PL775_03 and PL775_04) but was still best described by the A5.14 habitat type. The habitat within these areas displayed resemblances to several further habitat types including A5.444 '*Flustra foliacea* and *Hydrallmania falcata* on tide swept circalittoral mixed sediment' at PL776_03 and the three reference stations, A5.141 '*Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles' at the three reference stations, A5.251 '*Echinocyamus pusillus, Ophelia borealis and Abra prismatica* in circalittoral fine sand' at PL775_03 and PL775_04 and A5.252 '*Abra prismatica, Bathyporeia elegans* and polychaetes in circalittoral fine sand'. However, a lack of full conformance with any of these level five biotopes and low abundances of the characterising species, meant these areas were best described by the overarching A5.14 habitat type.

Figure 5-6: Example Images of Circalittoral Mixed Sediment (A5.44) Habitat in A1D

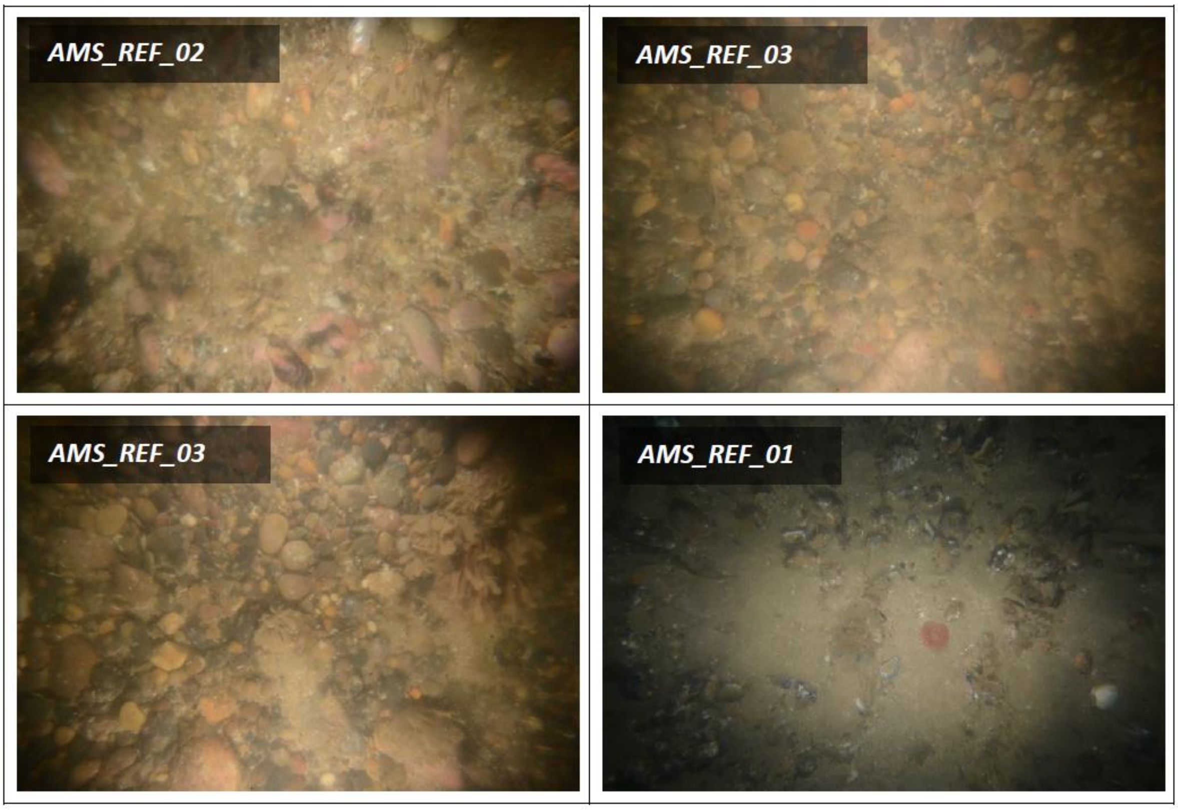


Figure 5-7: Example Images of Circalittoral Coarse Sediment (A5.14) Habitat in C1D

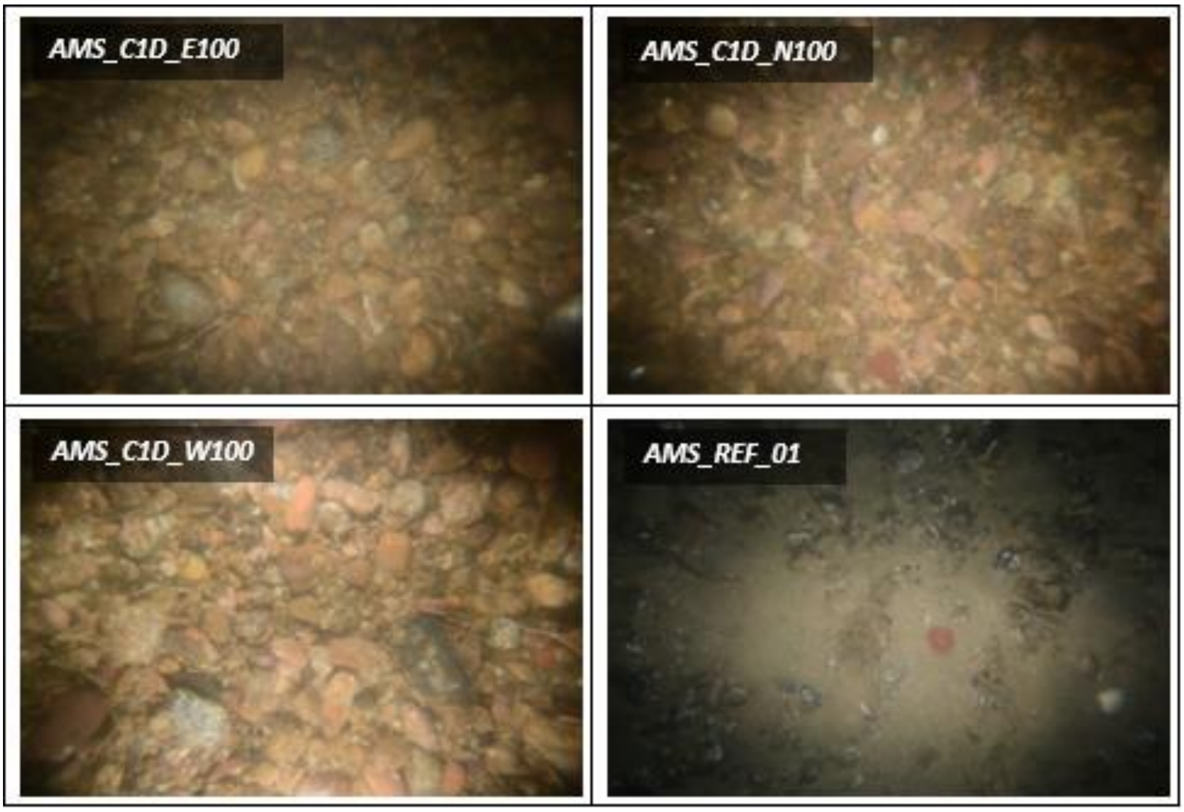


Figure 5-8: Example Images of Circalittoral Coarse Sediment (A5.14) Habitat in B1D

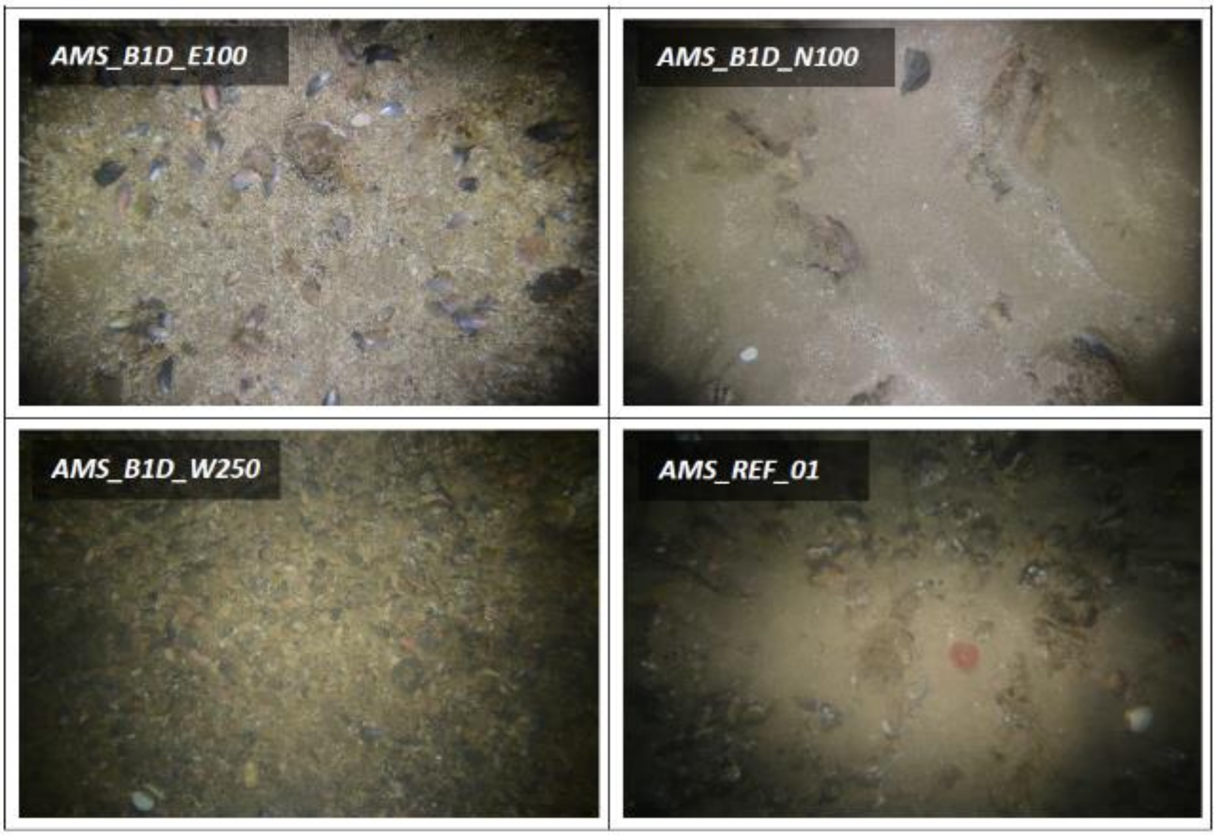
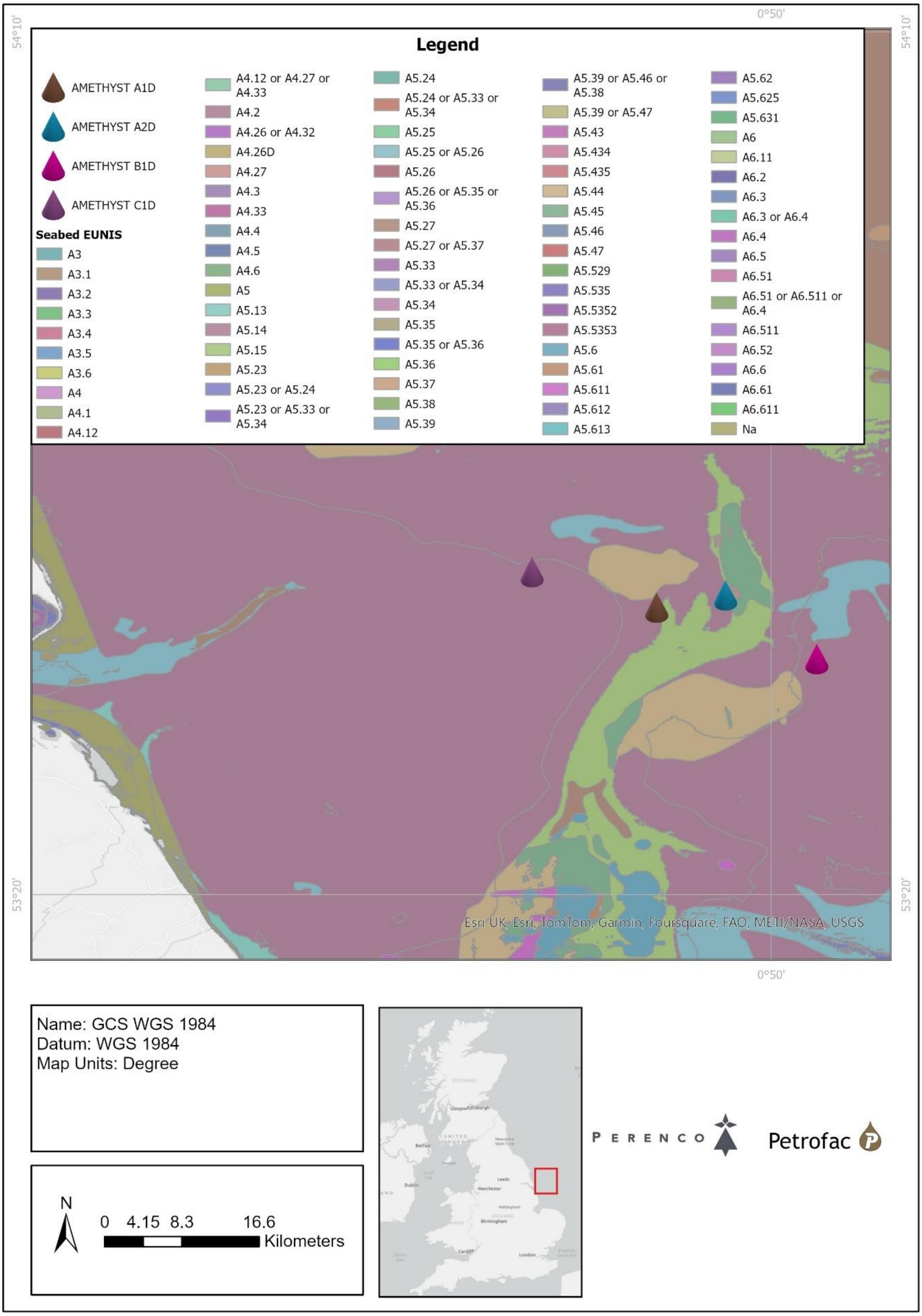


Figure 5-9: Seabed EUNIS broad-scale seabed classification



5.1.5 Particle Size Distribution

The particle size interpretation of sediments from the environmental baseline survey conducted within the Amethyst Interfield survey area was based on observations made from the acoustic data and seabed photography, as well as from the analytical results acquired from sediments at seventeen stations [4; 5]. The results obtained across the survey area are representative of the sediment composition at the Amethyst jackets within the scope of this EA.

The results of particle size analyses indicated a relatively varied sediment type across the Amethyst survey area with sediments along the PL 649 and PL 776 routes showing a slight gravel dominance (mean 54.6%±23.5 Standard Deviation (SD) and 55.8%±16.0 respectively) with significant proportion of sand (mean 38.5%±19.0SD and 41.8%±14.5SD respectively) and low levels of fines (mean 7.0±5.1SD and 2.5%±1.7SD respectively).

In contrast, PL 775 route was sand dominated (mean 66.7%±27.9SD), with the highest concentration found at the stations PL775_03 and PL775_04, both of which were located within the Inner Silver Pit channel. A significant gravel component was observed at the two stations closest to shore (PL649_01 and PL649_02) (mean 29.0%±25.6SD) but again, a low proportion of fines (mean 4.33%±2.8SD). The general variability in sediment type was thought to represent typical background sediments for this area of the SNS.

The 17 stations collected in the survey area were represented by six Folk classifications with almost half (eight stations) classified as ‘sandy gravel’. The varied sediment across PL 649 was illustrated by four Folk classifications ranging from ‘gravelly muddy sand’ to ‘gravel’. PL 775 was similarly varied with three Folk classifications ranging from ‘slightly gravelly sand’ to ‘sandy gravel’ while all PL 776 stations were classified as ‘sandy gravel’.

Full details of the PSD sampling for the 17 Amethyst stations are represented in Table 5-2.

Data comparison

No historical comparison has been made between the present 2020 pre-decommissioning survey and the historical data available from previous 2000 and 1991/1992 surveys due to differences in sample point location.

However, the mean particle size and associated standard deviation for a nearby survey of Pickerill A [16] below are provided in Table 5-2 to allow a regional comparison with the present Interfield study. The overall pattern across the interfield pipelines of similar proportions of gravel and sand with a minimal fines component is quite well echoed by the nearby Pickerel A survey [16] which reported overall survey means of 57.6% sand, 38.5% gravel and 3.92% fines.

Furthermore, the variability in sediment composition across the survey area is well illustrated by the highest values reported at each of the four Amethyst platforms (A1D, A2D, B1D, C1D) for the different size fragments (gravel, sand and fines). The general range encompassed by these selected values corresponded well with the overall range recorded by the Amethyst Interfield survey. The sediment composition observed along the pipeline routes also corresponded well with the varied composition of the sediment at the three reference stations which varied between sand and gravel dominance. This variability in sediment composition, together with low associated fines content is considered typical of background conditions of the SNS [5].

Table 5-2: Amethyst Surface Particle Size Characteristics

Station	Depth (m)	Distance from Closest Platform (m)*	Mean Sediment Size		Wentworth Classification	Sorting Coefficient	Sorting Classification	Fines (%)	Sands (%)	Gravel (%)	Modified Folk scale
			mm	Phi							
PL649_01	17	21,303 (C1D)	11.2	-3.48	Pebble	2.59	Very Poorly Sorted	4.29	14.2	81.5	Gravel
PL649_02	17	16,797 (C1D)	5.11	-2.35	Pebble	2.10	Very Poorly Sorted	0.74	25.4	73.9	Sandy Gravel
PL649_04	24	7,936 (C1D)	0.81	0.30	Coarse Sand	3.21	Very Poorly Sorted	13.9	56.8	29.3	Gravelly Muddy Sand
PL649_06	19	2,222 (C1D)	2.41	-1.27	Granule	2.72	Very Poorly Sorted	6.06	38.8	55.2	Muddy Sandy Gravel
PL649_08	33	1,965 (A2D)	0.94	0.09	Coarse Sand	2.87	Very Poorly Sorted	9.82	57.2	33.0	Muddy Sandy Gravel
Mean			**4.09**	**-1.34**	**-**	**2.70**	**-**	**6.96**	**38.5**	**54.6**	**-**
SD			**4.32**	**1.61**	**-**	**0.41**	**-**	**5.06**	**19.0**	**23.5**	**-**
Coefficient of Variation (CV) (%)			**105.6**	**-119.9**	**-**	**15.1**	**-**	**72.8**	**49.5**	**43.0**	**-**
PL775_01	22	1,810 (B1D)	1.03	-0.04	Very Coarse Sand	2.71	Very Poorly Sorted	6.31	58.0	35.7	Sandy Gravel
PL775_02	25	3,842 (B1D)	1.49	-0.57	Very Coarse Sand	2.92	Very Poorly Sorted	6.68	51.8	41.6	Muddy Sandy Gravel
PL775_03	45	5,337 (B1D)	0.40	1.31	Medium Sand	1.14	Poorly Sorted	3.04	93.7	3.30	Slightly Gravelly Sand
PL775_04	39	3,884 (A2D)	0.49	1.04	Medium Sand	0.75	Moderately Sorted	0.00	97.2	2.82	Slightly Gravelly Sand
PL775_05	25	1,908 (A2D)	4.64	-2.21	Pebble	3.27	Very Poorly Sorted	5.61	32.8	61.6	Muddy Sandy Gravel
Mean			**1.61**	**-0.09**	**-**	**2.16**	**-**	**4.33**	**66.7**	**29.0**	**-**
SD			**1.75**	**1.41**	**-**	**1.14**	**-**	**2.80**	**27.9**	**25.6**	**-**
CV (%)			**108.7**	**-1493.0**	**-**	**52.7**	**-**	**64.8**	**41.8**	**88.1**	**-**
PL776_01	19	1,982 (C1D)	4.25	-2.09	Pebble	2.28	Very Poorly Sorted	2.05	29.5	68.4	Sandy Gravel
PL776_02	23	3,981 (C1D)	1.21	-0.27	Very Coarse Sand	2.18	Very Poorly Sorted	3.65	58.7	37.7	Sandy Gravel
PL776_03	21	2,814 (A1D)	5.07	-2.34	Pebble	1.98	Poorly Sorted	0.27	29.8	70.0	Sandy Gravel
PL776_04	31	847 (A1D)	1.54	-0.63	Very Coarse Sand	2.13	Very Poorly Sorted	3.89	49.1	47.0	Sandy Gravel
Mean			**3.02**	**-1.33**	**-**	**2.14**	**-**	**2.47**	**41.8**	**55.8**	**-**
SD			**1.93**	**1.03**	**-**	**0.12**	**-**	**1.67**	**14.5**	**16.0**	**-**
CV (%)			**64.0**	**-77.7**	**-**	**5.7**	**-**	**67.8**	**34.8**	**28.7**	**-**
AMS_REF_01	24	4,196 (B1D)	0.83	0.28	Coarse Sand	2.31	Very Poorly Sorted	3.56	68.4	28.1	Gravelly Sand
AMS_REF_02	28	5,292 (C1D)	1.86	-0.90	Very Coarse Sand	2.23	Very Poorly Sorted	2.02	49.9	48.1	Sandy Gravel
AMS_REF_03	22	5,186 (C1D)	2.99	-1.58	Granule	2.26	Very Poorly Sorted	3.03	34.0	63.0	Sandy Gravel
Regional Comparison											
Pickerill A [16]		**Mean**	**1.22**	**-0.06**	**Very Coarse Sand**	**2.66**	**Very Poorly Sorted**	**3.92**	**57.6**	**38.5**	**Sandy Gravel**
		SD	**0.75**	**0.85**		**0.38**	**-**	**2.72**	**13.1**	**12.9**	**-**
		CV (%)	**61.6**	**-1449**		**14.4**	**-**	**69.4**	**22.7**	**33.4**	**-**

*** C1D = Amethyst C1D Platform, A2D= Amethyst A2D Platform, B1D=Amethyst B1D Platform, A1D = Amethyst A1D Platform**

5.1.6 Seabed Chemistry

5.1.6.1 TOM , TOC, and Moisture Content

Amethyst sediments were analysed for TOM, TOC, and moisture content; the results of which are representative of seabed composition for the Amethyst jackets location and are presented in Table 5-3 and Figure 5-10. TOC represents the proportion of biological material and organic detritus within the substrates. This method is less susceptible to the interference sometimes recorded using crude combustion techniques, such as analysing total organic matter by Loss on Ignition (LOI).

TOM content within the Amethyst Interfield survey area varied slightly, ranging from 1.1% at PL649_02 to 2.6% at PL775_01 and PL775_02 with comparable means between the pipelines of 2.1%±0.6SD, 2.1%±0.7SD and 2.2%±0.3SD at PL 649, PL 775 and PL 776 respectively. Levels of TOM could be considered slightly elevated, with all stations exceeding the United Kingdom Offshore Operators Association (UKOOA) [66] 50th percentile (%ile) for the SNS and a further nine stations exceeding the UKOOA [66] 95th %ile of 2.3%. No relationship between sediment characteristics and TOM content was observed, however, the lack of correlation between TOM and distance to the nearest Amethyst platform suggests that the higher levels within the survey area are not drilling related.

The TOC results, with the exception of PL776_03 (1.13%), were low throughout the survey area (PL 649 mean 0.27% ±0.09SD, PL 775 mean 0.32%±0.12SD, and PL 776 mean 0.49%±0.43SD), reflecting an organically deprived environment. Due to the generally low TOC, it appears unlikely that there has been any influence on TOC from drilling activities at the Amethyst platforms. This hypothesis is further supported by the lack of any significant Spearman's correlation between TOC and distance to platform. TOC in surface sediments is an important source of food for benthic fauna [62], although an overabundance may lead to reductions in species richness and abundance due to oxygen depletion. Increases in TOC may also reflect increases in both physical factors (That is (i.e.) fines) and common co-varying environmental factors through greater sorption on increased sediment surface areas [65]. As fines were consistently low across the survey area, no significant relationships with TOC were observed, nor were any for sands and gravel. Peak TOC (1.13%) was recorded at PL776_03, where gravel was the dominant fraction (70.0%). Review of the deck logs and sample photography for both PL776_03 and AMS_REF_02, which measured the second highest TOC, revealed the sediment consisted of a high proportion of shell debris, in particular large quantities of relic horse mussel shells (*Modiolus modiolus*) with a review of the video footage confirming mosaics of relic horse mussel shells and pebbles, particularly within sand troughs. It is possible that the high levels of shell debris may have contributed to the higher TOC in these areas.

Terrestrially derived carbon from runoff and fluvial systems, combined with primary production from sources such as phytoplankton blooms, contribute to the TOC levels recorded in sediments. While both allochthonous and autochthonous sources will be present throughout the Amethyst Interfield survey area, the general lack of fine sediment, and therefore reduced surface area for adsorption, meant that overall TOC levels were low. This may in turn affect the richness and abundance of deposit-feeding organisms within the sediment.

Moisture content ranged from 17.2% at station PL775_03 to 35.1% at station PL649_04 with all but two stations revealing a moisture content of less than 25%. There was no consistent trend between moisture content and other sediment characteristics ($p>0.05$), with differences in percentages of gravel, sand and fines appearing to have little or no effect on the moisture retention. Additionally there was no obvious spatial trend in moisture content across the survey area with similar values recorded across the three pipelines (PL 649 mean 22.8%±6.9SD, PL 775 mean 20.8%±2.8SD, and PL 776 mean 22.3%±2.8SD).

Data Comparison

No historical comparison was possible between the present 2020 pre-decommissioning survey and the historical data available from previous 2000 and 1991/1992 surveys.

The moisture content and TOC results from the pre-decommissioning survey were compared to the nearby PUK Pickerill A platform results to enable more localised regional comparison (Table 5-3). The mean moisture content within the current survey area was consistent with that of Pickerill A. Conversely, TOC was slightly higher along the pipeline routes in the present survey area when compared to Pickerill A, which could relate to the aforementioned presence of shell debris within the current survey area. However, the difference in mean TOC between the sites was considered to be minor.

Furthermore, the highest values for TOC reported at each of the four Amethyst platforms are presented alongside the values recorded as part of this Amethyst Interfield survey in Figure 5-10. With the exception of the previously mentioned PL776_03, the general range encompassed by these selected values corresponds well with the overall range in TOC recorded during the present Interfield survey. The three reference stations which recorded a range of 0.25%-0.57% TOC, 1.7%-2.5% TOM and a moisture content range of 19.7%-25.4% also compared well to the results reported along the pipeline routes. Therefore, it can be concluded that the organic content of the seabed within the Amethyst Interfield survey area is consistent with the wider region [5].

Table 5-3: Summary of Total Organic Carbon and Moisture Content pre-decommissioning survey

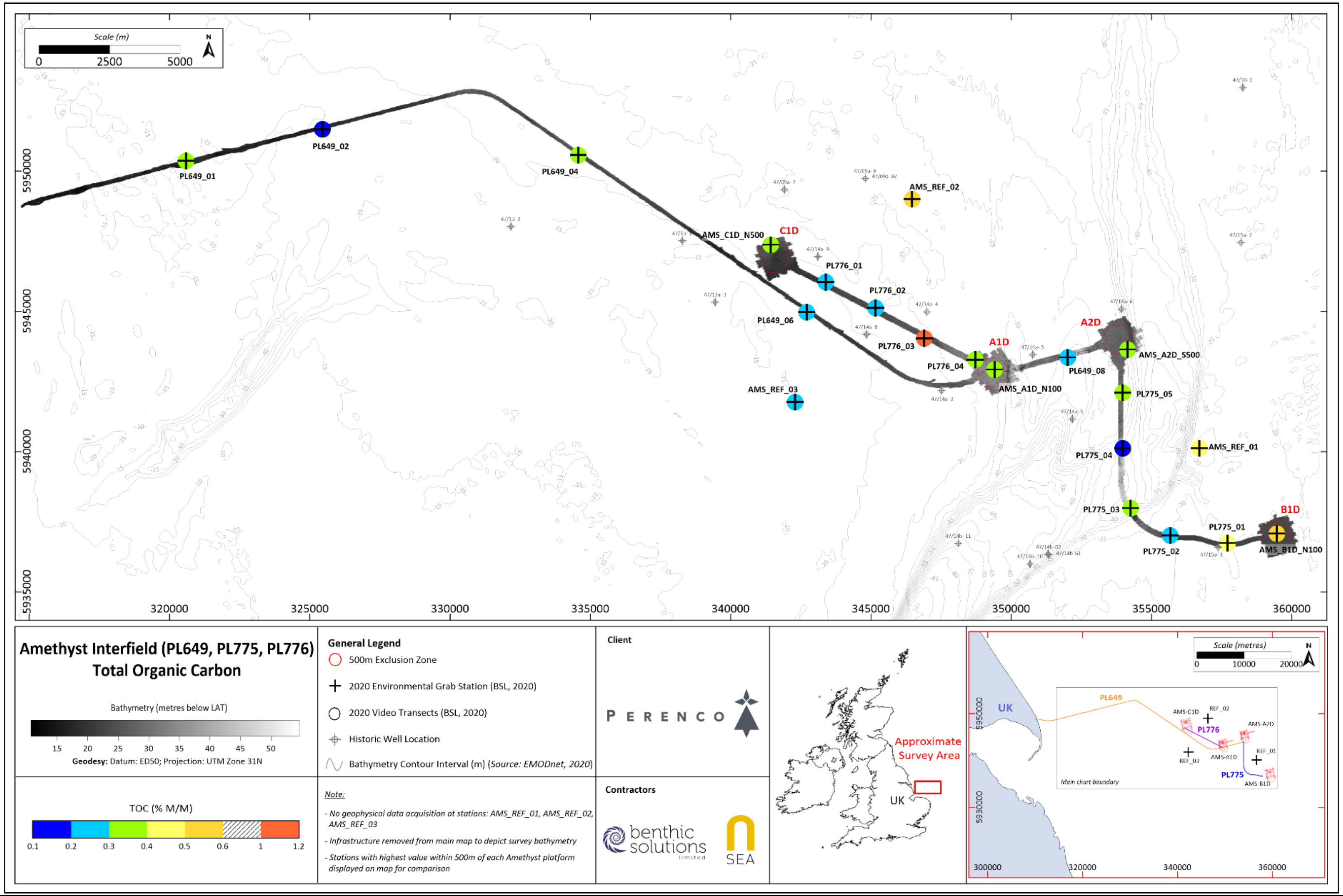
Station	Depth (m)	Distance from Closest Platform (m)*	TOM (%)	TOC (% M/M)	Moisture Content (% w/w)
PL649_01	17	21,303 (C1D)	2.4	0.36	20.3
PL649_02	17	16,797 (C1D)	1.1	0.14	20.2
PL649_04	24	7,936 (C1D)	2.4	0.33	35.1
PL649_06	19	2,222 (C1D)	2.3	0.26	18.3
PL649_08	33	1,965 (A2D)	2.1	0.24	20.2
Mean			**2.1**	**0.27**	**22.8**
SD			**0.6**	**0.09**	**6.92**
CV (%)			**26.7**	**32.3**	**30.3**
PL775_01	22	1,810 (B1D)	2.6	0.46	24.3
PL775_02	25	3,842 (B1D)	2.6	0.28	19.1
PL775_03	45	5,337 (B1D)	1.4	0.36	17.2
PL775_04	39	3,884 (A2D)	1.3	0.14	22.7
PL775_05	25	1,908 (A2D)	2.5	0.35	20.8
Mean			**2.1**	**0.32**	**20.8**
SD			**0.7**	**0.12**	**2.82**
CV (%)			**32.1**	**37.2**	**13.5**
PL776_01	19	1,982 (C1D)	1.8	0.23	25.6
PL776_02	23	3,981 (C1D)	2.1	0.29	23.7
PL776_03	21	2,814 (A1D)	2.5	1.13	20.4
PL776_04	31	847 (A1D)	2.2	0.31	19.6
Mean			**2.2**	**0.49**	**22.3**
SD			**0.3**	**0.43**	**2.81**
CV (%)			**13.4**	**87.4**	**12.6**
AMS_REF_01	24	4,196 (B1D)	2.3	0.42	25.4
AMS_REF_02	28	5,292 (C1D)	2.5	0.57	19.7
AMS_REF_03	22	5,186 (C1D)	1.7	0.25	22.9
Regional Comparison					
Pickerill A [16 below	**Mean**		**-**	**0.23**	**25.6**
	SD		**-**	**0.06**	**2.6**
	CV (%)		**-**	**24.1**	**10.3**
Reference Levels					
UKOOA (2001) Background 50th %ile			**1.12**	**-**	**-**
UKOOA (2001) Background 95th %ile			**2.30**	**-**	**-**

Yellow cell = above UKOOA SNS 50th %ile *Orange cell = above UKOOA SNS 95th %ile*

C1D = Amethyst C1D Platform, A2D= Amethyst A2D Platform, B1D=Amethyst B1D Platform, A1D = Amethyst A1D

w/w = Wet weight

Figure 5-10: TOC Amethyst pre-decommissioning environmental survey



5.1.6.2 THC

The Total Hydrocarbon Content (THC) of the sediments at Amethyst field were variable, ranging from 2.90mg.kg^{-1} at station PL649_02 to 35.9mg.kg^{-1} at station PL775_01. There were no obvious spatial patterns with comparable levels along all three pipelines (PL649 mean 12.3mg.kg^{-1} ±7.6SD, PL 775 mean 18.3mg.kg^{-1} ±12.0SD, PL 776 mean 12.4mg.kg^{-1}±5.4SD) and no correlations between THC and water depth, easting or distance to platform (Figure 5-11). Conversely, there was a positive correlation between THC and percent fines likely as a result of PL775_01 and PL775_02 which recorded the two highest THC and fines contents (6.3% and 6.7%).

The higher concentration of THC recorded at station PL775_01 is likely due to its location on the edge of a 3.7m deep channel which crosses the PL 775 route at Kilometre Point (KP) 1.80. The edges of seabed depressions can create turbulence to the overlying current, which causes a reduction in current speed and results in increased deposition in these areas and accumulation of naturally occurring hydrocarbons. However, given the station's proximity (approximately 360m NE) from the AB3 decommissioned wellhead 47/15a-3, low levels of historic drilling impact at the site cannot be completely ruled out.

Additional laboratory testing was analysed to determine concentrations of Saturate/Aliphatic Hydrocarbons, with results presented in Table 5-4. The contribution of alkanes to THC was consistently low throughout ranging between 3.61% at PL649_02 and 10.78% at PL775_02 and averaging 6.22%±1.94SD, 7.03%±2.41SD, 6.36%±1.67 at PL 649, PL 775 and PL 776 respectively. Although proportions of alkanes exceeded the UKOOA 50th %ile (5.95%) at 10 stations, five of which also exceeded the 95th %ile (6.85%), these percentages are as would be expected for background marine sediments with minimal contamination where background hydrocarbons are continuously replenished by a low but consistent source of alkanes in this area of the SNS.

The elevated THC across the survey area is thought to be due to an influx of non-drilling related hydrocarbons from shipping traffic and runoff associated with the Humber Estuary. This assertion was backed by the lack of correlation between THC and distance from the Amethyst platforms, and by the gas chromatographic profiles which showed weathered petroleum signatures over a broad range of n-alkanes at many stations, indicative of wider contamination. Total n-alkanes followed a similar pattern to THC, highest at PL775_02 and lowest at PL649_02, with 53% of stations exceeding the UKOOA 95th %ile for the SNS (0.78mg.kg^{-1}).

The Humber Estuary is the second largest coastal plain estuary in the UK, drains a catchment encompassing around 20% of the land surface of England, is the country's largest port complex handling 14% of the UK's international trade and serves a number of industries including chemicals, oil refineries and power generation [28]. In addition, this area of the SNS is characterised by heavy shipping traffic, which will release further hydrocarbons and other pollutants to the surrounding seas.

Data Comparison

No historical comparison was possible between the present pre-decommissioning survey and the historical data available from previous 2000 and 1991/1992 surveys due to the acquired sediment samples were considered to be of insufficient quality for this analysis.

However, the sediment hydrocarbons concentration from the Amethyst interfiled survey was compared to a recent BSL environmental survey around the nearby PUK Pickerill A.

The THC and total alkane results for the current survey were higher than those reported for Pickerill A (mean 8.55mg.kg^{-1}±3.95SD and 0.50mg.kg^{-1}) but were considered within the range of natural variation.

Furthermore, the highest values for both THC and total saturate alkanes at each of the four Amethyst platforms surveys corresponds well with the recent values recorded along the Interfield pipelines [47].

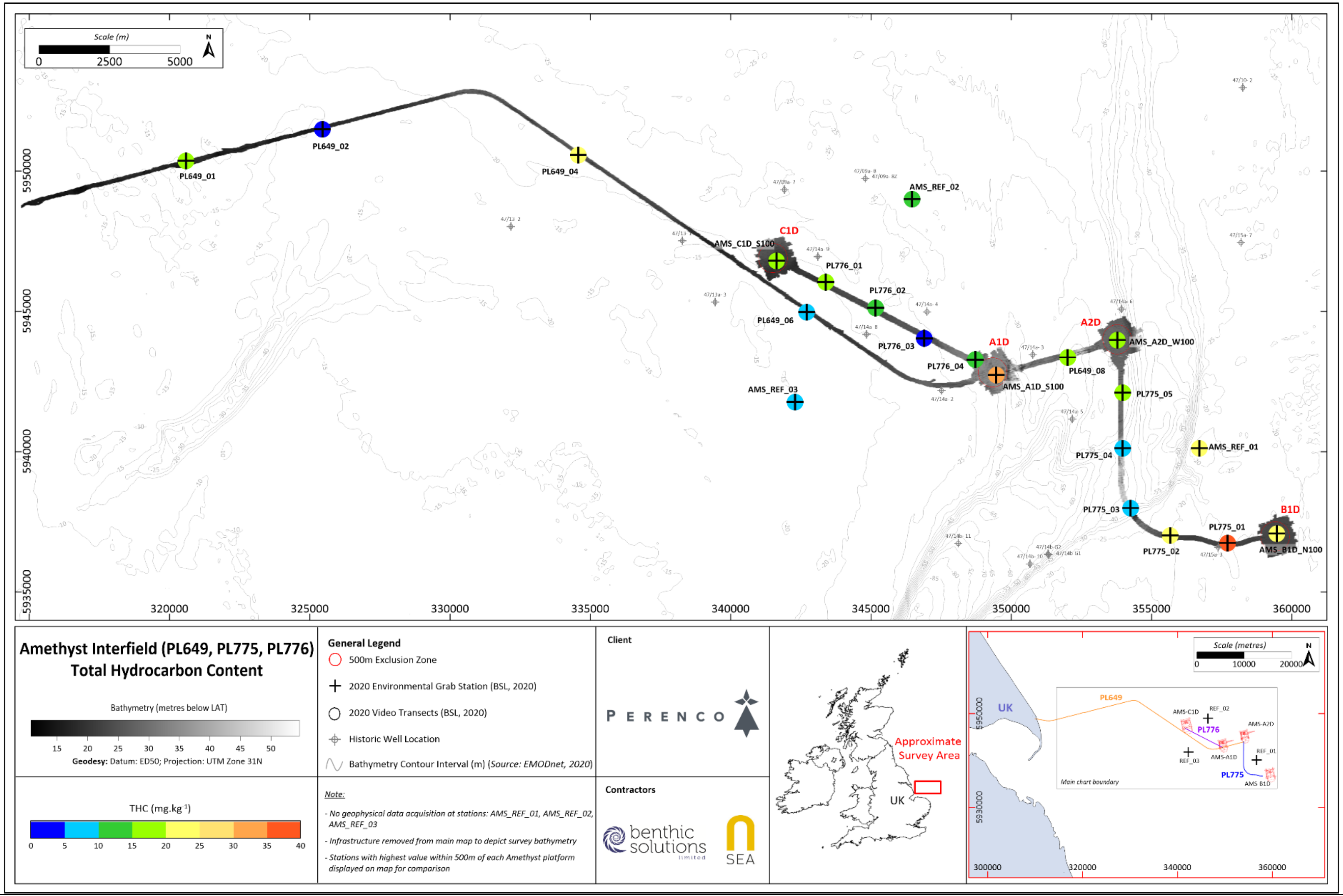
Table 5-4: Total hydrocarbon concentrations in 2020 pre-decommissioning survey

Station	Depth (m)	Distance from Closest Platform (m)*	THC ($mg.kg^{-1}$)	Total n-alkanes ($mg.kg^{-1}$)	Carbon Preference Index	Pristane / Phytane Ratio	Proportion of Alkanes (%)	Total PAHs ($mg.kg^{-1}$)	NPD ($mg.kg^{-1}$)
PL649_01	17	21,303 (C1D)	16.3	1.11	1.22	4.55	6.79	0.72	0.36
PL649_02	17	16,797 (C1D)	2.90	0.10	1.52	12.5	3.61	0.12	0.07
PL649_04	24	7,936 (C1D)	20.7	1.75	1.15	3.96	8.48	0.75	0.45
PL649_06	19	2,222 (C1D)	5.85	0.42	1.21	6.81	7.26	0.27	0.15
PL649_08	33	1,965 (A2D)	16.0	0.79	1.35	2.65	4.93	0.77	0.41
Mean			**12.3**	**0.83**	**1.29**	**6.09**	**6.22**	**0.53**	**0.29**
SD			**7.57**	**0.64**	**0.15**	**3.87**	**1.94**	**0.31**	**0.17**
CV (%)			**61.4**	**76.2**	**11.6**	**63.6**	**31.2**	**58.1**	**58.3**
PL775_01	22	1,810 (B1D)	35.9	2.28	1.11	1.98	6.36	0.69	0.37
PL775_02	25	3,842 (B1D)	23.2	2.50	1.11	3.72	10.78	0.31	0.17
PL775_03	45	5,337 (B1D)	7.59	0.35	1.28	3.19	4.56	0.13	0.06
PL775_04	39	3,884 (A2D)	7.24	0.41	1.19	1.99	5.60	0.13	0.06
PL775_05	25	1,908 (A2D)	17.5	1.38	1.17	4.35	7.86	0.42	0.21
Mean			**18.3**	**1.38**	**1.17**	**3.05**	**7.03**	**0.34**	**0.17**
SD			**11.95**	**1.01**	**0.07**	**1.05**	**2.41**	**0.24**	**0.13**
CV (%)			**65.3**	**73.1**	**5.86**	**34.6**	**34.3**	**70.2**	**74.4**
PL776_01	19	1,982 (C1D)	17.4	0.89	1.11	5.63	5.09	0.75	0.45
PL776_02	23	3,981 (C1D)	14.8	0.85	1.17	4.73	5.76	0.59	0.34
PL776_03	21	2,814 (A1D)	4.88	0.43	1.23	1.88	8.82	0.15	0.08
PL776_04	31	847 (A1D)	12.5	0.73	1.23	4.74	5.79	0.31	0.16
Mean			**12.4**	**0.72**	**1.19**	**4.25**	**6.36**	**0.45**	**0.26**
SD			**5.41**	**0.21**	**0.06**	**1.63**	**1.67**	**0.27**	**0.17**
CV (%)			**43.6**	**28.7**	**5.06**	**38.4**	**26.3**	**60.8**	**64.4**
AMS_REF_01	24	4,196 (B1D)	22.3	1.40	1.16	3.48	6.29	1.00	0.54
AMS_REF_02	28	5,292 (C1D)	11.3	0.52	1.18	4.38	4.64	0.36	0.21
AMS_REF_03	22	5,186 (C1D)	5.96	0.33	1.33	5.48	5.47	0.19	0.10
Regional Comparison									
Pickerill A [16]	**Mean**		**8.55**	**0.50**	**1.29**	**9.35**	**5.17**	**0.21**	**0.12**
	SD		**3.95**	**0.37**	**0.33**	**7.04**	**2.29**	**0.17**	**0.10**
	CV (%)		**46.1**	**75.0**	**25.5**	**75.3**	**44.4**	**79.5**	**87.6**
Reference Levels									
UKOOA (2001) SNS 50th %ile			**4.34**	**0.19**	**1.32**	**-**	**5.94**	**0.07**	**-**
UKOOA (2001) SNS 95th %ile			**11.4**	**0.78**	**-**	**-**	**6.85**	**0.37**	**-**
OSPAR (2006) THC Limit			**50**	**-**	**-**	**-**	**-**	**-**	**-**

Yellow cell = above UKOOA SNS 50th %ile *Orange cell = above UKOOA SNS 95th %ile* *Red cell = above OSPAR THC Limit*

C1D = Amethyst C1D Platform, A2D= Amethyst A2D Platform, B1D=Amethyst B1D Platform, A1D = Amethyst A1D

Figure 5-11: THC concentrations Amethyst pre-decommissioning survey



5.1.6.3 PAH

Total Polycyclic Aromatic Hydrocarbons (PAH) concentrations (2-6 compounds) were variable across the survey area and were highest at AMS_REF_01 and lowest at PL649_02 (1.0mg.kg-1 and 0.12mg.kg-1, respectively). Higher PAH concentrations tended to be found at the stations with a relatively higher proportion of fines, as evidenced by a positive Spearman's correlation between total PAHs and fines. PAH concentrations at all stations exceeded the UKOOA 50th %ile for the SNS, while eight stations also surpassed the 95th %ile of 0.37mg.kg^{-1} [52]. Although it appears values within the Amethyst survey area were higher than expected for the SNS, there was no significant correlation between distance from the platform and PAH concentration, so the results were attributed to diffuse impact from the Humber Estuary plume and shipping traffic [28]. Furthermore, stations were still found to sit at the low end of CEFAS PAH concentrations for sediments surrounding North Sea oil and gas installations which range from 0.02mg.kg^{-1} to 74.7mg.kg^{-1} [61].

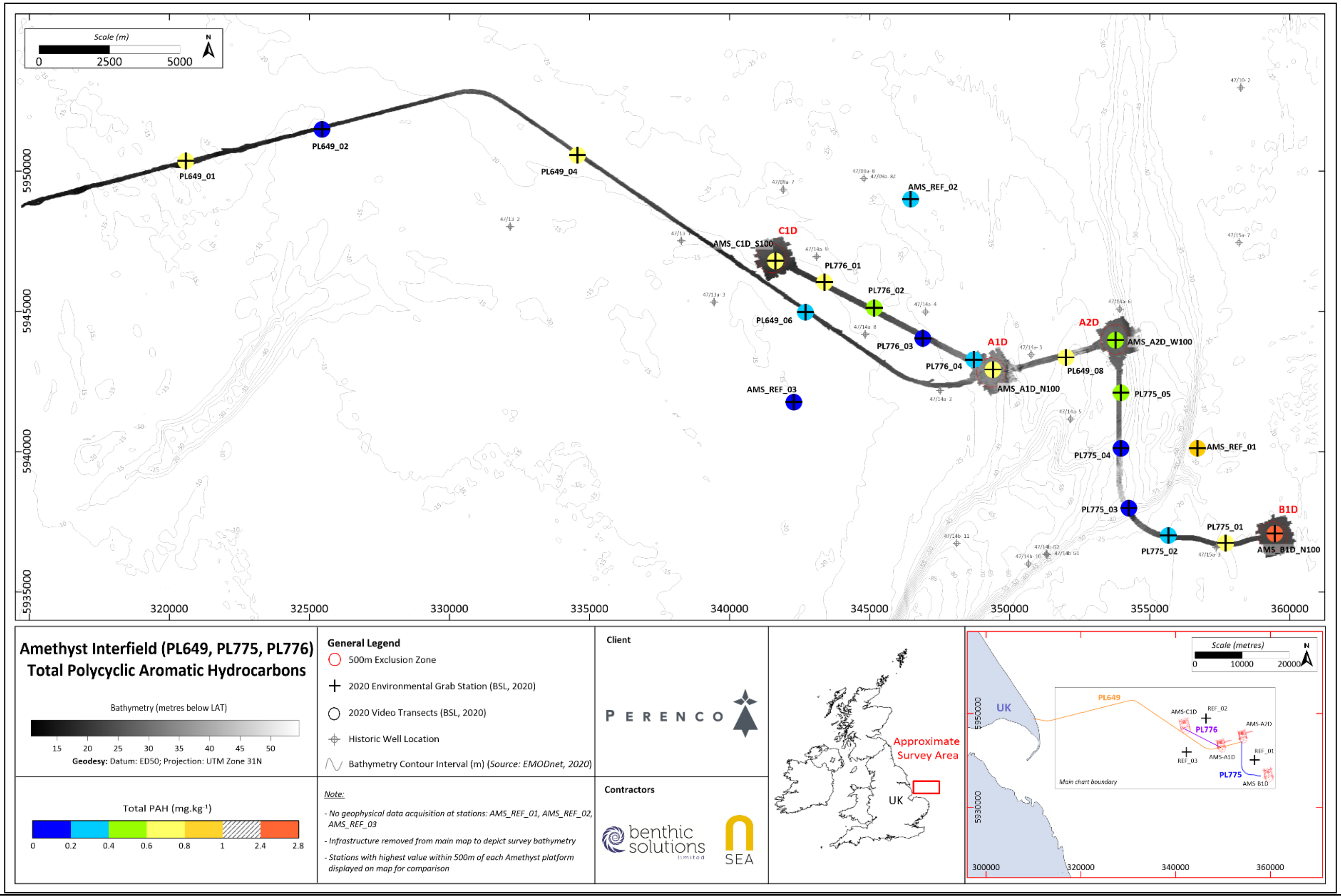
As with the other hydrocarbon results, slightly higher total PAH concentrations were found across much of the survey area. Unlike THC, total PAHs were positively correlated with the proportion of fines suggesting sediment characteristics were in part responsible for the variation in PAH across the survey area.

PAHs and their alkyl derivatives have been recorded in a wide range of marine sediments [36] with the majority of compounds produced from what is thought to be pyrolytic sources. These include the combustion of organic material such as forest fires [70], the burning of fossil fuels and, in the case of offshore oil fields, flare stacks. The resulting PAHs, rich in the heavier weight 4-6 ring aromatics, are normally transported to the sediments via atmospheric fallout or river runoff. Another PAH source is petroleum hydrocarbon, often associated with localised drilling activities. These are rich in the lighter, more volatile 2 and 3 ring PAHs (naphthalene (128), phenanthrene, anthracene (178) and dibenzothiophene) with their alkyl derivatives.

Data Comparison

Total PAHs reported at Pickerill A were similarly lower than those reported during the present survey but were considered within the range of natural variation. Furthermore, the highest total PAH concentrations at the Amethyst platforms surveys are comparable to the levels recorded at the pipeline stations [5].

Figure 5-12: Total PAH (2-6 Ring)



5.1.6.4 Heavy metals

Metals occur naturally in the marine environment and are widely distributed in both dissolved and sedimentary forms. Some are essential to marine life while others may be toxic to numerous organisms [52]. Rivers, coastal discharges, and the atmosphere are the principal modes of entry for most metals into the marine environment [58], with anthropogenic inputs occurring primarily as components of industrial and municipal wastes. Historically, several heavy and trace metals are found in elevated concentrations where drilling fluids or produced waters have been discharged by oil and gas installations. These include intentional additives (such as metal-based salts and organo-metallic compounds in the fluids) as well as impurities within the drilling mud systems such as clays (e.g. bentonites; a gelling and viscosifying agent) and metal lignosulphates (a viscosity controller). The metals most characteristic for offshore contamination of marine sediments from oil and gas activities are barium (Ba), chromium (Cr), lead (Pb) and zinc (Zn) [44], although these may vary greatly dependent upon the constituents used.

Trace metal contaminants in the marine environment tend to form associations with the non-residual phases of mineral matter, such as iron (Fe) and manganese oxides and hydroxides, metal sulphides, organics, and carbonates. Metals associated with these non-residual phases are prone to various environmental interactions and transformations (physical, chemical, and biological), potentially increasing their biological availability. Residual trace metals are defined as those which are part of the silicate matrix of the sediment and that are located mainly in the lattice structures of the component minerals. Non-residual trace metals are not part of the silicate matrix and have been incorporated into the sediment from aqueous solution by processes such as adsorption and organic complexes and may include trace metals originating from sources of pollution. Therefore, in monitoring trace metal contamination of the marine environment, it is important to distinguish these more mobile metals from the residual metals held tightly in the sediment lattice [11], which are of comparatively little environmental significance.

Of particular relevance to the offshore oil and gas industry are metals associated with drilling related discharges. These can contain substantial amounts of barium sulphate (barites) as a weighting agent and Ba is frequently used to detect the deposition of drilling fluids around offshore installations. Barites also contain measurable concentrations of HM as impurities, including Cadmium (Cd), Cr, Copper (Cu), Pb, Mercury (Hg), and Zn. HM, either as impurities or additives are also present in other mud components.

Metals are generally not harmful to organisms at concentrations normally found in marine sediments and some, like Zn, may be essential for normal metabolism although they can become toxic above a critical threshold. In order to assign a level of context for toxicity, an approach used by Long, et al. [37] to characterize contamination in sediments was used within the EBS. Consequently, the defined “effect range low” (ERL) values represents the lowest concentration of a metal that produced adverse effects in 10% of the data reviewed, whilst “effect range median” (ERM) values represents the level at which half of the studies reported harmful effects. In accordance with this, metal concentrations recorded below the ERL value are not expected to elicit adverse effects, while levels above the ERM value are likely to be toxic to some marine life.

The question of bioavailability of metals to marine organisms is a complex, as sediment granulometry and the interface between water and sediment all affect bioavailability and subsequently toxicity. Therefore, even if a metal is found in higher concentrations it does not necessarily conclude a detrimental effect on the environment, if present in an insoluble state.

The heavy and trace metal analysis results from the 2020 pre-decommissioning Amethyst survey, which are detailed in Table 5-5, are representative of the seabed composition at the four Amethyst jackets. All of the HM analysed (aluminium (Al), Ba, arsenic (As), Fe, Cd, Cr, Cu, Pb, Hg, nickel (Ni), vanadium (V) and Zn), underwent an aqua regia (AR) acid digestion and extraction for total sediment metals.

For this survey, natural Ba levels ranged from 17.7mg.kg^{-1} at station PL776_03 to 165mg.kg^{-}1 at PL775_01 (PL 649 mean 75.6mg.kg^{-1}±18.7SD, PL 775 mean 94.7mg.kg^{-1}±57.5SD, PL 776 mean 45.4mg.kg^{-1}±20.5SD) when analysed by qua regia extraction. Natural Ba levels were in excess of the UKOOA (2001) 50th %ile (26mg.kg^{-1}) for the SNS at every station but did not exceed the 95th %ile (272.4mg.kg^{-1}). When Ba was measured by fusion technique, which more effectively quantifies Ba in the barite form used in drilling muds, higher concentrations were recorded but following a different pattern to that of natural Ba as shown by a lack of significant correlation between the results of the two methods ($\varrho(17)=0.470$, $p>0.05$). Ba by fusion results ranged between 134mg.kg^{-1} at station PL775_03 and 315mg.kg^{-1} at station PL775_02 (PL 649 mean 246mg.kg^{-1}±48.0SD, PL 775 mean 204mg.kg^{-1}±89.6SD, PL 776 mean 217mg.kg^{-1}±34.5SD). Ba concentrations recorded during the current survey are consistent with natural background levels, with contaminated stations within 500m of active UK platforms often showing concentrations in the thousands of mg.kg^{-1} (e.g. 33,562mg.kg-1).

Levels of As, Cr, V, Zn and Fe were elevated above background levels (UKOOA 95th %ile as a minimum) for at least seven stations within the survey area with Cd and Ni above their UKOOA 50th %ile at all stations. The aforementioned metals are often associated with drilling-related barite discharges but, in the absence of elevated Ba concentrations, it is unlikely that the higher concentrations of these metals within the survey area are due to historic drilling operations. Cr and Zn both had concentrations in excess of their respective UKOOA 95th %ile (44.8mg.kg^{-1} and 35.8mg.kg^{-1}) at >70% of stations including all PL 649 stations for Cr. However, the presence of similar levels of both Cr and Zn at the three reference stations as at the pipeline stations, is more consistent with diffuse sources of these metals (e.g. shipping activities, Humber runoff, etc) than point source drilling contamination. Ni exceeded its associated OSPAR ERL (20.9mg.kg^{-1}) at one station, PL776_01, which as previously mentioned also had the highest THC concentrations. These elevated levels were attributed to the station's location on the edge of a 3.7m channel which crosses the PL 775 route at KP 1.80. The edges of seabed depressions can create turbulence to the overlying current and subsequently increase deposition to the seabed. However, higher levels of contaminants in this area could also relate to potential drilling related discharge from well 47/15a-3, located approximately 360m SW of the station.

As was elevated above its associated OSPAR ERL (8.20mg.kg^{-1}) at all stations, ranging from 7.6mg.kg^{-1} at station PL649_02 to 23.4mg.kg^{-1} at station PL776_04 (PL 649 mean 14.2mg.kg^{-1}±4.49SD, PL 775 mean 14.4mg.kg^{-1}±4.30SD, PL 776 mean 14.0mg.kg^{-1}±6.36SD). In particular, concentration of As at station PL776_04 was almost three times the ERL for this metal (8.2mg.kg^{-1}) with three other stations at least double this value. High concentrations of As in the western part of the SNS are a common feature for offshore environmental surveys, suggesting that As and other metals were impacted by a combination of the Humber plume and the mobilisation of metal-rich shales by offshore drilling activities [69].

Concentrations of Cd did not exceed the respective UKOOA 95th %ile at any station and did not correlate significantly with distance from the Amethyst platforms. As such, the correlations observed with other drilling associated metals are likely to reflect natural associations due to the speciation properties of the metals as opposed to a shared point source of discharge.

Fe is an important metal as it is often associated with other elements, such as As. Fe concentrations ranged from 7,490mg.kg^{-1} at station PL775_03 to 36,400mg.kg^{-1} at station PL649_01 and were significantly correlated to eight of the other metals. Fe concentrations exceeded the UKOOA 95th %ile for the SNS (18,555mg.kg^{-1}) at twelve stations, and was the only metal to correlate with both proportion of fines and proportion of sands.

The majority of metals did not show any spatial pattern in their distribution with very few correlations with depth and easting and no correlations with distance from the nearest Amethyst platform. However, most metal concentrations were related to sediment type with six metals (As, Pb, V, Zn, Fe and Ba) demonstrating significant positive correlations with proportion of fines, most of which also positively correlated with each other. Four metals (Cu, Ni, Al and Fe) showed significant negative correlations with proportion of sands, all of which also positively correlated with each other while Ni and Al both positively correlated with gravel and with each other. These correlations of metal concentrations with and within the different sediment fractions, suggest the variation in metal concentrations across the survey area may be as a result of their different associations with the mixed sediment composition observed throughout the area rather than a shared point source of discharge.

Overall, while metals were elevated within much of the Amethyst survey area, the concentrations are consistent with other studies in the region and are thought to reflect the input of contaminants from the Humber Estuary plume and/or the release of metals from the historic drilling of marine shales in this area of the SNS.

Data Comparison

No historical comparison has been made between the present survey and the historical data available due to the incomparable sampling locations and laboratory testing techniques used.

When comparing the metal concentrations means of the current survey with the nearby PUK Pickerill A results, only Cr was measured with higher concentrations. The pipeline means of the current survey were relatively comparable with the average concentrations reported at Pickerill A. As noted for the results of the present survey, the average concentration of every metal recorded at Pickerill A was above the UKOOA 50th %ile for the SNS with the average concentrations of three metals (Ni, Zn and Fe) also exceeding the 95th %ile. The differences between the two surveys could be attributable to subtle regional difference in metal concentrations or variation in shipping activity resulting in more leaching of contaminants to the natural environment.

Furthermore, the highest value recorded at each of the four Amethyst platforms generally corresponded well with the pipeline concentrations, further suggesting the metal concentrations recorded are likely due to naturally high levels in the region rather than any particular point source contamination [5].

Table 5-5: Total Heavy and Trace Metal Concentrations (mg.kg^{-1} or parts per million (ppm))

Station	Depth (m)	Distance from Closest Platform (m)*	As (AR-MS)	Cd (AR-MS)	Cr (AR-MS)	Cu (AR-MS)	Pb (AR-MS)	Hg (AR-MS)	Ni (AR-MS)	V (AR-MS)*	Zn (AR-MS)	Al (AR-MS)	Fe (AR-MS)*	Ba (AR-MS)*	Ba (By Fusion) (ICPOES)
PL649_01	17	21,303 (C1D)	15.9	0.10	45.9	11.6	15.7	<0.015	18.6	43.8	60.7	7,490	36,400	92.7	287
PL649_02	17	16,797 (C1D)	7.6	0.10	70.2	9.0	6.3	<0.015	18.9	30.7	29.8	5,850	20,200	47.7	250
PL649_04	24	7,936 (C1D)	14.1	0.11	45.6	9.1	13.0	<0.015	15.6	36.8	40.6	5,920	23,400	92.9	250
PL649_06	19	2,222 (C1D)	13.4	0.17	51.2	8.6	12.9	<0.015	27.9	37.3	44.4	8,690	31,700	71.7	279
PL649_08	33	1,965 (A2D)	20.0	0.17	56.5	8.5	12.5	<0.015	15.2	46.2	37.8	5,210	32,800	73.0	166
Mean			**14.2**	**0.13**	**53.9**	**9.36**	**12.1**	**-**	**19.2**	**39.0**	**42.7**	**6,632**	**28,900**	**75.6**	**246**
SD			**4.49**	**0.04**	**10.16**	**1.28**	**3.47**	**-**	**5.13**	**6.15**	**11.4**	**1,424**	**6,805**	**18.7**	**48.0**
CV (%)			**31.6**	**28.3**	**18.9**	**13.7**	**28.7**	**-**	**26.6**	**15.8**	**26.8**	**21.5**	**23.5**	**24.7**	**19.5**
PL775_01	22	1,810 (B1D)	16.8	0.15	36.0	10.1	11.6	0.02	12.2	33.6	36.6	4,690	24,200	165	287
PL775_02	25	3,842 (B1D)	19.4	0.13	43.1	6.8	14.6	0.02	12.8	38.6	44.3	4,320	24,100	138	315
PL775_03	45	5,337 (B1D)	9.3	0.08	55.7	6.9	11.6	0.04	6.1	18.6	20.9	1,900	7,490	19.3	134
PL775_04	39	3,884 (A2D)	10.6	0.09	51.6	4.1	12.6	0.03	6.7	21.2	21.7	1,840	8,490	73.5	146
PL775_05	25	1,908 (A2D)	16.1	0.18	48.8	9.2	11.1	0.02	16.6	31.2	32.0	5,910	23,800	77.8	136
Mean			**14.4**	**0.13**	**47.0**	**7.42**	**12.3**	**0.03**	**10.9**	**28.6**	**31.1**	**3 732**	**17 616**	**94.7**	**204**
SD			**4.30**	**0.04**	**7.69**	**2.35**	**1.40**	**0.01**	**4.43**	**8.46**	**9.97**	**1 799**	**8 796**	**57.5**	**89.6**
CV (%)			**29.8**	**33.0**	**16.3**	**31.6**	**11.4**	**34.4**	**40.7**	**29.6**	**32.1**	**48.2**	**49.9**	**60.7**	**44.0**
PL776_01	19	1,982 (C1D)	11.9	0.15	47.3	11.0	8.1	<0.015	21.0	42.3	43.9	6,970	26,000	44.8	211
PL776_02	23	3,981 (C1D)	11.1	0.26	34.9	4.9	8.4	<0.015	9.8	27.8	116	3,280	19,000	66.4	252
PL776_03	21	2,814 (A1D)	9.5	0.12	34.0	3.7	6.7	<0.015	13.6	24.0	29.9	3,290	14,100	17.7	172
PL776_04	31	847 (A1D)	23.4	0.27	62.2	8.6	13.3	<0.015	17.4	46.4	41.5	7,900	33,200	52.7	234
Mean			**14.0**	**0.20**	**44.6**	**7.05**	**9.13**	**-**	**15.5**	**35.1**	**57.8**	**5 360**	**23 075**	**45.4**	**217**
SD			**6.36**	**0.08**	**13.21**	**3.36**	**2.88**	**-**	**4.83**	**10.9**	**39.3**	**2 426**	**8 331**	**20.5**	**34.5**
CV (%)			**45.5**	**38.1**	**29.6**	**47.6**	**31.6%**	**-**	**31.3**	**31.0**	**67.9**	**45.3**	**36.1**	**45.2**	**15.9**
AMS_REF_01	24	4,196 (B1D)	12.8	0.08	49.8	7.5	10.3	0.02	8.6	26.2	28.0	3,220	14,500	65.4	173
AMS_REF_02	28	5,292 (C1D)	9.4	0.11	33.0	7.6	8.5	<0.015	10.1	22.0	25.5	3,600	14,600	29.8	166
AMS_REF_03	22	5,186 (C1D)	9.1	0.13	52.7	8.4	8.2	<0.015	16.6	36.6	33.0	5,160	25,200	48.6	255

Station	Depth (m)	Distance from Closest Platform (m)*	As (AR-MS)	Cd (AR-MS)	Cr (AR-MS)	Cu (AR-MS)	Pb (AR-MS)	Hg (AR-MS)	Ni (AR-MS)	V (AR-MS)*	Zn (AR-MS)	Al (AR-MS)	Fe (AR-MS)*	Ba (AR-MS)*	Ba (By Fusion) (ICPOES)
Regional Comparison															
Pickerill A [16]	**Mean**		**12.2**	**0.16**	**12.2**	**7.4**	**6.4**	**0.03**	**9.9**	**26.7**	**40.1**	**4,141**	**31,666**	**82.9**	**173**
	SD		**4.1**	**0.10**	**6.8**	**2.8**	**1.6**	**0.01**	**4.7**	**13.2**	**26.8**	**1,931**	**28,590**	**40.7**	**98.4**
	CV (%)		**33.8**	**61.1**	**55.9**	**37.9**	**24.9**	**30.2**	**47.4**	**49.4**	**66.9**	**46.6**	**90.3**	**49.1**	**57.0**
Reference Levels															
UKOOA 50th %ile (UKOOA, 2001)				0.03	6.51	2.04	6.00	0.02	3.97	14.7	12.2	-	5,183	26	-
UKOOA 95th %ile (UKOOA, 2001)			-	0.72	44.8	13.9	21.0	0.05	21.5	35.8	35.8	-	18,555	272.4	-
OSPAR ERL (OSPAR, 2009b)			8.20	1.20	81	34	46.7	0.15	20.9	-	150		-	-	-
OSPAR ERM (OSPAR, 2009b)			70	9.60	370	270	218	0.71	51.6	-	410		-	-	-

Light Yellow cell = above UKOOA 50th %ile *Orange cell = above UKOOA 95th %ile* *Pink cell = above ERL* *Red cell = above ERM*

*** C1D = Amethyst C1D Platform, A2D= Amethyst A2D Platform, B1D=Amethyst B1D Platform, A1D = Amethyst A1D Platform**

5.1.7 Waves

Waves are the result of energy being transferred between two fluids moving at different rates [20]. They are caused at sea by the differential motion of the air (wind) and the seawater. The height of a wave is the distance from the crest to trough, but as the waves at any one time are not of equal size, the significant wave height is taken and corresponds approximately to the mean height of the highest third of the waves. The wave period is the (mean) time between two wave crests, called the zero up-crossing period and is given in seconds. The wave climate of the area provides information on the physical energy acting on structures and dictates the structural design requirements.

The highest mean wave height corresponds to the western Amethyst infrastructure at the B1D jacket (1.36m), while the Amethyst C1D jacket location has the lowest wave height records (1.31m) [1]. The abrupt change in wave height along the Amethyst infrastructure is influenced by the short distance from the Amethyst field to the shore and the rapid alteration in water depth along the coastline.

There is considerable seasonal variation between sea states, as represented in Table 5-6. Wave direction is variable throughout the year.

Table 5-6: Average wave heights in the vicinity of the blocks of interest

Average wave height (m)			
Spring	Summer	Autumn	Winter
1.08 to 1.3	0.83 to 0.99	1.14 to 1.46	1.29 to 1.7

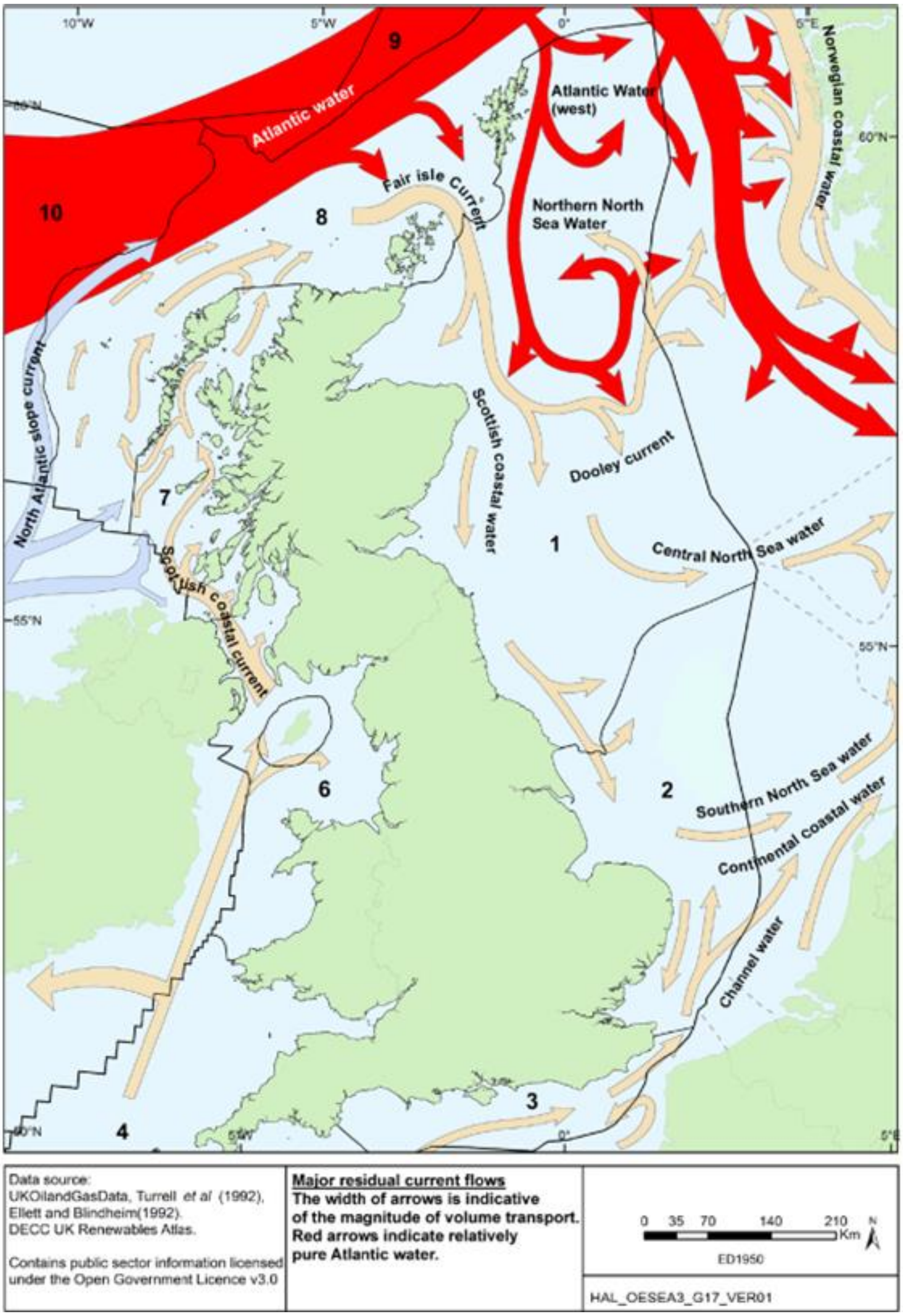
5.1.8 Water Circulation and tides

The general circulation of near-surface water masses in the North Sea is cyclonic, mostly driven by the ingression of Atlantic surface water in the western inlets of the Northen North Sea (NNS). As a result, residual water currents near the sea surface tend to move in a SE direction along the coast towards the English Channel [48][2].

In addition, counter currents occur towards the English/ Dutch sector median line, flowing NE towards Denmark (Figure 5-13). The effect of this counter current in the vicinity of the blocks of interest pushes the near-surface water movement towards a more southerly and easterly direction.

Tides in this region of the SNS are predominately semi-diurnal and increase towards Hunstanton coast. The mean spring tidal range in the region of the blocks of interest vary between 4.56m at B1D jacket to 4.90m at C1D jacket [2].

Figure 5-13: Major Current flows around the UK [6]



5.1.9 Temperature & Salinity

Winter water temperatures in the SNS are in the range of 4 – 8ºC, while summer water surface temperatures are in the range of 16ºC – 19ºC, with little variation, either down the water column or from near shore to offshore waters [22]. Salinities decrease both towards the S and towards the coastline, reflecting the influence of freshwater inputs from the adjacent landmasses.

The salinity in the region of the blocks of interest varies throughout the year. The mean annual salinity of the sea surface varies between 34.201 parts per thousand (ppt) in winter to 34.551ppt in summer, with an overall mean of 34.418ppt. While the mean salinity of the bottom is 34.207ppt in winter and 34.544ppt in summer with an overall mean of 34.434ppt [46].

5.2 Biological Environment

5.2.1 Benthic Biodiversity

Macrofaunal analysis was carried out within the Amethyst Interfield survey area. The sediment was relatively varied throughout the survey area conforming to the Folk classification of 'sandy gravel' at eight stations, 'muddy sandy gravel' at four stations with 'gravel', 'gravelly muddy sand', 'slightly gravely sand' and 'gravelly sand' also recorded.

Visible fauna included mobile Crustacea such as hermit crabs (*Paguridae*), edible crabs (*Cancer pagurus*) and the common shore crab (*Carcinus maenas*) were observed at all Amethyst jacket survey areas. A variety of echinoderms including the common star fish (*Asterias rubens*), common sun star (*Crossaster papposus*) and the edible sea urchin (*Echinus esculentus*) were also observed, while molluscs included the common whelk (*Buccinum undatum*) and the painted top shell (*Calliostoma zizyphinum*). Sessile fauna included anemones (*Urticina felina*), sand mason worms (*Lanice conchilega*), barnacles (*Cirripedia*), calcareous tube worms (*Serpulidae*), encrusting coralline algae (*Corallinales spp),* hornwrack bryozoa (*Flustra foliacea*), *Nemertesia* spp and hydrozoan/bryozoan turf. Macrofauna data revealed a high diversity of epifaunal specie from the phyla Annelida, Arthropoda and Mollusca at C1D jacket location, while a diverse range from the phyla Porifera, Cnidaria, Entoprocta, Chordata and Bryozoa at A1D and B1D jackets.

The presence *Sabellaria spinulosa* individuals was recorded Amethyst B1D and C1D survey area. *S. spinulosa* is a tube-building polychaete worm which, in large numbers, can form hard, reef-like structures, acting to stabilise the surrounding seabed. As their tubes are built of sand, a high suspended sediment content is essential for the growth of reef like structures. Due to the coarse nature of the sediment at A1D and C1D survey area, there was potential for EC Habitats Directive Annex I stony reef to be present. Therefore, a stony reef assessment was conducted, and this indicated the seabed sediments to vary between 'not a reef' and 'low reefiness' classifications across the survey area. Three PL649 stations (01, 02, and 06), two PL776 stations (01 and 02) and one reference station (AMS_REF_03) showed 'low' reefiness. As no areas of 'medium' or 'high' reefiness were observed it is unlikely that any of the survey area would be classified as an Annex I stony reef. No tubes were noted during the visual assessment of seabed video footage and still photograph data at all Amethyst jackets survey areas.

5.2.2 Plankton

The collective term plankton describes the plants (phytoplankton) and animals (zooplankton) that live freely in the water column and drift passively with the water currents. Typically, in the SNS a phytoplankton bloom occurs every spring, generally followed by a smaller peak in the autumn [6].

The SNS is characterised by shallow, well-mixed waters, which undergo large seasonal temperature variation. The region is largely enclosed by land and as a result the marine environment is highly dynamic with considerable tidal mixing and nutrient-rich run-off from land (eutrophication). Under these conditions, nutrient availability is fairly consistent throughout the year, therefore organisms with high nutrient uptake that thrive in dynamic waters, such as diatoms, are particularly successful [35]. The phytoplankton community in the Regional Sea 2 is dominated by the dinoflagellate genus Ceratium (*C. fusus, C. furca, C. lineatum*), along with higher numbers of the diatom, *Chaetoceros* (subgenera *Hyalochaete* and *Phaeoceros*) than are typically found in the NNS [6].

The zooplankton community is dominated by copepods including *Calanus helgolandicus and C. finmarchicus* as well as *Paracalanus* spp, *Pseudocalanus* spp, *Acartia* spp, *Temora* spp and cladocerans such as *Evadne* spp [6]. The planktonic assemblage in the vicinity of the Amethyst pipelines is not considered unusual. The phytoplankton community in the Regional Sea 2 is dominated by the dinoflagellate genus Ceratium (*C. fusus, C. furca, C. lineatum*), along with higher numbers of the diatom, Chaetoceros (subgenera Hyalochaete and Phaeoceros) than are typically found in the NNS. From November to May when mixing is at its greatest, diatoms comprise a greater proportion of the phytoplankton community than dinoflagellates [6].

From November to May when mixing is at its greatest, diatoms comprise a greater proportion of the phytoplankton community than dinoflagellates [6].

5.2.3 Fish & Shellfish

The Northeast Atlantic and North Sea is split into a statistical grid called International Council for the Exploration of the Sea (ICES) Rectangles in order to statistically map fisheries information about an area. All the Amethyst jackets are located at the SW corner of ICES Rectangle 36F0. Generally, there is little interaction between fish and offshore developments, although some species congregate around platforms and along pipelines. Spawning individuals and juveniles can however be sensitive to seismic activities, seabed disturbance activities, discharges to sea and, in some cases, accidental spills.

CEFAS/Marine Scotland has published data on critical spawning and nursery grounds for selected fish species around the UK [13; 21; 3]. Data is based on historic and more recent ichthyoplankton trawls to identify key spawning, nursery habitats and species of interest.

There are potential fish spawning areas in ICES rectangle 36F0 for Herring (*Clupea harengus*), Lemon Sole (*Microstomus kitt*), Sandeels (*Ammodytes* spp) Plaice (*Pleuronectes platessa*) and, Sole (*Solea solea*) (Figure 5-14) [13; 21; 3].

A number of species, which have benthic eggs, have a dependency on specific substrata for spawning. For example, sandeels lay their eggs on sandy sediments and therefore may spawn on discreet sandy sediments within the blocks of interest. Such sediments would therefore be considered important for this species [6]. A number of other species, including some demersal species, have pelagic eggs and/or larvae including cod, haddock, Norway pout and saithe and are therefore less reliant on specific sediment types for spawning [6].

In addition to the spawning grounds described above, the waters of ICES rectangles 36F0 also act as nursery areas (or aggregation area for 0 group fish) for Herring (*Clupea harengus*), Plaice (*Pleuronectes platessa*), Lemon Sole (*Microstomus kitt*), Sole (*Solea solea*), sandeel (*Ammodytes* spp), Sprat (*Sprattus sprattus*), Whiting (*Merlangius merlangus*) and, Cod (*Gadus morhua*) [13; 21].

Juvenile fish are vulnerable to predators and harsh conditions in the open water. Therefore, it is typical for juvenile fish to stay in sheltered nursery grounds, which also provide an abundance of food [6].

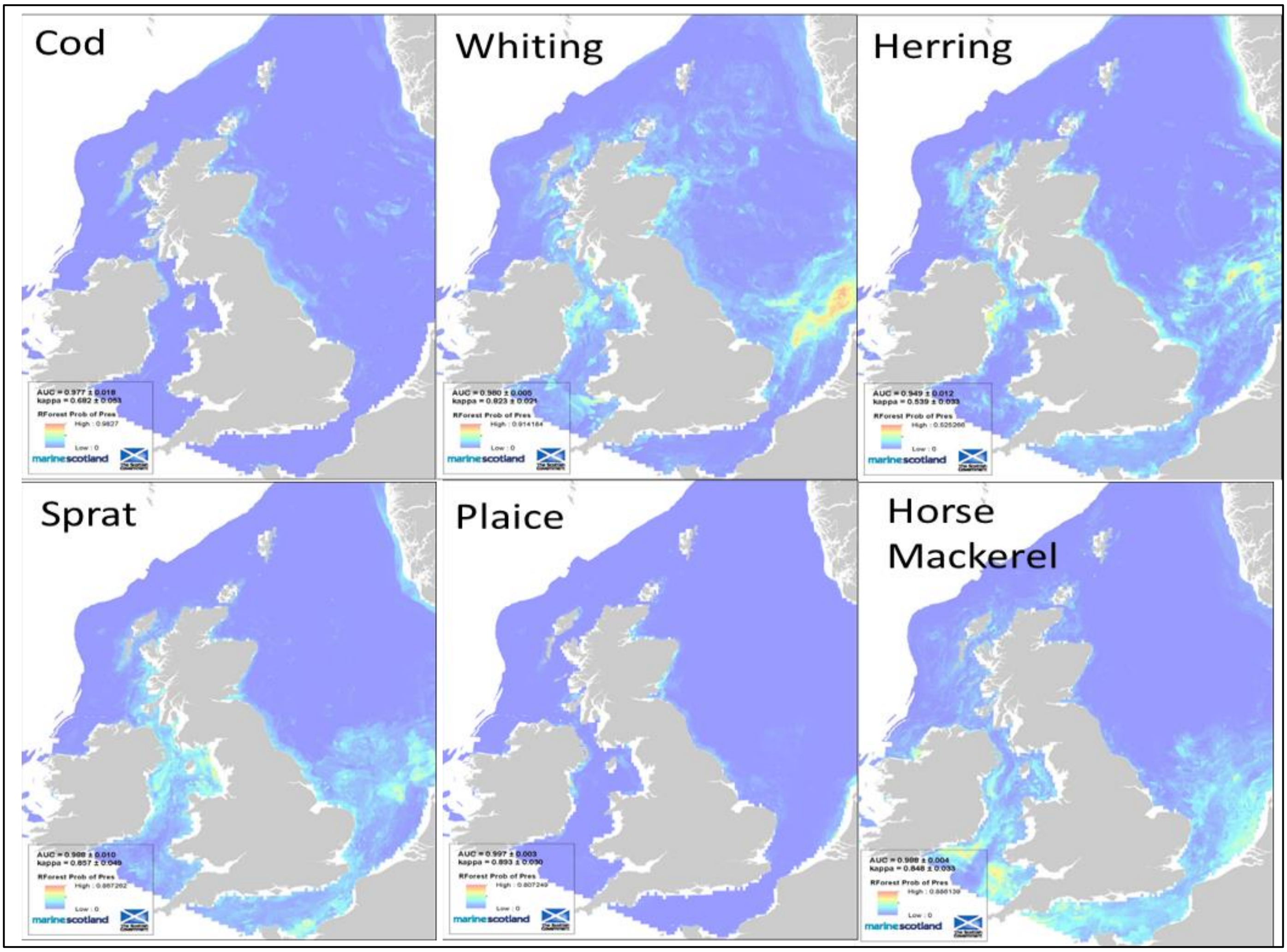
Table 5-7: Fish spawning and nursery areas within ICES Rectangle 36F0 [13, 21]

Species	January	February	March	April	May	June	July	August	September	October	November	December
Cod	N	N	N	N	N	N	N	N	N	N	N	N
Herring	N	N	N	N	N	N	N	N	N	N	N	N
Horse Mackerel[1]	N	N	N	N	N	N	N	N	N	N	N	N
Lemon sole	N	N	N	N	N	N	N	N	N	N	N	N
Plaice												
Sandeel	N	N	N	N	N	N	N	N	N	N	N	N
Sole												
Sprat	N	N	N	N	N	N	N	N	N	N	N	N
Spurdog[2]	N	N	N	N	N	N	N	N	N	N	N	N
Whiting	N	N	N	N	N	N	N	N	N	N	N	N
Key		Spawning				Peak Spawning			N	Nursery		

[1] Horse mackerel appear to be widespread and with no spatially discrete nursery grounds [21]

[2] Viviparous species (gravid females can be found all year) [21]

Figure 5-14: Sensitivity maps for selected fish species [13]



Elasmobranch Species

Elasmobranch species (sharks, skates, and rays) are also an important component of the North Sea ecosystem. Elasmobranchs have a low fecundity and slow growth rate, leaving them vulnerable to overfishing pressures and pollution events, and subsequent recovery of populations in response to disturbance events is low. Historically, many elasmobranch species have been fishery targets due to their fins and liver oils [34]. While many species are no longer subjects of targeted fisheries, they are still under threat from commercial pelagic and demersal fishery by-catch.

In a survey of the distribution of elasmobranchs in UK waters undertaken by Ellis et al. in 2004, a total of 26 elasmobranch species were recorded throughout the North Sea and surrounding waters. Species which have been recorded in the SNS at various times throughout the year and may therefore be present in the vicinity of the block of interest, are listed in Table 5-8 [21].

Table 5-8: Elasmobranch species likely to be found in the vicinity of the Amethyst pipelines

Common Name	Latin Name	Depth Range (m)	Common Name Note 1
Blonde skate	*Raja brachyura*	10 – 900	Near Threatened
Lesser spotted dogfish	*Scyliorhinus canicula*	0 - 800	Least Concern
Starry skate	*Amblyraja radiata*	0 - 1400	Vulnerable
Spiny dogfish	*Squalus acanthias*	15 – 528	Vulnerable
Spotted skate	*Raja montagui*	< 530	Least Concern
Starry smoothhound	*Mustelus asterias*	0 – 100	Near Threatened
Thornback skate	*Raja clavata*	10 – 300	Near Threatened

Note 1: Status as of May 2024.

Of these species, blonde skate, spiny dogfish, starry smooth-hound, thornback skate and starry skate are of most concern due to their unfavourable conservation status [30]. In addition, spotted skate, thornback skate, and spiny dogfish are listed on the OSPAR list of threatened and/or declining species and habitats [51].

5.2.4 Seabirds

The offshore SNS area is an important area for numerous seabird species, mainly for feeding purposes in and around the shallow sandbanks [6], although total numbers are generally lower in the Regional Sea 2 area compared to areas further N [6]. The Regional Sea 2 area also includes several areas suitable for cliff nesting seabirds and some of the most important sites for wintering and passage waterbirds in a national and international context, including the Wash and Thames Estuary. Individuals found offshore in the vicinity of the Amethyst jackets location may originate from these onshore colonies or be passing migrants.

The most common species of seabird found in this area of the SNS include: Northern fulmar (*Fulmarus glacialis*), Great Skua (*Stercorarius skua*), Black legged kittiwake (*Rissa tridactyla*), Great black backed gull (*Larus marinus*), Common gull (*Larus canus*), Lesser black backed gull (*Larus fuscus*), Herring gull (*Larus argentatus*), Common guillemot (*Uria aalge*), Razorbill (*Alca torda*), Little auk (*Alle alle*) and Atlantic puffin (*Fratercula arctica*) [33].

Fulmars are present in highest numbers during the early and late breeding seasons, leading to peak densities in September. Kittiwakes are widely distributed throughout the year. Lesser black-backed gull are mainly summer visitors, while in contrast guillemot numbers are greatest during winter months. In addition, substantial numbers of terns migrate northwards through the offshore North Sea area in April and May, with return passage from July to September [6].

For many years, the presence of seabirds on or within proximity to offshore installations has been well documented [60]. The use of offshore platforms by seabirds, is also documented within the HSE offshore technology report [27], which highlights the impact of Guano on helicopter operations on several platforms across the North Sea. The use of offshore infrastructure is primarily assumed to be for the purposes of roosting and providing resting places during foraging or migration trips, however recent observations have indicated the use of offshore platforms for nesting purposes, particularly by Kittiwakes. Due to the significant records of usage of both manned and unmanned offshore infrastructure by seabirds, it is reasonable to conclude that seabirds are not disturbed by most offshore operations and that they actively seek out such areas as they provide some form of benefit to the individual such as nesting/roosting sites and increased access to feeding areas.

This is further supported by observations made during the Pickerill B topside removal campaign in Q2 2020 (located 19km SE of Amethyst B1D), where ornithological monitoring of bird behaviour was carried out with the intention of documenting any potential disturbance from topside preparatory activities. It was noted that no significant disturbance (evidenced by a lack of nest/chick/egg abandonment and a successful breeding season with a productivity 0.768 compared to natural colonies 0.638-0.302 [14]), to nesting birds was observed during topside preparation works.

An overview of bird species surface density is provided in Figure 5-15.

5.2.4.1 Seabird Vulnerability to Oil Pollution

Seabird populations are particularly vulnerable to surface pollution. The vulnerability of bird species to oil pollution varies considerably throughout the year and is dependent on a variety of factors, including time spent on the water, total biogeographical population, reliance on the marine environment and potential rate of population recovery. Species considered most vulnerable to sea surface pollution are those which spend a great deal of time on the sea surface, for example, puffin, guillemot, and razorbill. Species considered to be at lower risk due to spending less time on the sea surface include gannet, cormorant, and kittiwake.

The Seabird Oil Sensitivity Index (SOSI) has been developed to identify areas where seabirds are likely to be most sensitive to oil pollution [68]. The SOSI combines seabird data collected between 1995 and 2015 and individual seabird species sensitivity index values to create a single measure of seabird sensitivity to oil pollution. The SOSI score for each UKCS Block can be ranked into sensitivity categories, from 1 (extremely high sensitivity) to 5 (low sensitivity) (Table 5-9). An assessment of the median SOSI scores indicates that the sensitivity of seabirds to oil pollution in UKCS blocks 47/14 and 47/15 can be extremely high to very high in October, November, December and March (Table 5-9).

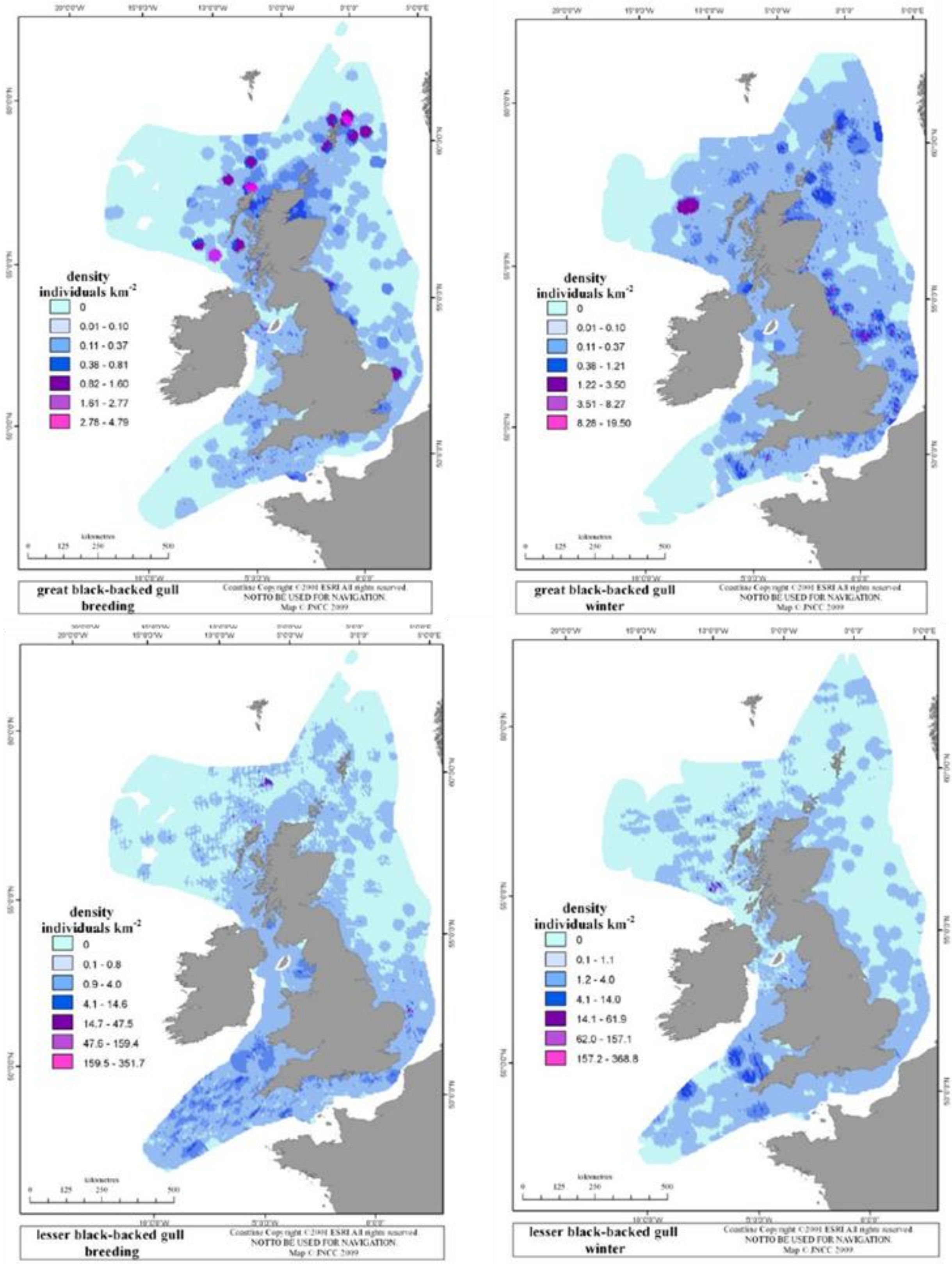
Table 5-9: SOSI scores for UKCS blocks 47/14 and 47/15 [68]

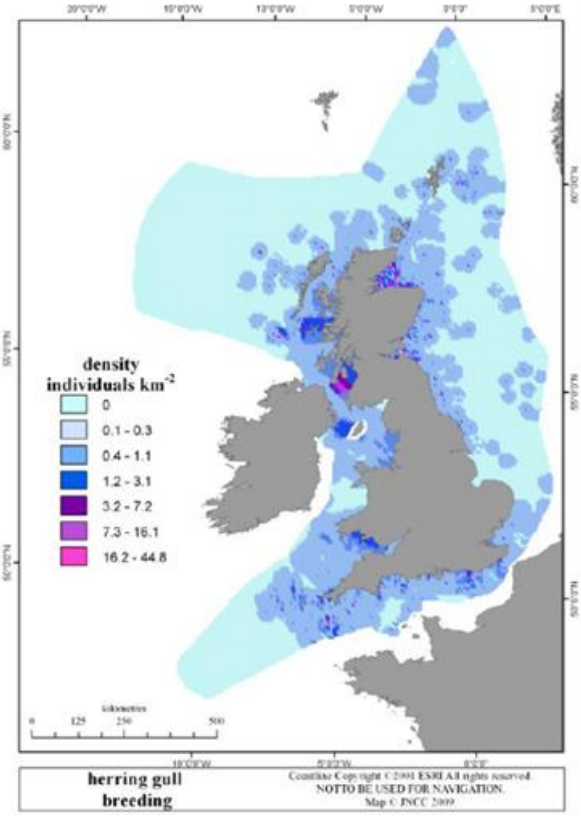
UKCS Block	January	February	March	April	May	June	July	August	September	October	November	December
47/9	4	2	2	5	5	4	5	3	4	1	2	3
47/8	4	3	3	5	5	3	5	3	3	1	3	4
47/13	4	3	2	5	5	5	5	3	4	1	2	2
47/18	4	4	2	5	5	5	5	4	4	1	2	2
47/14	3	3	2	5	5	5	5	3	5	2	1	2
47/10	2	2	2	2	5	5	4	3	4	2	2	1
47/15	3	3	2	5	5	5	5	3	5	3	1	2
47/20	3	4	2	5	5	5	5	4	4	3	1	2
47/19	3	3	2	5	5	5	5	4	4	3	1	2

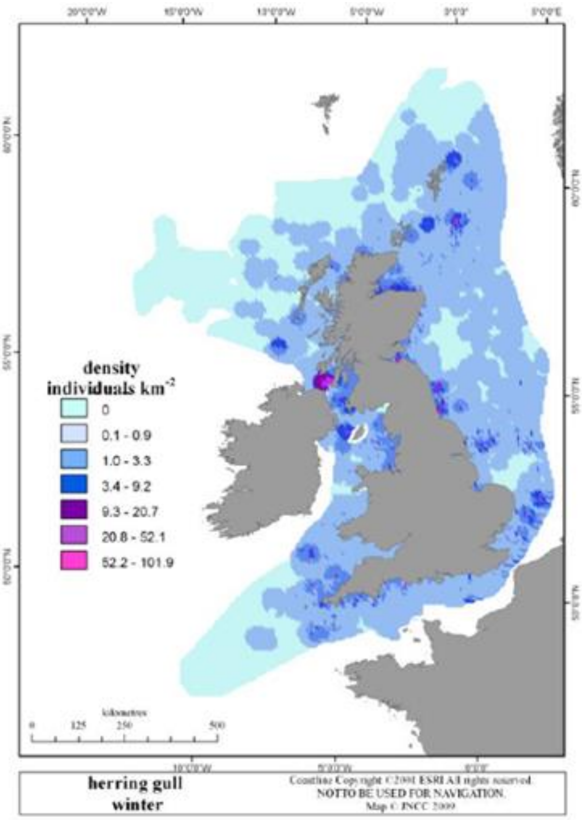
Key: 1 = Extremely High; 2 = Very High; 3 = High; 4 = Medium; 5 = Low; 'N'= No Data.
SOSI sensitivity category in red and underlined indicates an indirect assessment of SOSI scores, in light of coverage gaps.

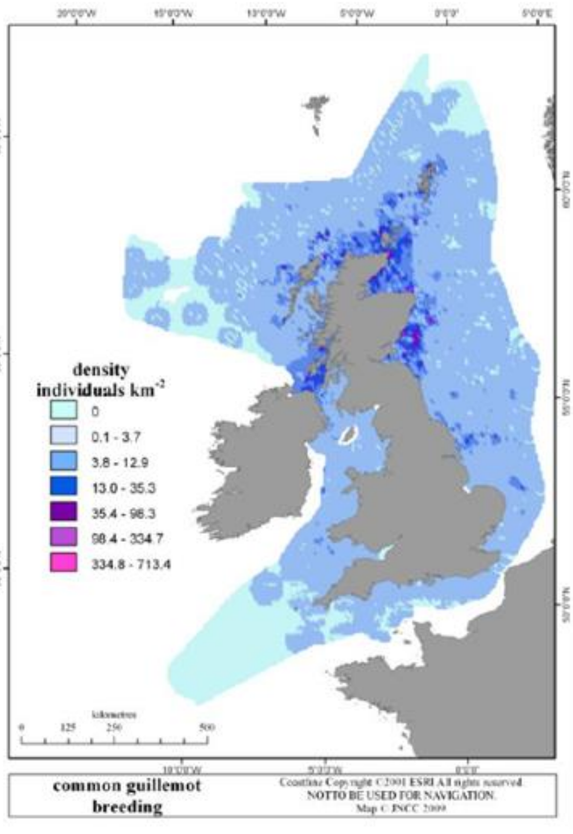
Vulnerability index	5 = low	4 = medium	3 = high	2 = very high	1 = extremely high	ND = No data

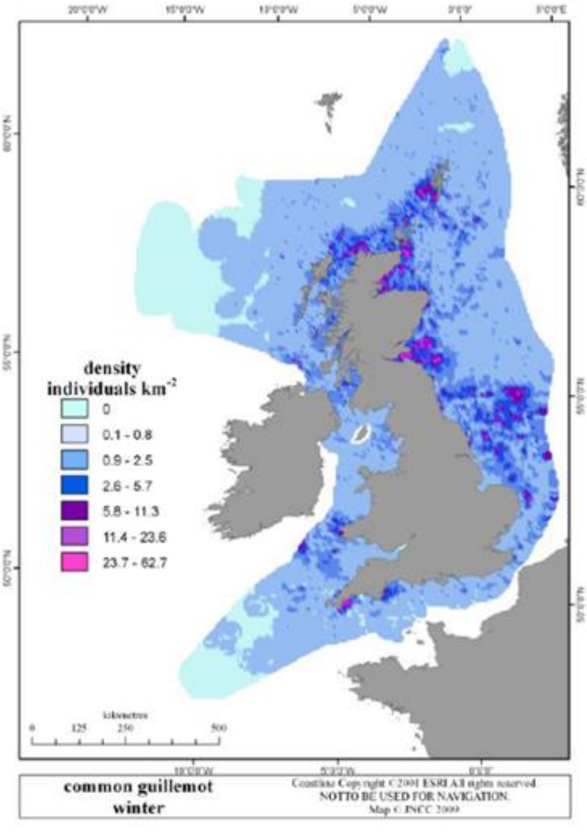
Figure 5-15: Seabird density surface maps for the species identified as frequently occurring in the SNS [33]

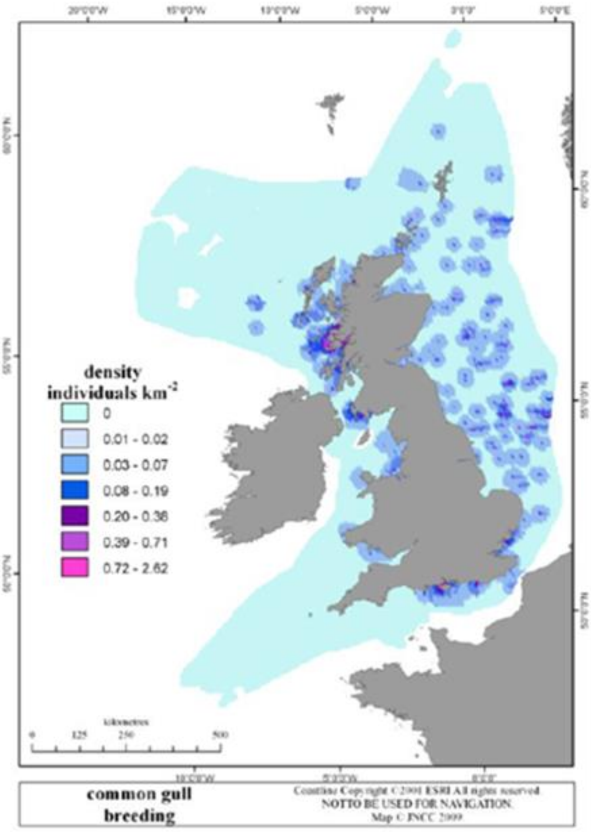


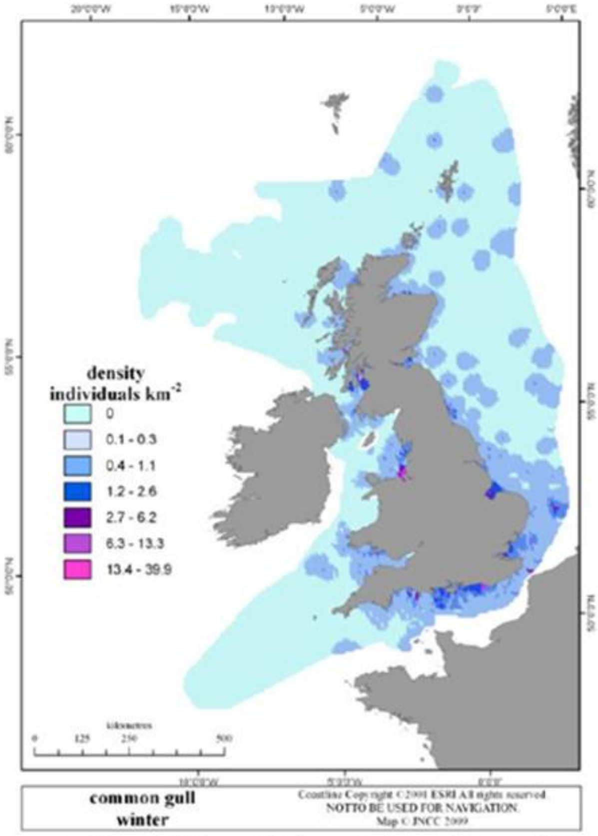

density
individuals km-2
0
0.1 - 0.3
0.4 - 1.1
1.2 - 3.1
3.2 - 7.2
7.3 - 16.1
16.2 - 44.8
herring gull
breeding
Coastline Copyright ©2001 ESRI All rights reserved
NOTTO BE USED FOR NAVIGATION.
Map © JNCC 2009

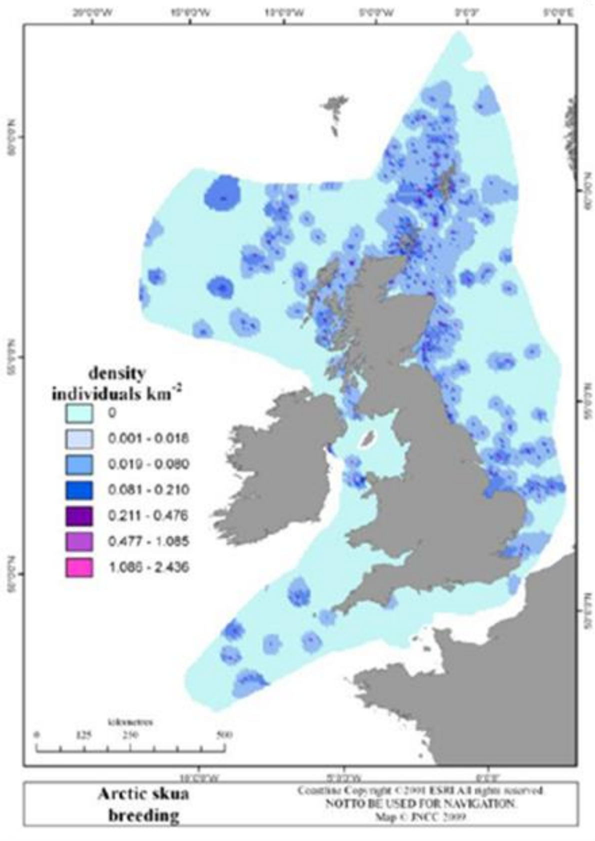

density
individuals km-2
0
0.1 - 0.9
1.0 - 3.3
3.4 - 9.2
9.3 - 20.7
20.8 - 52.1
52.2 - 101.9
herring gull
winter
Coastline Copyright ©2001 ESRI All rights reserved
NOTTO BE USED FOR NAVIGATION.
Map © JNCC 2009

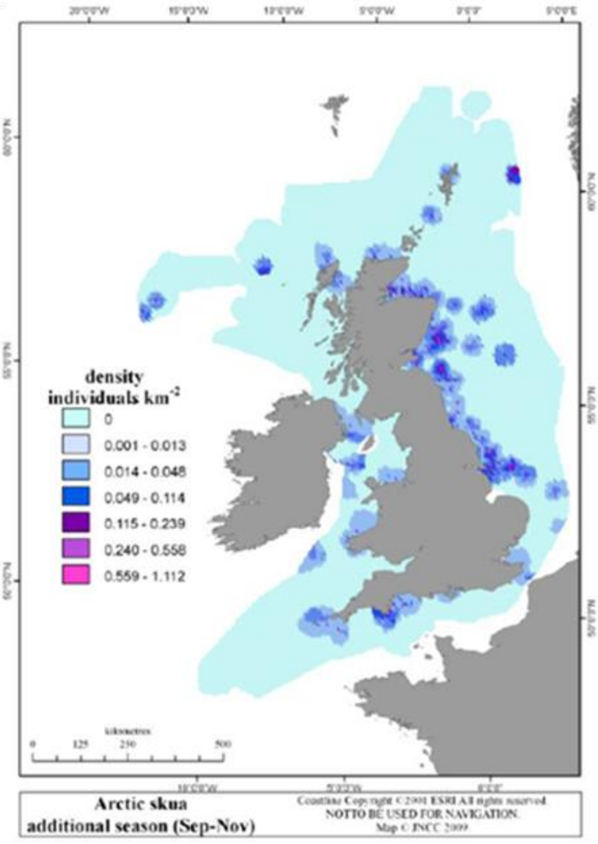

density
individuals km-2
0
0.1 - 3.7
3.8 - 12.9
13.0 - 35.3
35.4 - 98.3
98.4 - 334.7
334.8 - 713.4
common guillemot
breeding
Coastline Copyright ©2001 ESRI All rights reserved
NOTTO BE USED FOR NAVIGATION.
Map © JNCC 2009

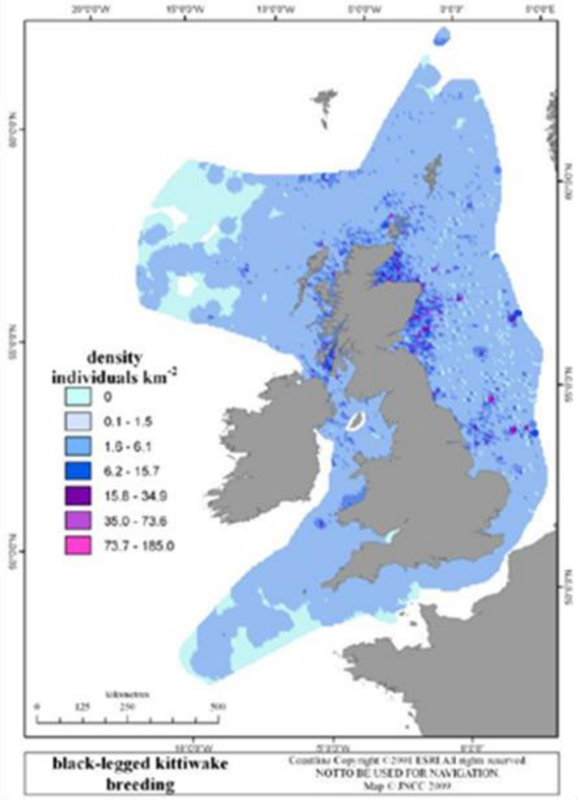

density
individuals km-2
0
0.1 - 0.8
0.9 - 2.5
2.6 - 5.7
5.8 - 11.3
11.4 - 23.6
23.7 - 62.7
common guillemot
winter
Coastline Copyright ©2001 ESRI All rights reserved
NOTTO BE USED FOR NAVIGATION.
Map © JNCC 2009

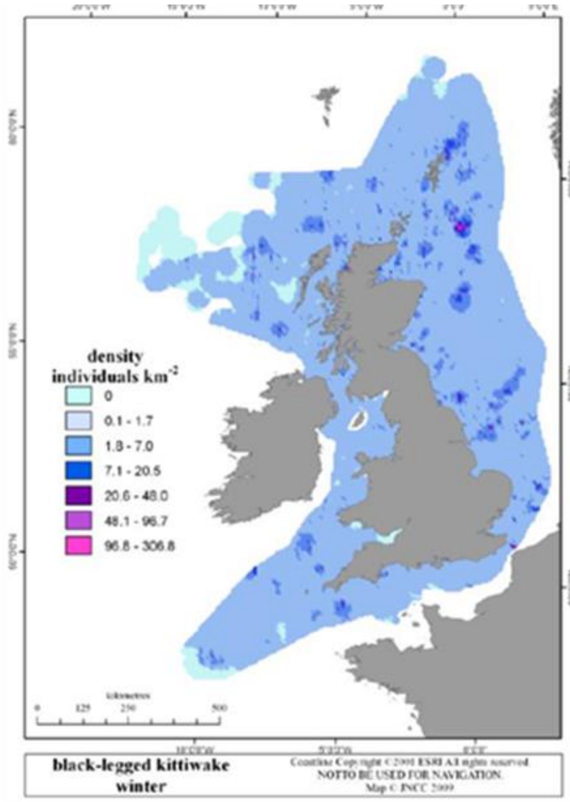

density
individuals km-2
0
0.01 - 0.02
0.03 - 0.07
0.08 - 0.19
0.20 - 0.38
0.39 - 0.71
0.72 - 2.62
common gull
breeding
NOT TO BE USED FOR NAVIGATION.

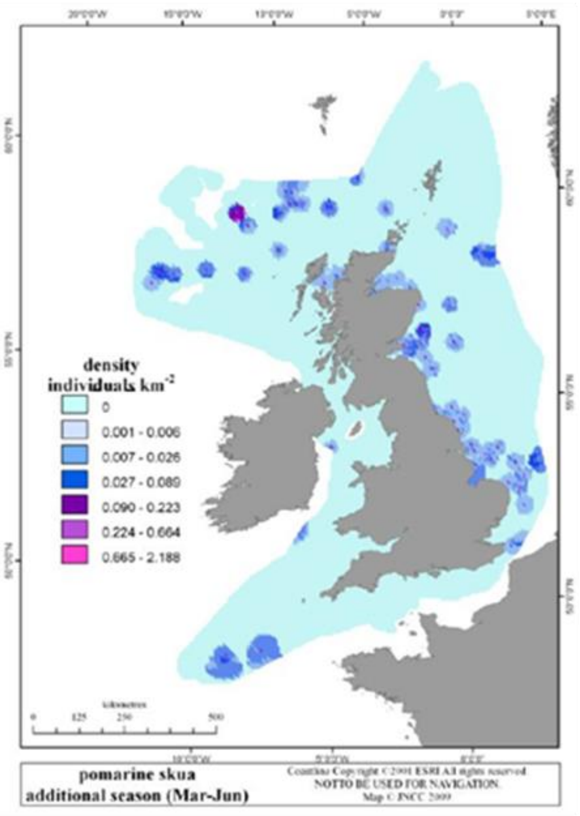

density
individuals km-2
0
0.1 - 0.3
0.4 - 1.1
1.2 - 2.6
2.7 - 6.2
6.3 - 13.3
13.4 - 39.9
common gull
winter
NOT TO BE USED FOR NAVIGATION.

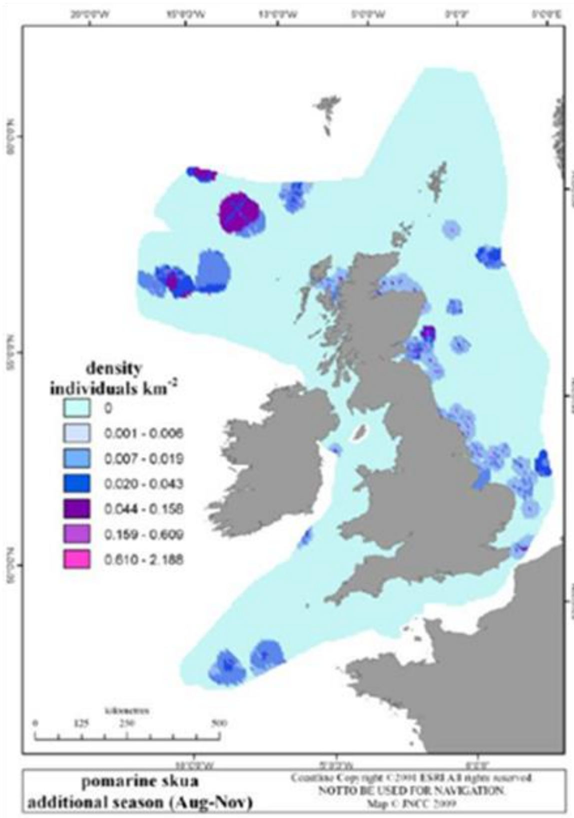

density
individuals km-2
0
0.001 - 0.018
0.019 - 0.080
0.081 - 0.210
0.211 - 0.476
0.477 - 1.085
1.086 - 2.436
Arctic skua
breeding
NOT TO BE USED FOR NAVIGATION.

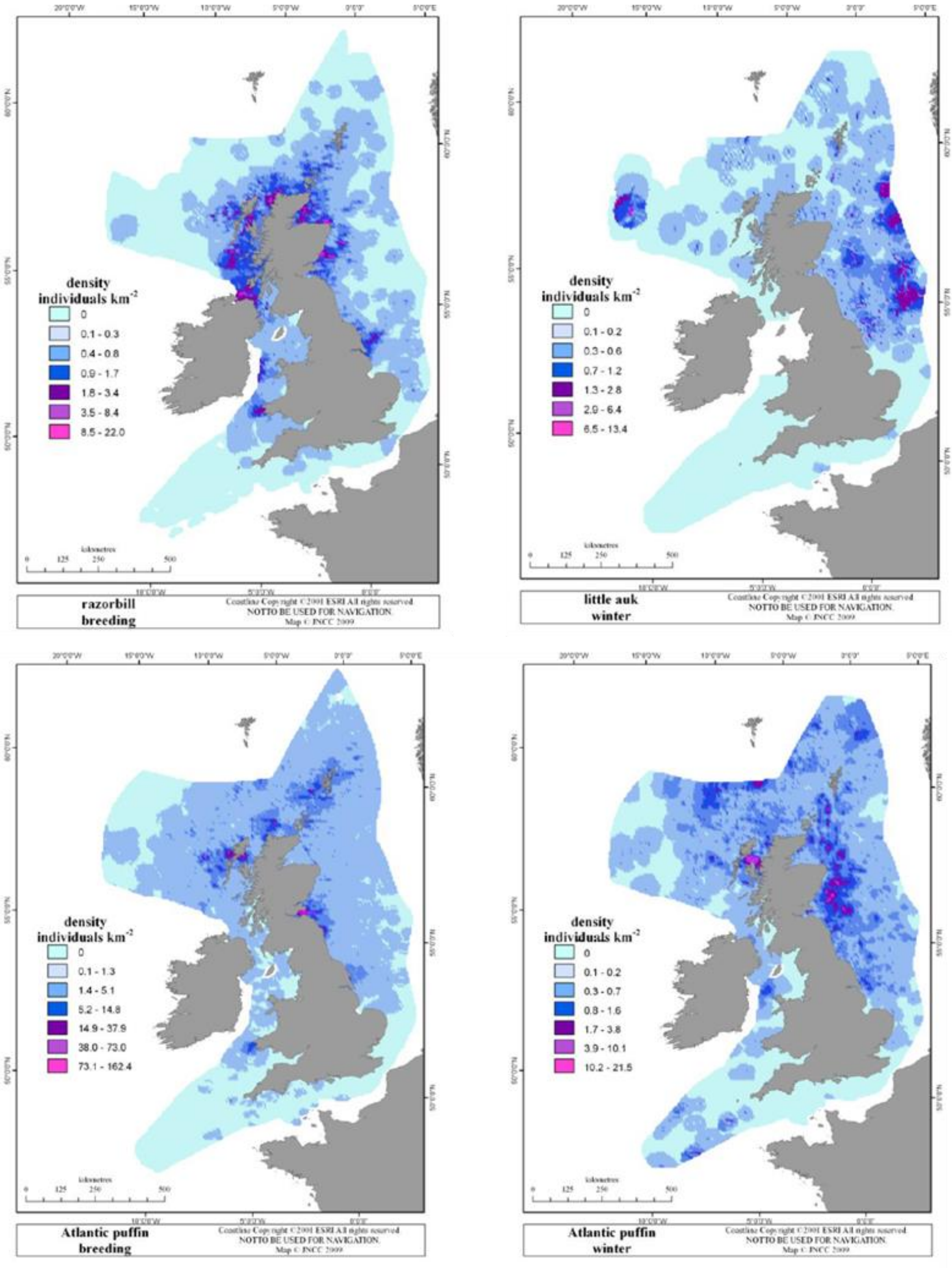

density
individuals km-2
0
0.001 - 0.013
0.014 - 0.048
0.049 - 0.114
0.115 - 0.239
0.240 - 0.558
0.559 - 1.112
Arctic skua
additional season (Sep-Nov)
NOT TO BE USED FOR NAVIGATION.


density
individuals km-2
0
0.1 - 1.5
1.6 - 6.1
6.2 - 15.7
15.8 - 34.9
35.0 - 73.6
73.7 - 185.0
black-legged kittiwake
breeding
NOTTO BE USED FOR NAVIGATION


density
individuals km-2
0
0.1 - 1.7
1.8 - 7.0
7.1 - 20.5
20.6 - 48.0
48.1 - 96.7
96.8 - 306.8
black-legged kittiwake
winter
NOTTO BE USED FOR NAVIGATION


density
individuals km-2
0
0.001 - 0.006
0.007 - 0.026
0.027 - 0.089
0.090 - 0.223
0.224 - 0.664
0.665 - 2.188
pomarine skua
additional season (Mar-Jun)
NOTTO BE USED FOR NAVIGATION


density
individuals km-2
0
0.001 - 0.006
0.007 - 0.019
0.020 - 0.043
0.044 - 0.158
0.159 - 0.609
0.610 - 2.188
pomarine skua
additional season (Aug-Nov)
NOTTO BE USED FOR NAVIGATION


density
individuals km^{-2}
0
0.1 - 0.3
0.4 - 0.8
0.9 - 1.7
1.8 - 3.4
3.5 - 8.4
8.5 - 22.0
razorbill
breeding
density
individuals km^{-2}
0
0.1 - 0.2
0.3 - 0.6
0.7 - 1.2
1.3 - 2.8
2.9 - 6.4
6.5 - 13.4
little auk
winter
density
individuals km^{-2}
0
0.1 - 1.3
1.4 - 5.1
5.2 - 14.8
14.9 - 37.9
38.0 - 73.0
73.1 - 162.4
Atlantic puffin
breeding
density
individuals km^{-2}
0
0.1 - 0.2
0.3 - 0.7
0.8 - 1.6
1.7 - 3.8
3.9 - 10.1
10.2 - 21.5
Atlantic puffin
winter
NOT TO BE USED FOR NAVIGATION
Map © JNCC 2009

5.2.5 Marine Mammals

5.2.5.1 Cetaceans

Cetaceans (whales, dolphins, and porpoises) are protected under Annex IV of the Council Directive 92/43/EEC (also known as the Habitats Directive). Cetacean abundance in the SNS is relatively low compared to the northern and central North Sea, with the exception of the harbour porpoise (*Phocoena phocoena*).

The relative abundance and density of cetaceans in the vicinity of the Amethyst jackets can be derived from data obtained during the Small Cetacean Abundance of the North Sea (SCANS-IV) aerial and ship-based surveys. This project identified the abundance and density of cetacean species within predefined sectors of the North Sea and Northeast Atlantic. The Amethyst field is situated within the SCANS-IV Block 'NS-C' and was surveyed by air [26]. The density of the harbour porpoise within the SCANS-IV Block 'NS-C' is higher than the total surveyed area, suggesting that the area may be important for these species (Table 5-10). Densities for minke whale were similar to the total surveyed area, whereas densities for white-beaked dolphin were a magnitude lower.

In addition to the aforementioned cetaceans, other species have been observed or have been modelled to have presence in the North Sea [67]. These include the Atlantic white-sided dolphin (*Lagenorhynchus acutus*), Risso's dolphin (*Grampus griseus*), short-beaked common dolphin (*Delphinus delphis*), and killer whale (*Orcinus orca*).

Table 5-10: Cetacean abundance and density recorded in SCANS-IV aerial survey area block 'NS-C' [26]

Species	SCANS-IV Block 'NS-C'	
	Abundance	Density Note1
Harbour porpoise	36,286	0.6027
Bottlenose dolphin	2,520	0.0419
White-beaked dolphin	894	0.0149
Minke whale	412	0.0068
Common dolphin	192	0.0032
Note1: Density is the number of animals per km^2		

For the management of marine mammals, UK Statutory Nature Conservation Bodies have identified Marine Mammal Management Units (MMMU's) to provide information on the geographical range and abundance of marine mammals, and therefore understand the potential effects of anthropogenic activities on populations. The abundance of cetacean species within their respective MMMU is shown in Table 5-11.

The most abundant species in the North Sea is the Harbour porpoises when compared to other species identified in Table 5-11, despite its MMMU being smaller in area. White-sided dolphins are the next most abundant; however, these were not recorded in significant numbers in other surveys (refer to Table 5-10 and Table 5-12).

Table 5-11: Estimates of cetacean abundance in the relevant MMMUs [29]

Species	Management unit	Abundance in MMMU	95% Confidence Interval	Abundance in UK part of MMMU	Confidence Interval
Harbour porpoise	North Sea (678,206km^2)	227,298	176,360 – 292,948	110,433	80,866 – 150,811
Common dolphin	Celtic and Greater North Sea (1,560,875km^2)	56,556	33,014 – 96,920	13,607	8,720 – 21,234
White-beaked dolphin		15,895	9,107 – 27,743	11,694	6,578 – 20,790
White-sided dolphin		69,293	34,339 – 139,828	46,249	26,993 – 79,243

Additional to the above marine mammal abundance surveys, the Atlas of Cetacean Distribution in Northwest European Water [56] provides a comprehensive review of cetacean sightings in Northwest European waters. The seasonal sightings data for ICES Rectangles 36F0 is summarised in Table 5-12.

Due to the inherent difficulty in observation in the wild it is important to note that the lack of recorded sightings does not necessarily preclude the presence of a species at a certain time of year. In addition, the highly mobile nature of cetaceans means that species that are found within the area in general, such as the harbour porpoise, white-beaked dolphin and white sided dolphin may be present at other times of the year.

Harbour porpoise have been recorded in the vicinity of the project area for all months, with offshore sightings peaking in the early to late summer months between May – August. The Southern North Sea SAC lists Harbour porpoise as its protected feature making the reduction of noise in this environment a key objective.

Bottlenose dolphin have not been recorded in the area.

Table 5-12: Cetacean sightings in ICES Rectangle 36F0 [56]

Species	January	February	March	April	May	June	July	August	September	October	November	December
Harbour porpoise												
White-beaked dolphin												
White-sided dolphin												

Key	ND = No data	Very Low (< 0.01)	Low (0.01-1)	Moderate (1-10)	High (>10-100)

5.2.5.2 Pinnipeds

Two species of seals are found in the North Sea around the English E coast; grey seal (*Halichoerus grypus*) and the harbour (or common) seal (*Phoca vitulina*) (Figure 5-16, Figure 5-17). Both species are listed under Annex II of the EC Habitats Directive and protected under the Conservation of Seals Act 1970 (from 0 to 12 nautical miles (nm) from the coast) as well as being listed as UK Biodiversity Action Plan priority marine species.

Established colonies of grey seals are present on the E coast of England, at Donna Nook, at the mouth of the Humber, and around Blakeney on the North Norfolk coast [59]. Like all seals, grey seals spend a significant proportion of their time hauled out on land during the breeding, moulting and pupping seasons and also between tides and foraging trips [59]. Grey seals forage down to depths of 100m and at distances of up to 100km from their haul-out sites and, therefore, whilst unlikely, could be present in the vicinity of the Amethyst field, particularly at their western most extent. Models of marine usage by grey seals show that there are high levels of foraging activity along the E coast of England. The nearest coastline Amethyst field jacket is C1D, located approximately 30km to shore, and thus the distribution of grey seals in the vicinity of C1D may be considerable low (15-76 individuals per 25km^2) and very low for A1D, A2D and B1D jackets location (0-15 individuals per 25km^2) (Figure 5-16) [57].

Harbour seals tend to be found closer to the coast [59]. As with grey seals, the UK harbour seal population is predominantly found around the Scottish coast with smaller colonies around The Wash and along the E coast of England [59]. Harbour seals are restricted to their haul-out sites and the surrounding waters during pupping (June and July) and during their annual moult (August) [57]. This species can be found offshore from late August through to the following June and tends to forage within 40 – 50km of its haul-out sites. The harbour seal at-sea utilisation of waters surrounding the Amethyst jackets may be consider low for C1D and B1D (10-46 individual per 25km^2) and very low for A1D and 2AD jackets (0-15 individuals per 25km^2) (Figure 5-17) [57].

Figure 5-16: Grey seal (*Halichoerus grypus*) at sea density

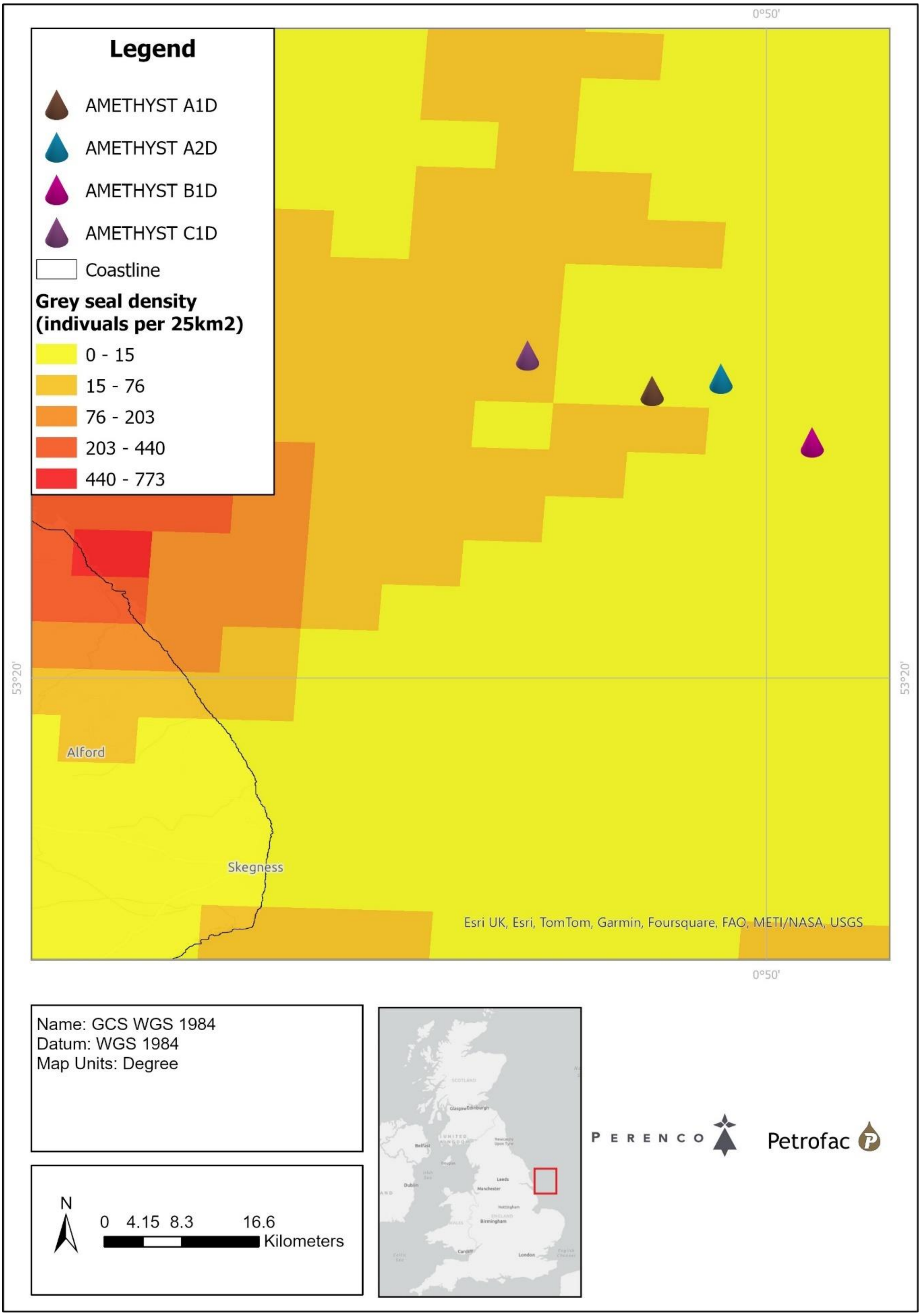
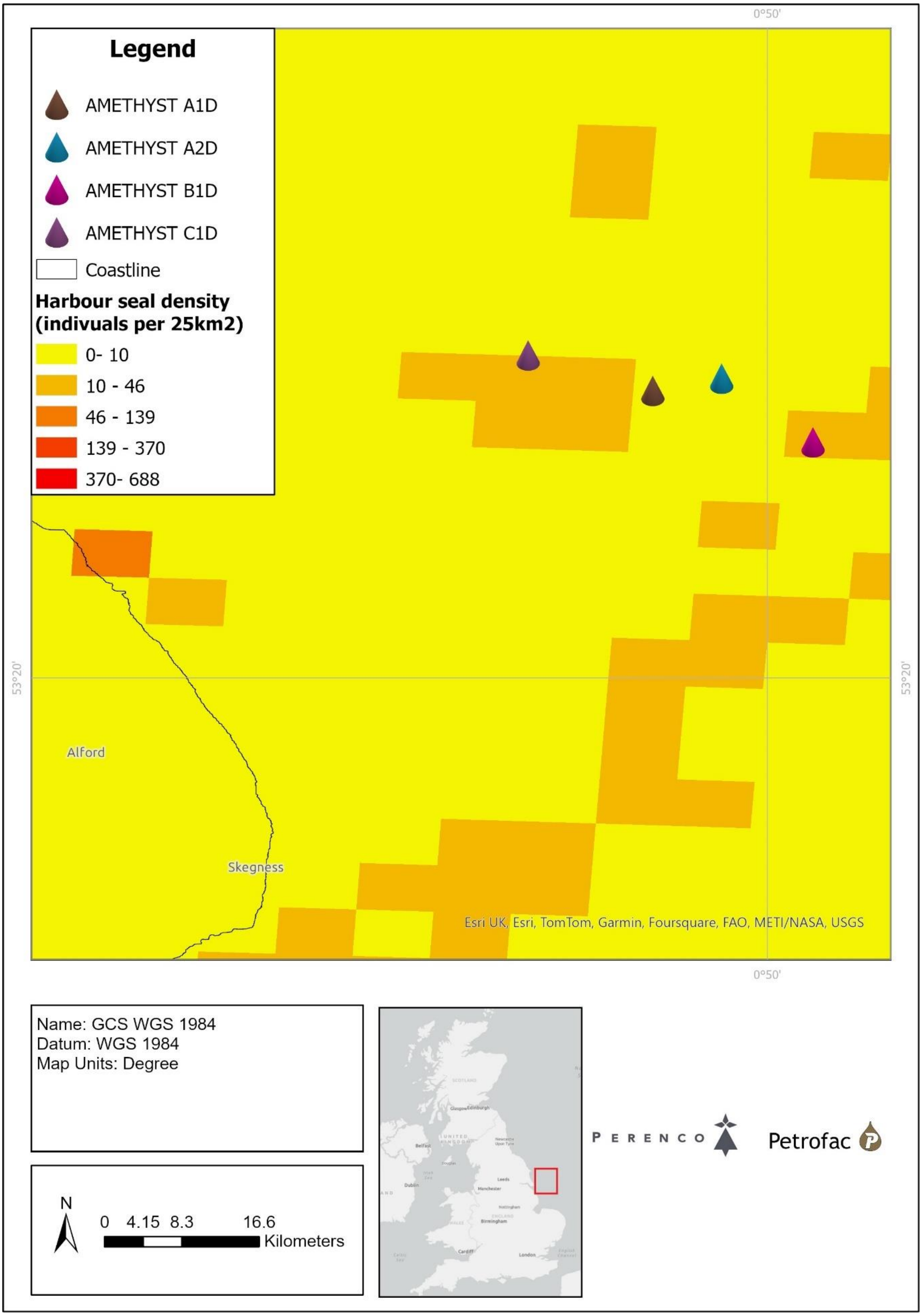


Figure 5-17: Harbour seal (*Phoca vitulina*) at sea density



5.3 Management

5.3.1 Conservation Areas

The UK is party to a number of international agreements to establish an ecologically important network of Marine Protected Areas (MPA's) within UK waters. As a signatory to the OSPAR Convention the UK must establish an ecologically coherent and well-managed network of MPA's across the Northeast Atlantic by 2016 [31]. These commitments are transposed through national legislation and regulations. The main types of MPA's in UK waters are:

- SAC (also known as European Sites of Community Importance which are designated for habitats and species listed under the EU Habitats Directive. These qualifying features include three marine habitat types (shallow sandbanks, reefs and submarine structures made by leaking gases) and four marine species (grey seal, harbour seal, bottlenose dolphin and harbour porpoise) [31]. In the UK there are 116 SACs with marine components [31].
- Special Protection Areas (SPA's) which are designated to protect birds under the EU Wild Birds Directive. The Directive requires conservation efforts to be made across the sea and land area. In the UK 112 SPAs with marine components have been designated, including four wholly marine SPA's [31].
- Marine Conservation Zones (MCZ's) which are designated under the Marine and Coastal Access Act (2009) to protect nationally important marine wildlife, habitats, geology, and geomorphology and can be designated anywhere in English, Welsh territorial, or UK offshore waters [31]. To date there are 97 designated MCZ's in UK waters [31].

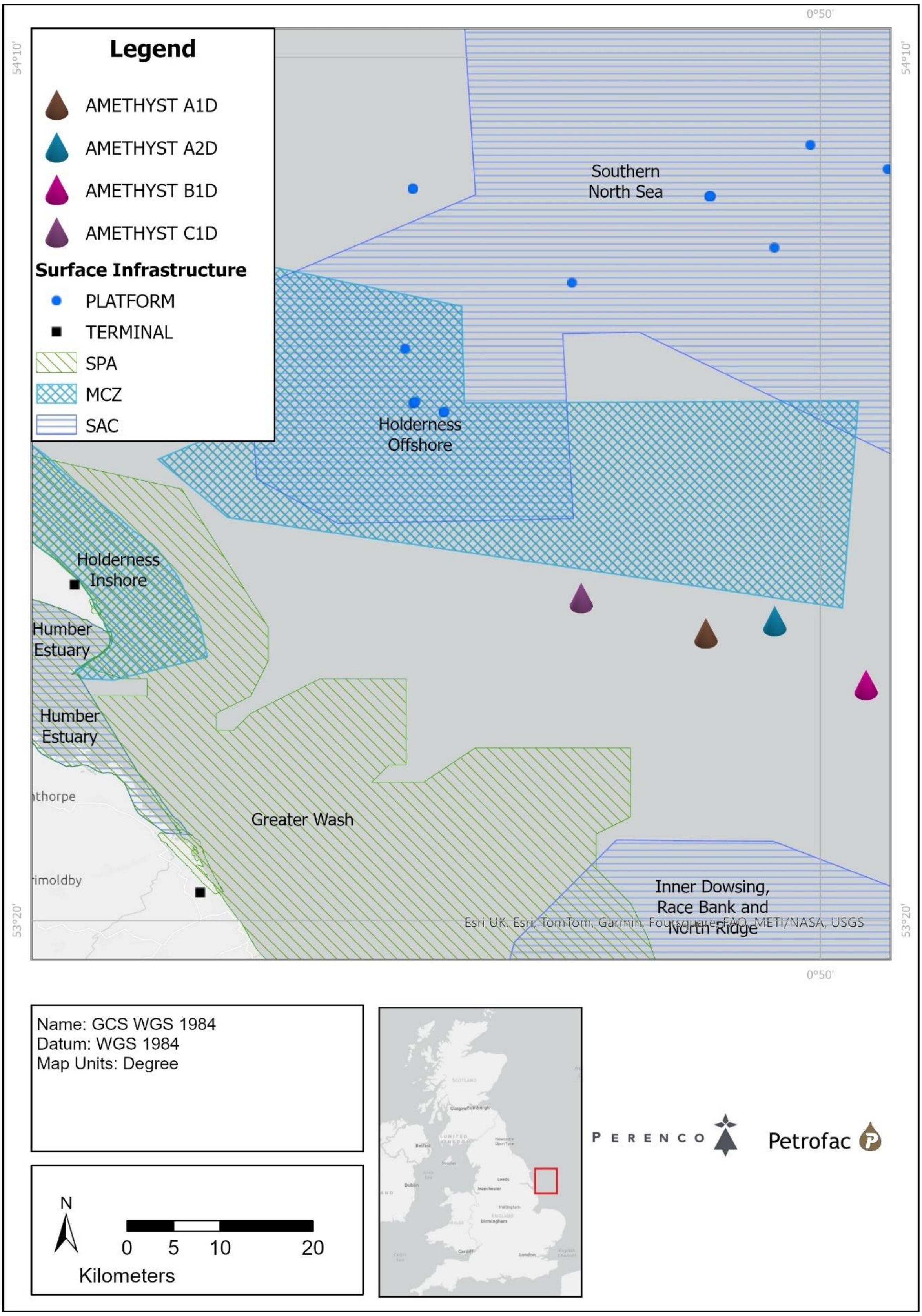
SAC's and SPA's form part of the European Natura 2000 network. Other international designations such as Ramsar Wetlands of International Importance (hereafter referred to as Ramsar sites), and national designations such as Sites of Special Scientific Interest also form part of the UK MPA network through their protection of marine, coastal terrestrial and geological features [31]. OSPAR MPA's encompass existing MPA's designated under existing legislation including SAC's, SPA's and MCZ's [31].

There are six MPA's within 40km of the Amethyst field. Table 5-13 presents the qualifying features and a description for each of these sites and Figure 5-18 shows the MPA's in the vicinity of the of the Amethyst field.

Table 5-13: MPA's within 40km of the Amethyst field

Site Name	Distance and Direction	Qualifying Features and Site Description
Greater Wash SPA	13.1km SW of A1D	The site has been designated to protect important areas of sea used by waterbirds during the nonbreeding period, and for foraging terns in the breeding season. Breeding tern colonies along the coast are already protected by a number of existing classified SPAs: Humber Estuary, Gibraltar Point, North Norfolk Coast, Breydon Water and Great Yarmouth North Denes. The Greater Wash SPA boundary is a composite of the areas used by these foraging terns, common scoter and red-throated diver.
Inner Dowsing, Race Bank and North Ridge SAC	18km S of B1D	This site features Annex I Habitat: Sandbanks which are slightly covered by sea water all the time and Reefs. The Inner Dowsing, Race Bank and North Ridge site is located off the S Lincolnshire coast in the vicinity of Skegness, extending eastwards and N from Burnham Flats on the North Norfolk coast, occupying The Wash Approaches. Abundant *Sabellaria spinulosa* agglomerations have consistently been recorded within the boundary of the SAC. Survey data indicate that reef structures are concentrated in certain areas of the site, with a patchy distribution of crust-forming aggregations across the site.
Southern North Sea SAC	8.4km N of C1D and 18.7km E of A2D	This site features Annex II species: Harbour porpoise (*Phocoena phocoena*). Proposed for designation for the Annex II species harbour porpoise. The conservation objective for the Southern North Sea SAC is "to avoid deterioration of the habitats of the harbour porpoise or significant disturbance to the harbour porpoise, thus ensuring that the integrity of the site is maintained, and the site makes an appropriate contribution to maintaining Favourable Conservation Status for the UK harbour porpoise".
Holderness Offshore MCZ	3km N of C1D	This site features broad scale habitats. The seabed is mostly composed of coarse and mixed sediment habitats, which can support a number of different infaunal and epifaunal communities including polychaetes, worm, bivalve, burrowing amphipod, bloodworm, sea squirt, tube worm and a range of encrusting bryozoans. The Ross worm *Sabellaria spinulosa* has a wide distribution over the area; it occurs mainly in a low-lying encrusting form, with one record in biogenic reef form. The site is also proposed due to the presence of Ocean Quahog (*Arctica islandica*), which is an OSPAR-listed threatened and/or declining species.
Humber Estuary SAC	38km W of C1D	This site features a number of habitats which qualify it for designation as an SAC, including estuaries, mudflats and sandflats not covered by seawater at low tide, coastal lagoons, Salicornia, salt meadows, shifting dunes and fixed coastal dunes. The presence of Annex II species such as the Sea lamprey, River lamprey and Grey seal are also qualifying features.
Holderness inshore MCZ	25km W of C1D	This site has been designated due to the presence of the following features: Intertidal sand and muddy sand, moderate/high energy circalittoral rock, subtidal course/mixed sediments and subtidal mud/sand.

Figure 5-18: Location of Amethyst pipelines and power cables in relation to the UK coast and environmentally sensitive areas.



5.3.2 National Marine Plans

Table 5-14 details policies and objectives contained within relevant marine plans (East offshore) and highlights how these have been addressed by the proposed decommissioning strategy [41].

Table 5-14: Marine planning objectives and policies relevant to the proposed decommissioning strategy

Relevant Objectives	Associated Policies	Addressed by Project
Economic Productivity - To promote the sustainable development of economically productive activities, taking account of spatial requirements of other activities of importance to the East marine plan areas.	**EC1** - Proposals that provide economic productivity benefits which are additional to Gross Value Added currently generated by existing activities should be supported.	The proposed decommissioning strategy is in line with minimising taxpayer costs for decommissioning oil & gas infrastructure in the SNS.
Employment and Skill Levels - To support activities that create employment at all skill levels, taking account of the spatial and other requirements of activities in the East marine plan areas.	**EC2** - Proposals that provide additional employment benefits should be supported, particularly where these benefits have the potential to meet employment needs in localities close to the marine plan areas.	The proposed operations will utilise local contractors in the area and a support base close to the proposed operations.

Heritage Assets - To conserve heritage assets, nationally protected landscapes and ensure that decisions consider the seascape of the local area.	**SOC2** - Proposals that may affect heritage assets should demonstrate, in order of preference: a) that they will not compromise or harm elements which contribute to the significance of the heritage asset; b) how, if there is compromise or harm to a heritage asset, this will be minimised; c) how, where compromise or harm to a heritage asset cannot be minimised it will be mitigated against, or; d) the public benefits for proceeding with the proposal if it is not possible to minimise or mitigate compromise or harm to the heritage asset. **SOC3** - Proposals that may affect the terrestrial and marine character of an area should demonstrate, in order of preference: a) that they will not adversely impact the terrestrial and marine character of an area; b) how, if there are adverse impacts on the terrestrial and marine character of an area, they will minimise them; c) how, where these adverse impacts on the terrestrial and marine character of an area cannot be minimised they will be mitigated against; d) the case for proceeding with the proposal if it is not possible to minimise or mitigate the adverse impacts.	The proposed decommissioning strategy is not anticipated to have an impact on any heritage assets or the character of the marine area.
Healthy Ecosystem - To have a healthy, resilient, and adaptable marine ecosystem in the East marine plan areas.	**ECO1** - Cumulative impacts affecting the ecosystem of the East marine plans and adjacent areas (marine, terrestrial) should be addressed in decision-making and plan implementation.	Refer to Section 7. Environmental & Social impact assessment.
	ECO2 - The risk of release of hazardous substances as a secondary effect due to any increased collision risk should be taken account of in proposals that require an authorisation.	The proposed decommissioning strategy minimises the risk of release of hazardous substances to low levels compared to alternative strategies. This includes the use of a MSV and a HLJB for the pipelines cutting and jackets/risers removal operations.
Biodiversity - To protect, conserve and, where appropriate, recover biodiversity that	**BIO1** - Appropriate weight should be attached to biodiversity, reflecting the need to protect biodiversity as a whole, taking account of the best available evidence including on habitats	The proposed decommissioning strategy reduces any potential impact on

is in or dependent upon the East marine plan areas.	and species that are protected or of conservation concern in the East marine plans and adjacent areas (marine, terrestrial).	biodiversity in the East Marine Plan and terrestrial areas.
Marine Protected Areas (MPAs) - To support the objectives of MPAs (and other designated sites around the coast that overlap or are adjacent to the East marine plan areas), individually and as part of an ecologically coherent network.	**MPA1** - Any impacts on the overall MPA network must be taken account of in strategic level measures and assessments, with due regard given to any current agreed advice on an ecologically coherent network	The proposed decommissioning strategy will not impact on the SAC's located within the East Marine Plan area (refer to section 5.3.1).
Governance - To ensure integration with other plans, and in the regulation and management of key activities and issues, in the East marine plans, and adjacent areas.	**GOV2** - Opportunities for co-existence should be maximised wherever possible.	Refer to Section 5.4
	GOV3 - Proposals should demonstrate in order of preference: a) that they will avoid displacement of other existing or authorised (but yet to be implemented) activities; b) how, if there are adverse impacts resulting in displacement by the proposal, they will minimise them; c) how, if the adverse impacts resulting in displacement by the proposal, cannot be minimised, they will be mitigated against or; d) the case for proceeding with the proposal if it is not possible to minimise or mitigate the adverse impacts of displacement.	Refer to Section 5.4

5.4 Societal

5.4.1 Commercial Fisheries

Fishing effort and landings within ICES rectangle 36F0 between 2017 and 2021 is presented in Figure 5-19 and Figure 5-20. Fishing activity in the area primarily takes place over summer months between July and October and is dominated by traps with 94% of the total efforts, followed by dredges with 6% and lastly trawls, seine nets and harvesting machines with negligible fishing activity recorded within the area (<1%) [38]. This is reflected in the landings data which indicates that shellfish species are the most significant component of the fishery in terms of landed tonnage (98.6%) and value [39], although some demersal fish are also caught. Of the species caught between the years 2017 and 2021, Crabs (C.P. Mixed Sexes) landings are greatest tonnages in ICES Rectangle 36F0, followed by Lobsters, scallops and whelks.

Data presented within the Navigational Risk Assessment indicates fishing vessel activity on Automatic Identification System (AIS) (15m length and above) to be moderate in the area. The vast majority of vessels were UK registered (94%) followed by French (4%) and Dutch (2%) [3].

Figure 5-19: Fishing effort for ICES rectangle 36F0

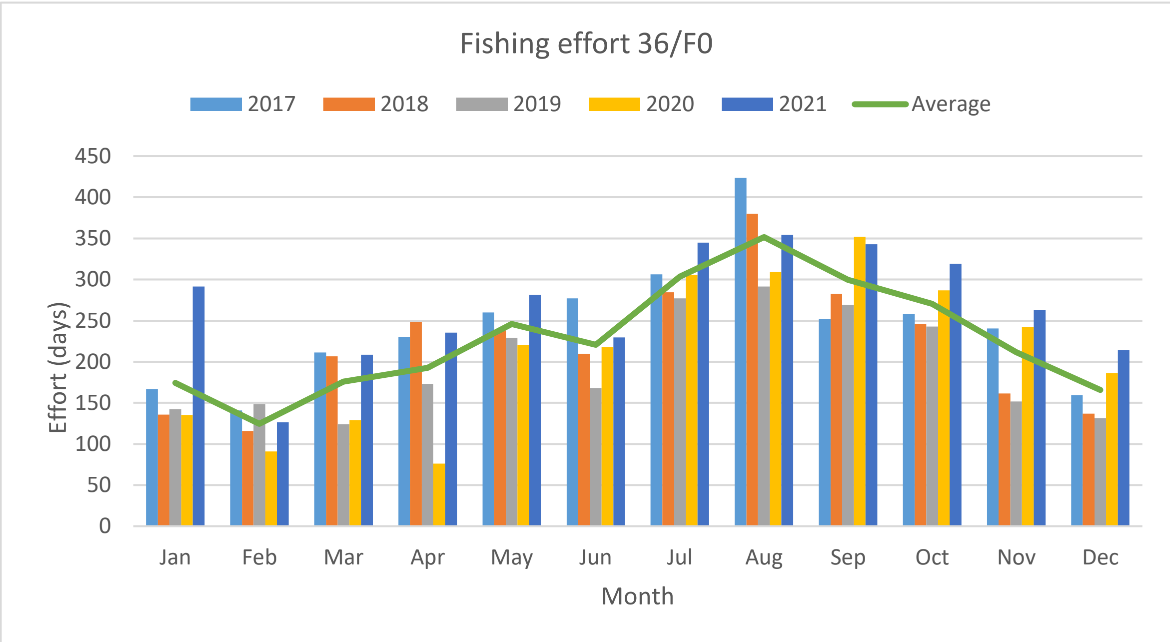
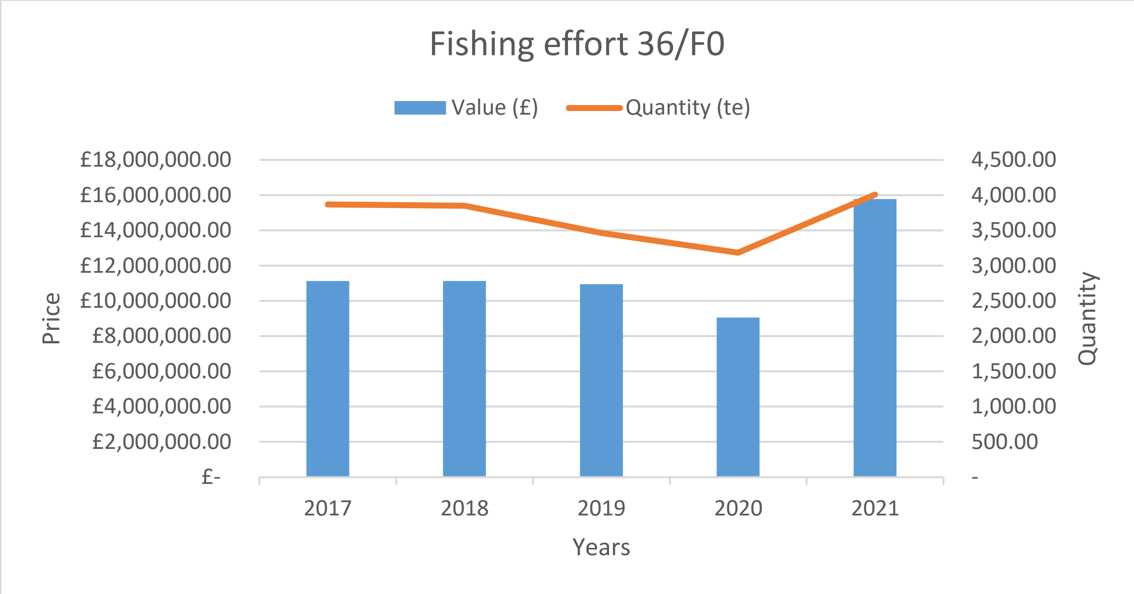


Figure 5-20: Fishing landings for ICES rectangle 36F0



5.4.2 Oil & Gas Activities

Oil and gas activity within the SNS is generally high and targets a number of existing gas fields. There is significant surface and subsurface infrastructure in UKCS Blocks 47/13, 47/14 and 47/15 [50]

A total of 59 wells have been drilled across UKCS Blocks 47/14 and 47/15, most of which are associated with PUK Limited and the Amethyst development but includes wells owned by Spirit Energy, Neptune Energy and Chrysaor petroleum. Of these wells 47 have been abandoned to phase 3, 2 to phase 2, 2 to phase 1 and 1 have been completed and shut in [50].

The surrounding area has also been heavily licensed for oil and gas development. Neighbouring fields include the Rose and Juliet fields to the E and the Mercury and Helvellyn fields to the N operated by PUK and Spirit energy respectively. Only the Mercury field is currently producing, with all others having ceased production or being in the post COP stage.

Due to the high oil and gas activity in the area, there are also a number of pipelines, flowlines and umbilical's that pass through UKCS blocks 47/14 and 47/15 where Amethyst and neighbour gas fields facilities are located. A total of 14 pipelines/umbilicals/flowlines pass through UKCS blocks 47/14 and 47/15, among which the PUK-operated Amethyst and Pickerill A field pipelines are present. The remaining seven offshore lines owned by third-party operators are the 'Juliet to Pickerill A' abandoned gas line and umbilical operated by Neptune Energy; the 'Helvellyn' active gas pipeline operated by Alpha Petroleum; the abandoned 'Rose' control umbilical and pipeline operated by Spirit Energy; and the abandoned Theddlethorpe to Murdoch MD pipelines operated by Harbour Energy PLC [50]. (Figure 5-22).

5.4.3 Marine Aggregates

There are several licenced marine aggregate areas within close proximity to the Amethyst infrastructure [15] (Figure 5-23). One licensed marine aggregate area within UKCS block 47/14 (Humber 4) is located approximately 1.5km of C1D jacket [64]. The remaining Humber 1, 2, and 3 aggregation areas lie adjacent towards the W. Within a range of 20km towards the S of B1D, there are six additional aggregation areas, including the Humber Estuary, Off Saltfleet, Humber Overfalls, Outer Dowsing, and Inner Dowsing [64]; [15].

5.4.4 Offshore wind

The closest offshore windfarm to the Amethyst field is the Trinton Knoll offshore wind farm developed by Innogy Renewables UK Ltd which is located approximately 15km SE of the Amethyst C1D jacket falling within the boundaries of block 47/14 (Figure 5-23). Turbine commissioning was successfully completed in January 2022.

Additionally, the Humber gateway wind farm operated by E.on is located 18km W of C1D jacket, and adjacent to the Amethyst trunk line in block 47/12 (Figure 5-23).

5.4.5 Commercial Shipping

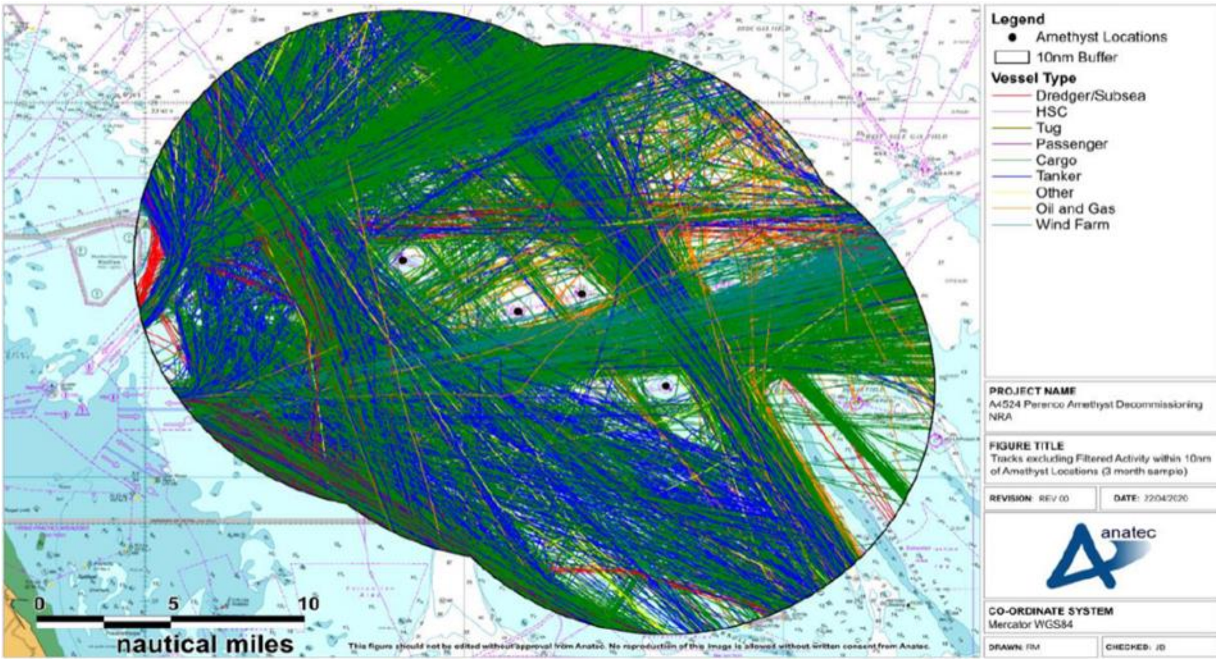
The density of shipping traffic in the SNS is relatively high due to the presence of fishing vessels, some ferries between the UK and the rest of Europe and cargo and offshore support vessels [6].

The waters surrounding the Amethyst field are described as having 'High' to 'Very High' shipping activity [49]. A Navigational Risk Assessment commissioned by PUK in 2020 identified the area as having high shipping density, with an estimated 74 vessels per day passing within 10nm of Amethyst based on the AIS data. The majority of these were cargo vessels and tankers [3].

5.4.6 Wrecks

There are circa 354 wrecks recorded within 40km the Amethyst infrastructure, however none are recorded as protected [42].

Figure 5-21: Shipping tracks recorded within 10nm of the Amethyst jackets



5.4.7 Telecommunications & Cables

Six subsea telecommunication cables link the shore to Hornsea 1 and Hornsea 2 offshore wind farms across the UKCS blocks 47/14 and 47/15. Two electric substations associated with this wind farms are located approximately 10km E of the A2D jacket location in the UKCS block 47/15. Furthermore, these subsea cables cross over PL 775, PL 777 and the power line PL 6401 connecting A2D to the B1D platform [32].

5.4.8 Military Activity

C1D jacket is located within a Ministry of Defence (MOD) practice and exercise area [18]. However, for offshore activities within the UKCS block 47/14, there are no restrictions identified by the MOD [49]. In addition, 22km W of C1D jacket is located Donna Nook practice and exercise area.

5.4.9 Tourism

Due to the distance between the Amethyst field area in scope and the nearest landfall (30km), no recreational vessel use is known to occur in the area.

Figure 5-22: Amethyst infrastructure in relation to surrounding oil and gas activity

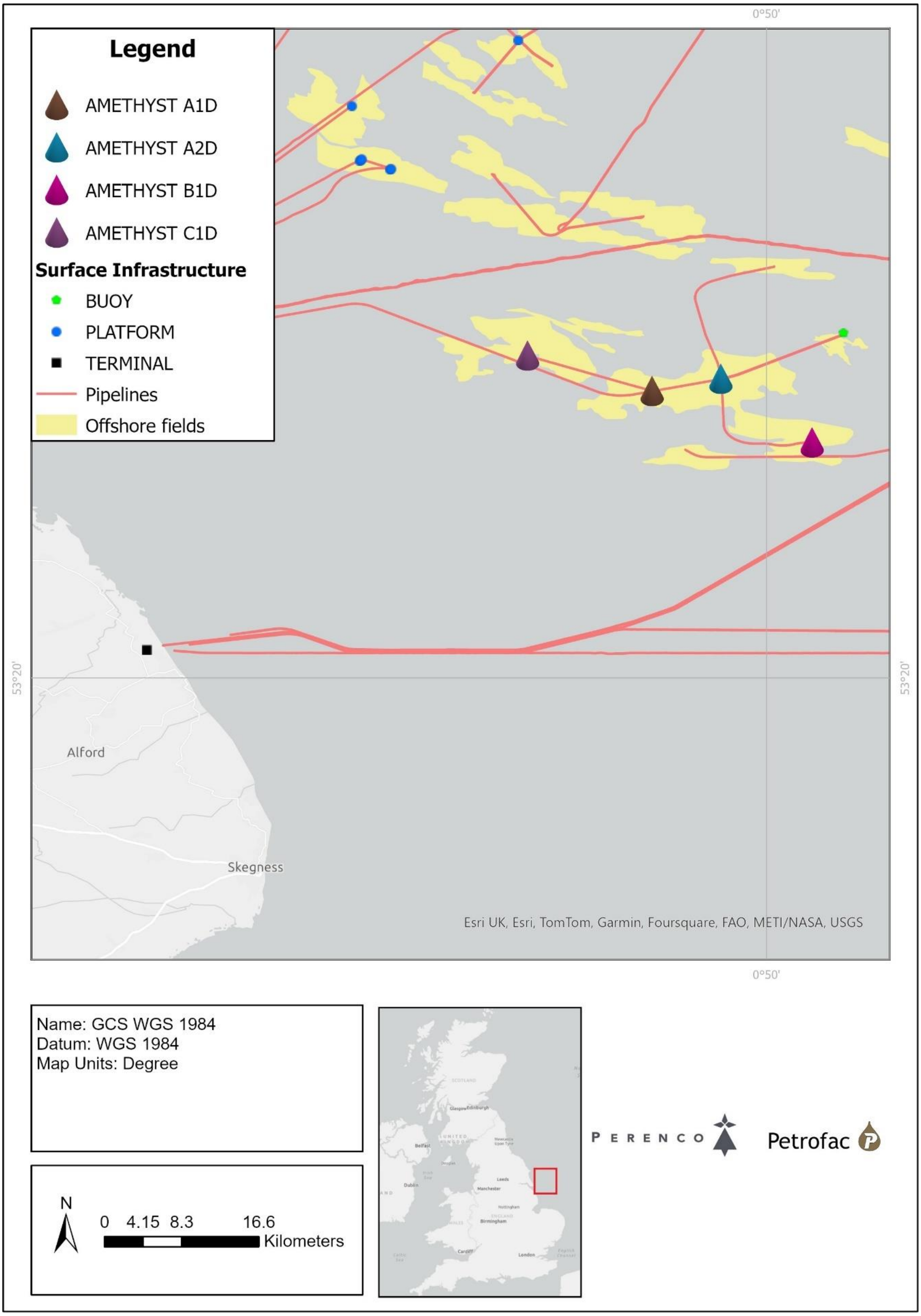
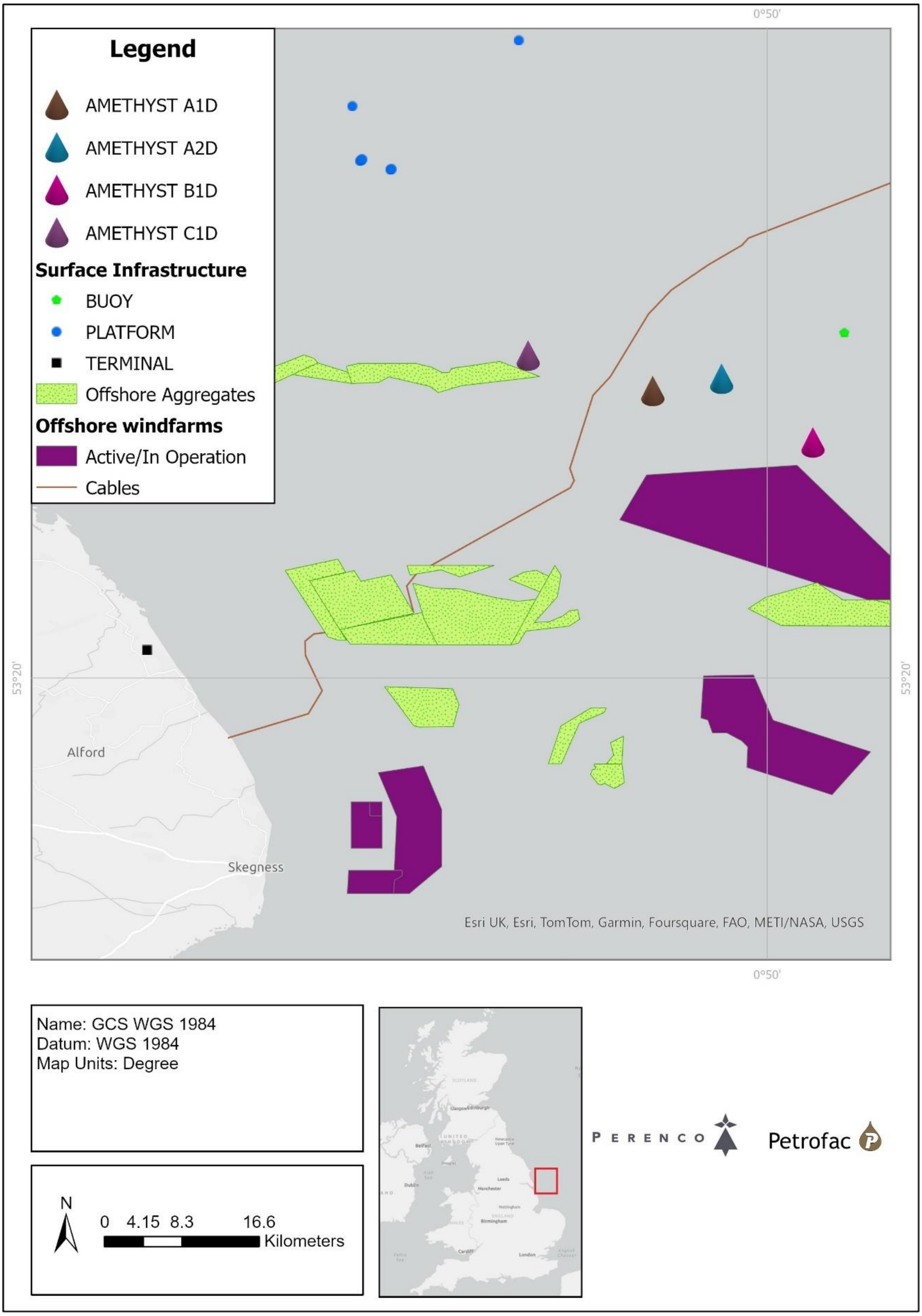


Figure 5-23: Amethyst infrastructure in relation to surrounding aggregate, offshore renewables, and cable activity.



6 Environmental Impacts Identification (ENVID) Summary

Table 6-1 provides details of the potential impacts associated with the preferred decommissioning option as identified in the ENVID. All significant potential impacts have been scoped in for further assessment in section 7.

Table 6-1: Assessment of impacts from the preferred decommissioning option across all Amethyst jackets

Assessment Topic	Project Activity / Event	Physical Receptors				Biological Receptors						Human Receptors										
		Seabed Sediments	Water Quality	Air Quality	Climate	Plankton	Benthic Communities	Fish & Shellfish	Seabirds	Marine Mammals	MPA	Shipping	Commercial Fisheries	Oil & Gas & CCS Activity	Subsea Cables	Renewable Energy Activity	Cultural Heritage	Military Activity	Disposal, Dredging & Aggregate Activity	Seascape	Tourism & Leisure	Population & Human Health
Amethyst Jackets removal																						
Physical presence	Physical presence of vessels	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	A	*	*
Seabed Disturbance	Excavation around the piles/Garnet settlement	A	A	*	*	*	A	A	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	Jacket removal	A	A	*	*	*	A	A	A	*	*	*	*	*	*	*	*	*	*	*	*	*
	Placement of HLJB spudcans, chains and anchors	A	A	*	*	*	A	A	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	Excavation for pipelines cuts	A	A	*	*	*	A	A	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	Mattresses removal	A	A	*	*	*	A	A	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Noise emissions	Use of vessels	*	*	*	*	*	*	A	*	A	*	*	*	*	*	*	*	*	*	*	*	*
	Use of underwater cutting equipment	*	*	*	*	*	*	A	*	A	*	*	*	*	*	*	*	*	*	*	*	*
Marine discharges	Vessel discharges (operational/domestic)	*	A	*	*	A	A	A	A	A	*	*	*	*	*	*	*	*	*	*	*	*
Atmospheric emissions	Use of HLJB	*	*	A	A	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Waste (Hazardous/non-hazardous)	Operational/domestic waste from vessel	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	A
	Decommissioning waste (jackets/risers/Pipeline sections)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Accidental Events	Vessel collision	*	A	A	A	A	A	A	A	A	*	A	A	A	*	*	*	*	*	*	*	A

Key:

(dark blue)	Potential for significant effects	(light blue)	No potential for significant effects	A - Adverse effect	P - Beneficial effect	* - No interaction

7 Environmental & Social Impact Assessment

7.1 Assessment Methodology

7.1.1 Introduction

The method PUK has been used to determine if the project is likely to have any significant effects on the environment is described in this section, and follows EIA good practice guidance [24; 12; 63; 29]. The process commences with the identification of project activities (or aspects) that could impact environmental and socio-economic receptors (i.e., components of the receiving environment), with consideration given to both planned (routine) activities and unplanned (accidental) events. The terms "impact" and "effect" have different definitions in EIA, and one may occur as a result of the other. Impacts are defined as changes to the environment as a direct result of project activities and can be either beneficial or adverse.

Effects are defined as the consequences of those impacts upon receptors. Impacts that could potentially result in significant effects are then subject to detailed assessment based on best available scientific evidence and professional judgement so that, where necessary, measures can be taken to prevent, reduce or offset what might otherwise be significant adverse effects on the environment through design evolution or operational mitigation measures. Residual effects are those that are predicted to remain assuming the successful implementation of the identified mitigation measures and are reviewed by PUK to confirm that the project complies with legal requirements and does not adversely impact the East Offshore Marine Plan policy goals and objectives.

7.1.2 Identification of Impacts

Environmental and social receptors that may be impacted by the project, have been identified in the receptor-based activity and events matrix in Table 6-1. The matrix has been populated by PUK after completion of an ENVID, with reference to the requirements of Article 3(1) of the EIA Directive [24], the OPRED EIA Guidance [7] and relevant OPRED Offshore Strategic Environmental Assessment Reports (2003-2022).

It is noted that the type of impacts which could occur from the project can be categorised as follows:

- **Direct:** resulting from a direct interaction between a planned or unplanned project activity and a receptor;
- **Indirect:** occurring as a consequence of a direct impact and may arise as a result of a complex pathway and be experienced at a later time or spatially removed from the direct impact;
- **In-combination (or Intra-Project):** arising from different activities within the project resulting in several impacts on the same receptor or where different receptors are adversely affected to the detriment of the entire ecosystem;
- **Cumulative (or Inter-Project):** resulting from incremental changes caused by other past, present, or reasonably foreseeable projects/proposals together with the project itself.

The nature, duration, scale, and frequency of the effects resulting from these impacts will vary and are described using the terminology in Table 7-1.

Table 7-1: Categories and definitions of effects

Category	Descriptor	Definition
Nature	Adverse	Unfavourable consequences on receptors.
	Beneficial	Favourable consequences on receptors.
Duration	Short-term	Effects are predicted to last for a few days or weeks.
	Medium-term	Effects are predicted to last for a prolonged period of time, between one and five years.
	Long-term	Effects are predicted to last for a prolonged period of time, greater than 5 years.
	Temporary	Effects are reversible.
	Permanent	Effects are irreversible.
Scale	Local	Effects are limited to the area surrounding the project site or are restricted to a single habitat/biotope or community.
	Regional	Effects occur beyond the local area to the wider region.
	National	Effects occur at a national level (UKCS).
	Transboundary	Effects occur at an international level (outside of the UKCS).
Frequency	One-off	Effects which occur only once.
	Intermittent	Effects that occur on an occasional basis.
	Continuous	Effects that occur continuously.

PUK has undertaken a preliminary assessment of the impacts identified in Table 6-1 to determine whether there is the potential for any significant effects on the environment to occur.

Where it has been identified that a project activity has the potential to result in a likely significant effect on the environment, a detailed assessment of the impact(s) and effect(s) has been undertaken, using the significance criteria defined in Section 7.1.3. The results of the assessment are documented in section 7.2 and 7.2.4. For some project activities, potential impacts have been identified, but none of the resulting effects are likely to be significant. These impacts have therefore been scoped out from detailed assessment.

Despite potential significance, in accordance with OPRED guidance [7], there is no requirement to assess accidental events such as spills from vessels within the EA. This has therefore been scoped out of further assessment.

7.1.3 Evaluation of Impact Significance

This section describes the criteria used for determining the likely significance of effects on the environment and society to ensure the assessment process is as transparent and consistent as possible. Where uncertainty exists, this has been acknowledged in the assessment text.

Planned Activities

For planned activities, the significance of effects has been evaluated by considering the sensitivity of the receptor affected in combination with the magnitude of impact that is likely to arise, having regard to the criteria detailed in Annex III of the EIA Directive, including:

- The magnitude and spatial extent of the impact (geographical area and size of the population likely to be affected);
- The nature of the impact;
- The transboundary nature of the impact;
- The intensity and complexity of the impact;
- The probability of the impact;
- The expected onset, duration, frequency, and reversibility of the impact;
- The accumulation of the impact with the impact of other existing and / or approved projects and / or projects not yet approved, but that PUK is aware of;
- The possibility of effectively reducing the impact.

Sensitivity Criteria

Sensitivity is a function of the value of the receptor (a measure of its importance, rarity and worth), its capacity to accommodate change when a pressure is applied (resistance or tolerance), and its subsequent recoverability (resilience). The criteria presented in Table 7-2 has been used as a guide in this assessment to determine the sensitivity of receptors.

Table 7-2: Determining sensitivity.

		Resistance and Resilience			
		Very High	***High***	***Medium***	***Low***
Value	***Low***	Low	Low	Medium	Medium
	Medium	Low	Medium	Medium	High
	High	Low	Medium	High	Very High
	Very High	Medium	High	Very High	Very High

Definitions:

Resistance and Resilience	
Very High:	Highly adaptive and resilient to pressure. High recoverability in the short-term.
High:	Some tolerance / capacity to accommodate pressure. High recoverability in the medium-term.
Medium:	Limited tolerance / capacity to accommodate pressure. Recoverability is slow and/or costly.
Low:	Very limited or no tolerance / capacity to accommodate pressure. Recovery is unlikely or not possible.
Value	
Very High:	Very high value and/or of international importance.
High:	High value and/or of national importance.
Medium:	Moderate value and/or of regional importance.
Low:	Low value and/or of local importance.

Magnitude of Impact Criteria

The magnitude of impact considers the characteristics of the change that are likely to arise (e.g., a function of the spatial extent, duration, reversibility, and likelihood of occurrence of the impact) and can be adverse or beneficial. Where it is not possible to quantify impacts, a qualitative assessment has been carried out, based on best available scientific evidence and professional judgement. The criteria presented in Table 7-3 has been used as a guide in this assessment to define the magnitude of impact.

Table 7-3: Determining magnitude of impact

Magnitude	Definition
Substantial	Permanent or long-term (>5 years) change in baseline environmental conditions, which is certain to occur. Impact may be one-off, intermittent, or continuous and/or experienced over a very wide area (i.e., transboundary in scale). Impact is likely to result in environmental quality standards or threshold criteria being routinely exceeded.
Major	Medium to long-term (1 – 5 years), reversible change in baseline environmental conditions, which is likely to occur. Impact may be one-off, intermittent, or continuous and/or experienced over a wide area (i.e., national in scale). Impact could result in one-off exceedance of environmental quality standards or threshold criteria.
Moderate	Short to medium-term (< 1 year), temporary change in baseline environmental conditions, which is likely to occur. Impact may be one-off, intermittent, or continuous and/or regional in scale (i.e., beyond the area surrounding the Project site to the wider region).

Magnitude	Definition
	Impact is unlikely to result in exceedance of environmental quality standards or threshold criteria.
Minor	Short-term (a few days to weeks), temporary change in baseline environmental conditions, which could possibly occur. Impact may be one-off, intermittent and/or localised in scale, limited to the area surrounding the proposed Project site. Impact would not result in exceedance of environmental quality standards or threshold criteria.
Negligible	Immeasurable or undetectable changes (i.e., within the range of normal natural variation).

Significance of Effect

For planned activities, the overall significance of an effect has been determined by cross referencing the sensitivity of the receptor with the magnitude of impact, using the matrix shown in Table 7-4.

In the context of this assessment, effects classed as **Major** or **Moderate** are considered to be "significant" in EIA terms and therefore mitigation measures are required to be identified in order to prevent, reduce, or offset adverse significant effects or enhance beneficial effects. The overall significance of the effect is then re-evaluated, taking the mitigation measures into consideration, to determine the residual effect utilising the methodology outlined above.

Effects classed as **Minor** are not considered to be significant and are usually controlled through good industry practice.

Effects classed as **Negligible** are also not considered to be significant.

Table 7-4: Significance Evaluation Matrix (Planned Activities)

		Magnitude of Impact				
		Negligible	Minor	Moderate	Major	Substantial
Receptor Sensitivity	Low	Negligible	Minor	Minor	Minor	Minor / Moderate note1
	Medium	Negligible	Minor	Minor	Moderate	Moderate / Major[1]
	High	Negligible	Minor	Moderate	Major	Major
	Very High	Negligible	Minor / Moderate[1]	Moderate / Major[1]	Major	Major

Note 1 The choice of significance level is based upon professional judgement and has been justified in the assessment text in section 7.2.

Unplanned Events

In accordance with OPRED guidance [7], there is no requirement to assess accidental events such as spills from vessels within the EA. This has therefore been scoped out of further assessment.

7.2 Insignificant Impacts

With regards to the aspects presented in Table 6-1 following the methodology outlined above, the aspects for which PUK consider there to be minimal or non-significant impact and therefore have been screened out from further detailed assessment within this EA report are described below.

7.2.1 Energy And Emissions

Although the project will produce atmospheric emissions and consume energy, these activities are required to be undertaken to meet decommissioning obligations for the infrastructure.

Decommissioning activities are anticipated to be completed within 10 days for all pipeline and powerline cuts using a single MSV, and 16 days for each Amethyst jacket by using a single HLJB. The preferred option has been considered with a focus on minimising vessel time and therefore minimising any associated emissions. The pipeline cutting campaign will be planned in conjunction with other nearby assets operations.

An assessment of air emissions associated with the jackets removal is presented in Appendix 1. These air emission contributions are far below any thresholds for emissions in the UKCS or on a global scale and are not significantly larger than general vessel operations in the region, resulting in negligible emissions. Future legacy survey will be related to Amethyst pipelines which will be determined and agreed with OPRED in a separated DP.

Although there will be a short term and localised increase in emissions from the proposed operations, the total emissions will contribute in an extremely small percentage to the offshore and UK total Carbon dioxide equivalent (CO_2e) emissions.

Sensitivity: High

Magnitude: Negligible

Significance: Negligible

Best practices will be employed to minimise this environmental footprint. This includes optimal pipeline cutting and jacket removal operations, planning and procurement of vessels which operate effective EMS minimising their emissions.

As a result, no further assessment is required.

7.2.2 Waste Generation

All waste generated from decommissioning activities (which will be limited to the jackets, Amethyst and Helvellyn risers, pipeline/powerline cut sections, limited mattresses and vessel derived waste from the HLJB and MSV), will be handled, and recovered or disposed of in line with existing waste management legislation following the principles of the waste hierarchy.

Cleaning, break up and recycling is considered the current most likely removal methodology for Amethyst jackets and risers. Raw materials will be returned to shore with the expectation to recycle the majority of the returned non-hazardous material.

Other non-hazardous waste which cannot be reused or recycled will be disposed of to a landfill site. Hazardous waste will be disposed of in accordance with established waste legislation. Only licensed contractors will be used for waste handling and treatment/disposal.

No Naturally Occurring Radioactive Material (NORM) was detected when the risers were previously cut. Therefore, NORM waste it is not expected during the jackets and riser removal campaign.

An assessment of waste associated with the jackets removal and pipeline cutting campaign is presented in Table 7-5 and Table 7-6 respectively.

Table 7-5: Amethyst jackets waste inventory

Asset	Weight (te)[Note 1]	Steel (te)	Concrete (te)	Others (te)
A1D	2285	2197	11	11
A2D	2098.67	2015	10	10
B1D	1711	1645	9	9
C1D	1938	1864	10	10
Total	**8029**	**7721**	**40**	**40**
Destination		Recycling or re-use	Re-use or landfill	Landfill

Note 1: Includes jackets, risers, umbilical and marine growth weight

Table 7-6: Amethyst pipelines and risers waste inventory

Asset	Installation	Number	Material composition (te)				
			Weight	Steel	Concrete	Plastic	Others
A1D	Pipelines	4 x 1m section	0.72	0.29	0.41	-	0.02
	Powerlines	3 x 1m section	0.02	0.02	-	<0.00	-
A2D	Pipelines*	4 x 1m section 1x10m section	1.77	0.73	0.98	-	0.05
	Powerline	2 x 1m section	0.01	0.01	-	0.00	-
	Mattresses	2 (10m cover)**	23.52	-	23.52	-	-
B1D	Pipelines	2 x 1m section	0.15	0.07	0.07	-	<0.00
	Powerlines	1 x 1m section	0.01	0.01	-	<0.00	-
C1D	Pipelines	2 x 1m section	0.17	0.09	0.08	-	<0.00
	Powerlines	1 x 1m section	0.01	0.01	-	<0.00	-
		Total:	**2.859**	**1.229**	**1.54**	**0**	**0.07**
Destination				Recycling	Re-use or landfill	Recycling or landfill	Landfill

* Umbilical weight included within the Helvellyn pipeline.

**Assumption Mattresses weight per unit 11.76te, as per Amethyst Design Fabrication & Installation Resume [55].

Sensitivity: Medium

Magnitude: Negligible

Significance: Negligible

As a result, no further assessment is required

7.2.3 Physical Presence of Vessels in Relation to Other Sea Users

The requirement to deploy vessels to the area for the preferred decommissioning option will be limited to a single HLJB placed alongside each jacket installation and a single MSV for the pipeline and powerline cutting operations. Jacket removal and pipeline/powerline cutting campaigns will be conducted at separated times, so there will be no in-combination impact from both operations.

The project area has a high to very high amount of shipping activity within it. However, this will not be significantly increased due to project activity.

Cutting operations will be conducted by a dynamically positioned MSV located within the Amethyst jackets 500m exclusion zones. Similarly, during jacket removal the HLJB will be positioned within the existing 500m exclusion zones around each jacket avoiding the interaction with other sea users. It is assumed that the HLJB will be at each jacket for approximately 10 days, and all Amethyst subsea cuts will be performed in 9.5 days.

No impacts are anticipated for the transportation of the decommissioning assets to shore via HLJB. Instead, the impacts of this presence will be managed via standard maritime navigational rules.

Sensitivity: Medium

Magnitude: Negligible

Significance: Negligible

The MSV and HLJB will be positioned within the existing 500m exclusion zones only. Vessel traffic and activity will be managed by the issuing of kingfisher notice to mariners and vessel operated AIS.

As a result, no further assessment is required.

7.2.4 Operational Discharges to Sea

Vessel based discharges will be limited to those generally associated with MSV and HLJB operations and controlled via established methods under the International Convention for the Prevention of Pollution from Ships. Approved contractor procedures will assess and minimise vessel-based discharges.

Prior to lifting the Amethyst jacket from the seabed, pipeline cutting operations will be performed at the bottom of all Amethyst pipeline risers, allowing the internal pipeline fluids to enter the open sea. All Amethyst and Helvellyn pipelines have been flushed clean to a standard agreed upon with OPRED, rendered HCS and remain attached to the jackets. The infield pipelines PL 775, PL 776, PL 777 and PL 778 have been filed with sea water. PL 649 and PL 650 have been filled with filtered seawater with an additional preservation chemical.

Any potential residual hydrocarbon and chemical volumes that may escape to sea during pipeline cutting operations are expected to be minimal and will be considered under the individual permit consent applications for the decommissioning activities through the Portal Environmental Tracking System.

Sensitivity: Medium

Magnitude: Negligible

Significance: Negligible

Potential residual volumes discharged to sea during cutting operations will be assessed and permitted under an Oil Pollution Prevention and Control and Chemical permit applied for via the UK energy portal.

Vessel based discharges will be limited to those generally associated with the decommissioning vessel controlled via established methods under (Convention on Marine Pollution). Approved contractor procedures will assess and minimise vessel-based discharges.

As a result, no further assessment is required.

7.2.5 Noise Emissions

Noise emissions associated with the preferred decommissioning option are those generated from underwater cutting activities (pipelines, risers and jacket piles), operation of the MSV, HLJB and any potential ROV.

Underwater cutting will be performed on two cuts per pipeline and powerline using hydraulic shears or a diamond wire saw, totalling a maximum of 38 subsea cuts. Additionally, each Amathyst jacket pile will be cut approximately 3m below the seabed level using internal abrasive cutting at each platform location. In total, 18 underwater cuts are expected on A1D, 20 at A2D, 14 at B1D and 10 at C1D during decommissioning activities (Table 7-7).

Table 7-7: Number of subsea cuts as a result of Amethyst decommissioning activities

Subsea infrastructure	Number of subsea cuts*			
	A1D	A2D	B1D	C1D
Pipelines	(4) 8	(5) 10	(2) 4	(2) 4
Powerlines	(3) 6	(2) 4	(1) 2	(1) 2
Umbilical	-	(1) 2	-	-
Jacket piles	(4) 4	(4) 4	(8) 8	(4) 4
TOTAL	**18**	**20**	**14**	**10**

** Number in brackets indicates the number of subsea items to be cut (pipelines, powerlines, umbilical or piles)*

Previous decommissioning activities conducted by PUK using similar cutting methods have indicated that associated noise levels from these operations fall far below those which may be considered significant in their potential to impact on fish or marine mammals.

The operation of two vessel independently and ROV equipment within all the Amethyst 500m exclusion zone areas, classed as having high to very high shipping density is not expected to add any significant noise to the surrounding area.

Sensitivity: Medium

Magnitude: Minor

Significance: Minor

Effective operational planning will minimise vessel time in the area. Cutting activities will be planned and carried out efficiently to prevent excessive noise generation.

Any required surveys will be scheduled and planned efficiently to minimise vessel operation time. If required, geotechnical survey equipment will be selected based on the lowest sound volume capable to achieving required survey results. Standard mitigations for minimising impacts on marine mammals will be employed where required.

As a result, no further assessment is required.

7.2.6 Seabirds

The proposed decommissioning activities could disrupt seabirds if they are present or nesting during the removal of the remaining Amethyst jackets.

There are numerous records of seabirds using both manned and unmanned offshore structures, indicating they are generally undisturbed by most offshore operations. Instead, seabirds are drawn to these areas, as they offer some form of benefits to the individuals such as roosting sites and increased access to feeding grounds.

In 2024, Amethyst A1D, A2D, B1D and C1D jackets were boat-based surveyed to assess the extent of birds (or evidence thereof) and potential nest locations, to confirm the presence/absence of nests, or birds displaying nesting behaviour on the jackets [53]. No nesting birds were observed during the surveys conducted across all the Amethyst jackets, and only two Herring Gulls were observed on C1D jacket showing attempts of copulation.

Decommissioning activities for Amethyst are expected to begin in Q2-Q3 of 2025. Where feasible, PUK plans to avoid the nesting seasons when removing the jackets. Despite no evidence of nesting activity in 2024, a further assessment on the presence of nesting will be carried out prior to the works starting. Should any nesting be observed, decommissioning options will be discussed with OPRED.

Sensitivity: High

Magnitude: Minor

Significance: Minor

As a result of 2024 survey, no impacts from the proposed jacket decommissioning activities are anticipated for any nesting seabirds on Amethyst jackets. Should nesting birds be identified on the platform during the breeding season PUK will assess ongoing activities to determine the potential for disturbance.

As a result, no further assessment is required.

7.3 Assessment of Potentially Significant Impacts

7.3.1 Seabed Disturbance

7.3.1.1 Source of Potential Impacts

The Amethyst Jackets and Helvellyn riser decommissioning option will require activities that interact with the seabed which may result in either short-term or long-term disturbance to the seabed sediments and marine organisms. The extent of any disturbance, combined with the seabed type and hydrodynamic conditions during the activities, will determine the burial and smothering from suspended sediments and any indirect impact to species or habitats.

The proposed decommissioning activities at each jacket location will directly impact the seabed and benthic fauna living in and on the sediments in the following ways:

- Excavation of seabed for pipelines, powerlines and umbilical cutting operations;
- Jacket pile cutting, including Excavation of soil plug from pile annulus and complete pile cuts;
- HLJB placement: HLJB spudcans, chains and anchors;
- Removal of jackets and attached risers;
- Indirect disturbance through re-suspension and deposition of seabed sediments.

Physical impact

The principal sources of potential seabed impact from the selected decommissioning option is the positioning of the HLJB at each jacket location and the seabed excavation for pipeline/powerline cutting and mattresses lifting operations. Table 7-8 describes the expected environmental seabed impact duration from Amethyst decommissioning operations activities. Overall seabed impact area is summarised in Table 7-12.

Table 7-12

Table 7-8: Summary of seabed impacts from the proposed decommissioning option

Decommissioning activities	Impact Duration			
	Suspended sediments	Release of contaminants	Burial and smothering	Change in habitat
Pipeline, powerline, umbilical cutting	Short-term	Limited	Short-term	Short-term
Mattresses displacement	Short-term	Limited	Short-term	Short-term
Jacket pile cuttings	Short-term	Limited	Short-term	Short-term
Jacket removal	Short-term	Limited	Short-term	Short-term
HLJB spudcans	Short-term	Limited	Short-term	Short-term
HLJB anchors	Short-term	Limited	Short-term	Short-term

- **Pipeline cutting campaign**

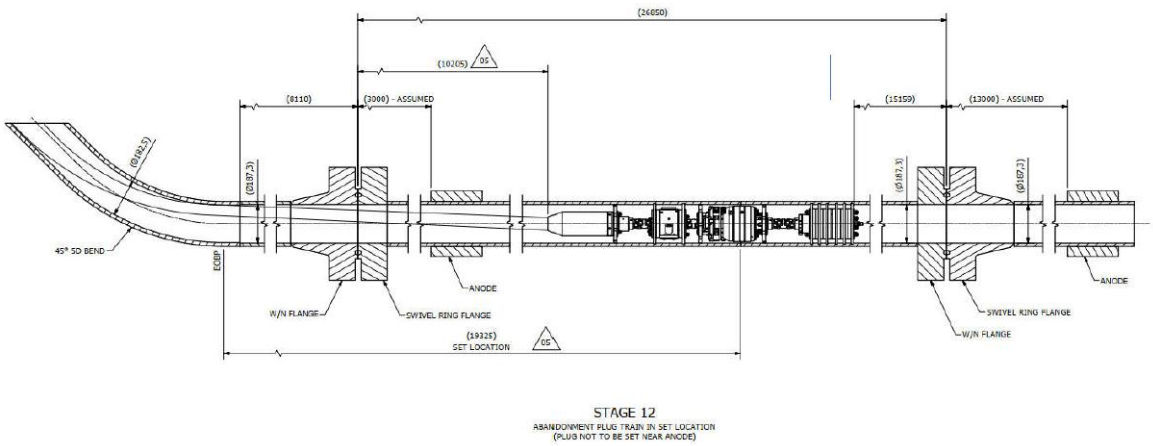
The Amethyst jackets decommissioning will begin by isolating the jackets and risers from the subsea infrastructure currently attached. This operation will be carried out by performing 38 subsea cuts at the base of the riser on all the subsea pipelines, powerlines and umbilical, using a hydraulic shear or diamond wire saw. It is expected that MSV Kingsborg will be the operative vessel for these activities, with no requirement for the use of anchors.

Two subsea cuts will be executed for each pipeline (PL 649, PL 650, PL 775, PL 776, PL 777, and PL 778) powerlines (PL 4997, PL 6399, PL 6400, and PL 6401) to enabling the removal of a 1m section to the vessel and physical separation from the jackets.

It is anticipated that a de-burial of the Amethyst subsea installation will be required to gain access and safely execute the proposed cuts. Equipment, such as Mass Flow Excavation, will be used to clear the seabed, consequently disturbing the seabed. For each subsea cut, seabed clearance of 1m on either side of the two cuts, 1m wide along the infrastructure being removed, and 1m in depth will be sufficient to expose the infrastructure, resulting in a worst case total seabed impact of 3m^3 for each removed section.

With the same cutting methodology explained above, the Helvellyn 8" gas export (PL 1956) and umbilical (PL 1957) will be cut to enable lifting of the A2D jacket. To do so, an abandoned STATS Plug located inside of PL 1956 is expected to be recovered as a part of this decommissioning campaign. It is assumed a maximum length of 10m of the spool piece section will need to be cut and recovered (Figure 7-1).

Figure 7-1: Location of STATS PLUG in Helvellyn pipeline



As represented in Figure 7-2, the Helvellyn line is protected by a series of concrete mattresses, potentially fully or partially buried under the seabed. Consequently, some of these mattresses will need to be moved prior to pipeline cutting. These matrasses will be moved back to their original location once the cutting operation is complete.

While the specific types of mattresses used at Helvellyn are unknown, it is anticipated that they consist of a combination of Seamark flexiweight mattresses and Seamark massive mesh mattresses, with a maximum width of 4 meters, similar to those used at Amethyst.

Considering the maximum length of PL 1957 cut and the width of the concrete mattresses, the worst case total seabed impact resulting from moving and repositioning the concrete mattresses prior to the cutting of PL 1957 is 40m^3 (assuming seabed penetration depth of 0.5m).

Similarly, the seabed impact resulting from the final de-burial and cutting of Helvellyn line is calculated to be 11m^3 for the pipeline and 3m^3 for the umbilical.

A summary of total seabed impact resulting from the Amethyst pipeline cutting campaign is represented in Table 7-9.

Figure 7-2: A2D jacket approach

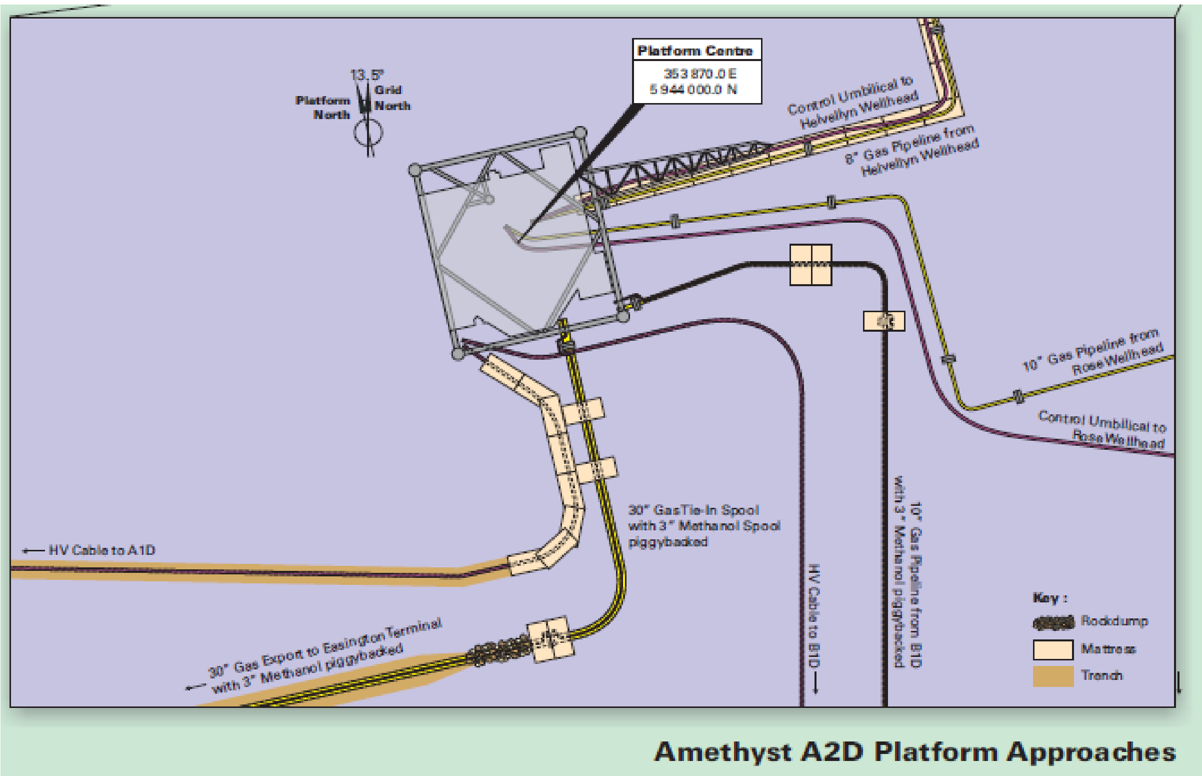


Table 7-9: Summary of seabed impact resulting from the Amethyst pipeline/powerline cutting campaign

Subsea infrastructure	Seabed Impact (m^3)			
	A1D	A2D	B1D	C1D
Pipelines	6	17	3	3
Powerlines	9	6	3	3
Umbilical	-	3	-	-
Mattresses	-	40	-	-
TOTAL	**15**	**66**	**6**	**6**

- **Jacket removal campaign**

The HLJB will be used within each of the four Amethyst 500m exclusion zones by the positioning of six legs terminating in a spudcan on the seabed each with an area of 84m^2 and a penetration of 3.8m. For the decommissioning of each Amathyst jacket, the maximum seabed impact by the six spudcans of the HLJB is predicted in 1915.2m^3. It is anticipated that the deposit of stabilisation material can be avoided with additional preloading of the HLJB during the jacking down procedure.

Prior to the legs of the HLJB being installed on the seabed, four anchors will be used to assist in the final positioning of the HLJB. The placement of anchors for positioning will occur once the HLJB has entered the 500m exclusion zone. Each of the four anchors has an estimated disturbance area of 9m^2 and the anchor chains / mooring lines have a length of up to 900m, of which 500m will be deployed and 250m of chain will be laid on the seabed with a lateral movement of two metres. The estimated seabed disturbance from the anchor chains is therefore 2,000m^2 to a depth of 1m (2000m^3). Details of total seabed disturbance from the positioning of the HLJB at each jacket location are presented in Table 7-11.

The A1D, A2D and C1D jackets have four piles each (one in each leg) and B1D has a total of eight piles (2 per leg). Piles will be cut to 3m below the seabed by internal abrasive cutting. The cutting head will use an abrasive cutting stream (garnet and water mix used at high pressure) to sever the piles. The garnet will be deposited in the vicinity of the cutting operations causing localised seabed disturbance. The maximum garnet discharge expected from the abrasive cutting would be 5800kg for each pile, resulting in 1.41m^2 seabed disturbance for each pile.

It is anticipated that up to 5800kg of garnet (1.41m^3) will be required to sever each piles of each jacket. Consequently, a total of 116,000kg (28.02m^3), in a worst-case scenario, could be deposited on the seabed, accounting for the 20 piles present in total for the Amethyst jackets. It is assumed that the area of seabed sediment disturbed will be equal to the volume of garnet discharged (maximum disturbance depth assumed to be 1m).

In addition, seabed sediments may also be mobilised as the jackets are lifted out of the seabed. It is assumed, as a conservative estimate, that seabed sediments may be disturbed to a diameter of approximately 2m (1372mm leg ED) around each of the legs and to a depth of three metres. This equates to a total sediment volume of 63.52m^3 that could be disturbed at each leg (total of 1,016.32m^3 for all four Amethyst jackets).

In total, up to 1,044.34m^3 of seabed disturbance may occur from pile cutting (garnet discharge) and lifting operations at the Amethyst jackets (Table 7-10).

Table 7-10: Proposed jacket removal seabed impact for all Amethyst jackets

Disturbance Source	Total number of legs	Garnet discharged (kg)note 1	Area of seabed impact (m^3)
Pile cutting x20 (A1D, B1D, A2D, C1D)	N/A	116000	28.02
Jacket and risers removal x4 (A1D, B1D, A2D, C1D)	16	N/A	1,016.32
Total (A1D, A2D, C1D, B2D)	**-**	**-**	**1,044.34**

Note 1: Garnet density = 4,100 kg/m^3Note 2: Impact from excavation around each pile for external cutting if requires is assumed to be within the same footprint as discharged garnet.

Table 7-11: Proposed HLJB placement and associated seabed impact per jacket

Disturbance Source	Area of seabed impact (m^3)
Spudcan x 6	1915.2
Anchors x 4	36
Anchor Chain Laydown (250m with lateral movement of 2m) x 4	2000
Total impact per jacket	**3951.2**
Total impact decommissioning (A1D, A2D, C1D, B2D)	**15804.8**

Table 7-12: Summary of the overall potential seabed impact for Amethyst jackets decommissioning

Seabed impact activities	Total area (m^2)	Depth (m)	Total volume (m^3)
Pipeline, powerline, umbilical cutting and mattresses displacement	93	1	**93**
Jacket pile cuttings	28.02	n/a	**28.02**
Jacket/ risers removal	50.24	3	**1,016.32**
HLJB spudcans	2016	3.8	**7,660.8**
HLJB anchors	144	1	**144**
HLJB anchors chains	8000	1	**8,000**
		Total Seabed impact	**16,942.14**

Indirect disturbance may occur through re-suspension and deposition of seabed sediments; however, it is likely to be temporary and short term in all instances. Considering the small area of the seabed affected by the decommissioning activities, the resuspension of sediments is not predicted to exceed levels of natural variability. Overall, it is expected that these effects will be limited and occur within close proximity to the disturbance footprint.

It is anticipated that any impacted seabed would be recolonised by benthic fauna typical of the area as a result of natural settlement by larvae and plankton and through the migration of motile animals from adjacent undisturbed benthic communities [17]. Recovery times for soft sediment faunal communities are difficult to predict, although studies have attempted to quantify timescales. The Minerals Management Service quote various sources and report that recolonisation takes 1-3 years in areas of strong currents but up to 5-10 years in areas of low current velocity [43]. Longer recovery times are reported for sands and gravels where an initial recovery phase in the first 12 months is followed by a period of several years before pre-activity population structure is attained.

Mobilisation of contaminants

EBS completed pre-decommissioning indicate a low level of contaminants in the seabed adjacent to the previous platform locations and along the pipeline routes (see section 5.2.3). The potential level for the mobilisation of contaminants is similar to that of seabed disturbance, where it is the physical disturbance of the seabed which may mobilise embedded contaminants. As seabed disturbance for the selected method is relatively low both in spatial extent and frequency, the potential for the mobilisation of contaminants is also expected to be low. Therefore, the proposed decommissioning method is unlikely to lead to the mobilisation of significant levels of contaminants into the water column.

Seabed clearance

Following approval of the Amethyst installation jackets and Helvellyn riser DP, the 500m exclusion zones will remain active until a dedicated DP for the Amethyst pipelines is completed and pipelines and stabilisation material are decommissioned. As a result, seabed clearance activities within the platform 500m zones are not expected at this decommissioning stage, and therefore, no seabed disturbance from seabed clearance activities are expected at this stage.

Based on the information presented above, the proposed decommissioning activities for Amethyst jackets and risers will cause some seabed impact. However, this will be temporary and over a very limited area and is not expected to cause any significant impacts on the wider area or to protected species/habitat.

7.3.1.2 Effects on Sensitive Receptors

The Amethyst field does not fall within any designated environmental conservation area, as represented in Figure 5-18.

Published data sources and data from previous surveys indicates that the seabed habitat across A1D, A2D, B1D and C1D jacket locations is dominated by Circalittoral coarse sediment (A5.14) and Circalittoral mixed sediment (A5.44).

The habitat A5.14 may be characterised by robust infaunal polychaetes, mobile crustacea and bivalves, as with shallower coarse sediments. Certain species of sea cucumber (e.g. *Neopentadactyla*) may also be prevalent in these areas along with the lancelet *Branchiostoma lanceolatum*.

There is the variable nature of the seabed in A5.44 habitat, which could develop into a variety of diverse communities. A wide range of infaunal polychaetes, bivalves, echinoderms, and burrowing anemones such as *Cerianthus lloydii* are often present in such habitat and the presence of hard substrata (shells and stones) on the surface enables epifaunal species to become established, particularly hydroids such as Nemertesia Species (spp) and *Hydrallmania falcata*.

A number of potential sensitive habitats and species are known to occur in the wider region of the SNS. However, little evidence of these were seen in the Amethyst Interfield survey or platform areas. The ross worm *Sabellaria spinulosa* was found within several seabed samples, albeit in relatively low abundances; typical reef structures which form Annex I habitats require large communities that were not observed in any of the surveyed areas. Furthermore, no evidence of ross worm reefs were seen on underwater video footage or MBES bathymetry/backscatter datasets.

7.3.1.3 Cumulative and Transboundary Impacts

The closest transboundary line (UK / Netherlands) is located approximately 157km E of the Amethyst B1D 500m exclusion zone, as such it is assumed that the potential for transboundary impacts will be nil. While there is the potential for finer sediments to remain in suspension for longer after seabed disturbance activities and potentially travel further from the working area before settling, this is not expected to be significant.

As part of the EIA process, the potential impacts of the proposed project must be considered in conjunction with other proposed or ongoing projects or plans.

The Amethyst field is situated in an area of high oil and gas and shipping activity. At the time of writing, no other significant oil & gas activity (decommissioning, drilling) is taking place within UKCS Blocks 47/14, 47/15, and surrounding areas. Construction of the nearby Triton Knoll offshore wind farm was completed in 2022.

The Humber 4 aggregates area is located within close proximity to the Amethyst C1D 500m exclusion zone. The impact of suspended sediments from aggregate extraction was considered in the OSEA4 report [8], with conflicting findings. Newell et al. [45] concluded that there was little evidence that suspended sediments from aggregate dredging had any significant impact on the seabed outside of the immediate area, while Desprez et al. [19] suggests that the impact on benthic fauna may extend up to 2km. This included reductions in species diversity and abundance [8].

The disturbance of seabed over Amethyst jackets infrastructure has the potential to temporarily suspend sediments in the local area. However, this impact will be reduced in surface, localised, and short term, with no lasting impact on the water column or nearby sediments.

7.3.1.4 Mitigation Measures

The following mitigation measures will be employed to further reduce any impacts from seabed disturbance associated with the decommissioning option:

- Proposed internal pile cuts will be carefully planned to avoid excessive seabed disturbance and prevent deposition of garnet.
- Preference of vessels with use of dynamic positioning instead of anchors;
- Avoid the usage of stabilisation material on spudcans with efficient jack down procedure;

- Optimal de-burial technology reducing seabed impact footprint.

7.3.1.5 Residual Impact

Localised seabed impact will occur as a result of the proposed decommissioning activities. The extent of this impact will be managed to be as low as reasonably possible.

Considering the above assessment and mitigation measures, it has been determined that the decommissioning of the Amethyst jackets and associated risers is unlikely to pose a significant hazard to other users of the area or a significant impact on local ecology.

8 Assessment Conclusions

Following detailed review of the proposed decommissioning option, the environmental sensitivities present in the area and potential impacts the environment it has been determined that the decommissioning of the A1D, A2D, B1D and C1D Amethyst jackets and associated risers by removal will not present any significant impacts.

The impacts associated with the decommissioning option are well understood and managed through the implementation of established mitigation measures. The impacts with potential to be significant was associated with seabed disturbance. However, following further assessment, these have been determined not to be significant following the implementation of the stated mitigation measures. Overall, the decommissioning option presented within this report is determined as not having a significant impact.

In addition, this EA is considered by PUK to be in alignment with the objectives and marine planning policies of the East marine plan area.

Based on the assessment findings of this EA, including the identification and subsequent application of appropriate mitigation measures it is considered that the proposed decommissioning activities do not pose any significant impact to environmental or societal receptors within the UKCS or internationally.

9 Environmental Management

This section describes the arrangements that will be put into place to ensure that the mitigation and other measures of control, including the reduction or elimination of potential impacts are implemented and conducted effectively. This section also serves to outline the key elements of relevant corporate policies and the means by which PUK will manage the environmental aspects of the Amethyst pipelines and powerlines decommissioning operations.

9.1 Introduction

PUK hold ISO 14001 standard certification. Additionally, PUK operate under a SEMS, which forms part of the PUK Operating Management System (POMS). The POMS provide the framework for PUK to achieve safe and reliable operations day-in and day-out and ensures compliance with PUK's HSSE Policy.

In addition to enabling the implementation of identified mitigation and control measures, the SEMS provides the means to monitor the effectiveness of these measures through check and environmental performance. The SEMS, by design, will enable PUK to control activities and operations with a potential environmental impact and provide the assurance on the effectiveness of the environmental management.

9.2 Scope of the SEMS

The SEMS provides the framework for the management of Health, safety and Environmental (HSE) issues within the business. This SEMS is intended for application to all of PUK's activities as directed under the OSPAR recommendation 2003/5, promoting the design, use and implementation of EMS by the Offshore Industry. PUK, as a business, is centred on oil and gas exploration activities both onshore and offshore, with the offshore components of their business including seismic and drilling operations. As a relatively small operator PUK intend to resource such projects through the utilisation of contractors, should these not be available within the business itself.

The SEMS focuses on:

- Clear assignment of responsibilities;
- Excellence in HSE performance;
- Sound risk management and decision making;
- Efficient and cost-effective planning and operations;
- Legal compliance throughout all operations;
- A systematic approach to HSE critical business activities; and
- Continual improvement.

9.3 Principle of the SEMS

The following sub-sections describe the principles followed though the utilisation of the SEMS.

9.3.1 Improvement Programmes and the Management of Change

The purpose of employing an improvement programme is to:

- Ensure the continuous development of the PUK policy commitment.

- Introduce changes and innovations that ensure the achievement of performance standards where current performance is below expectations.

The SEMS also makes provision for the management of change. Changes may occur for a number of reasons, and at a number of levels. A 'management of change' procedure specifies the circumstances under which formal control of change is required to ensure that significant impacts remain under control and/or new impacts are identified, evaluated, and controlled.

9.3.2 Roles and Responsibilities

PUK will review existing environmental roles and responsibilities for staff participating in the Amethyst DP. These will be amended and recorded in individual job descriptions to ensure that they take into account any changes required for the management of the impacts identified in this EA.

9.3.3 Training and Competence

The competence of staff with environmental responsibilities is a critical means of control. The SEMS, in conjunction with the Human Resources department of PUK allows for the appointment of suitably competent staff. The development and implementation of training programmes facilitates understanding and efficient application.

9.3.4 Communication

Internal environmental communication generally employs existing channels such as management meetings, minutes, poster displays, etc. External communication with stakeholders and interested parties is controlled through a communication programme. This establishes links between each stakeholder, the issues that are of concern to them, and the information they require to assure them that their concerns and expectations are being addressed. This EA and the consultation process that informed its production will be used to design the ongoing communication programme. Communication and reporting will employ information derived from the monitoring programme.

9.3.5 Document Control

The control of the SEMS documents is managed in the PUK Document Control System.

9.3.6 Records

Records provide the evidence of conformance with the requirements of the SEMS and of the achievement of the objectives and targets in improvement programmes. The PUK SEMS specifies those records that are to be generated for these purposes, and controls their creation, storage, access, and retention.

9.3.7 Monitoring and Audit

Checking techniques employed within PUK's SEMS are a combination of monitoring, inspection activities and periodic audits.

The requirement for monitoring and inspection stems from the need to provide information to a number of different stakeholders, but primarily regulators, and PUK management. As such, there is a requirement for the results of monitoring and inspection to be integrated with the PUK internal and external communication programme.

Monitoring and inspection activities focus on:

- Checks that process parameters remain within design boundaries (process monitoring);
- Checks that emissions and discharges remain within specified performance standards – (emissions monitoring); and
- Checks that the impacts of emissions and discharges are within acceptable limits (ambient monitoring).

9.3.8 Incident Reporting and Investigation

The PUK SEMS stipulates documented procedures to control the reporting and investigation of incidents.

9.3.9 Non-confidence and Corrective Action

The checking techniques outlined above are the means of detecting error or non-conformances. PUK's SEMS includes procedures for the formal recording and reporting of detected non-conformance, the definition of appropriate corrective action, the allocation of responsibilities and monitoring of close out.

9.3.10 Review

PUK's SEMS includes arrangements for management review. This provides the means to ensure that the SEMS remains an effective tool to control the environmental impacts of operations, and to re-configure the SEMS in the light of internal or external change affecting the scope or significance of the impacts. Of particular importance is the role management review plays in the definition and implementation of the improvement programme, and the management of change.

10 References

1. ABP Marine Environmental Research - Annual Mean Significant Wave Height (m). https://marine.gov.scot/maps/424 [Accessed September 2023]
2. ABP Marine Environmental Research - Mean Spring Tidal Range (m). https://marine.gov.scot/node/12611. Accessed September 2023]
3. Anatec (2016). Navigational Risk Assessment Amethyst field decommissioning. A4524-PER-NRA-1
4. Benthic Solutions limited Amethyst Interfield: Pre-decommissioning Habitat Assessment - 2010_AMS-INT_HAS_00
5. Benthic solutions limited Amethyst Interfield: Pre-decommissioning Environmental Baseline Survey - 2010_AMS-INT_EBS_00
6. OPRED (2016). UK Offshore Energy Strategic Environmental Assessment 3 (OESEA3). Available from https://www.gov.uk/government/consultations/uk-offshore-energy-strategic-environmental-assessment-3-oesea3 [Accessed July 2023].
7. OPRED (2018). Guidance notes - Decommissioning of Offshore Oil and Gas Installations and Pipelines.
8. OPRED (2022) UK Offshore Energy Strategic Environmental Assessment (OSHEA4).
9. CAL-013b Amethyst Jackets Emissions Assessment, Rev 1.
10. Connor, D.W., Allen, J,H., Golding, N., Howell, K,L., Lieberknecht, L.M., Northern, K,O., Reker, J,B. (2004). The marine habitat classification for Britain and Ireland Version 04.05. JNCC.
11. Chester, R. and Voutsinou, F.G. (1981). The initial assessment of trace metal pollution in coastal sediments. Marine Pollution Bulletin. Volume 12, Issue 3, March 1981, Pages 84-91.
12. CIEEM (2018). Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine. Chartered Institute of Ecology and Environmental Management, Winchester.
13. Coull, K.A., Johnstone, R., and S.I. Rogers. (1998). Fisheries Sensitivity Maps in British Waters. Published and distributed by UKOOA Ltd.
14. Coulson, J.C. (2011) The Kittiwake. T & A D Poyser
15. Crown Estate (2021) The Crown Estate Offshore Activity Map. https://opendata-thecrownestate.opendata.arcgis.com/ [Accessed September 2023].
16. BSL, 2019. Pickerill A - Pre-decommissioning Survey - Environmental Baseline Survey Report.
17. Dernie, K.M., Kaiser, M.J. and Warwick, R.M. (2003). Recovery rates of benthic communities following physical disturbance. Journal of Animal Ecology 72(6):1043-1056
18. DECC (2016). UK Offshore Energy Strategic Environmental Assessment 3 (OESEA3). Available from https://www.gov.uk/government/consultations/uk-offshore-energy-strategic-environmental-assessment-3-oesea3 [Accessed September 2020].
19. Desprez M, Pearce B, & Le Bot S (2010). The biological impact of overflowing sands around a marine aggregate extraction site: Dieppe (eastern English Channel). ICES Journal of Marine Science 67: 270-277.
20. Dobson, M. and Frid, C. (1998). Ecology of aquatic systems, Addison Wesley Longman Ltd.

21. Ellis, J. R., Milligan, S. P., Readdy, L., Taylor, N. & Brown, M .J. (2012). Spawning and nursery grounds of selected fish species in UK waters, CEFAS, Science Series, Technical Report no. 147, Available at: https://www.cefas.co.uk/publications/techrep/TechRep147.pdf [Accessed August 2023].

22. Energinet (Viking Link (2017) Volume 2: UK Offshore Environmental Statement

23. Environment Agency (EA), 2010. Waste and Resources Assessment Tool for the Environment Life Cycle Analysis model.

24. European Commission (2017). Environmental Impact Assessment of Projects Guidance on the Preparation of the Environmental Impact Assessment Report (Directive 2011/92/EU as amended by 2014/52/EU). European Union.

25. Gilles, A, Authier, M, Ramirez-Martinez, NC, Araújo, H, Blanchard, A, Carlström, J, Eira, C, Dorémus, G, Fernández- Maldonado, C, Geelhoed, SCV, Kyhn, L, Laran, S, Nachtsheim, D, Panigada, S, Pigeault, R, Sequeira, M, Sveegaard, S, Taylor, NL, Owen, K, Saavedra, C, Vázquez-Bonales, JA, Unger, B, Hammond, PS (2023). Estimates of cetacean abundance in European Atlantic waters in summer 2022 from the SCANS-IV aerial and shipboard surveys. Final report published 29 September 2023. 64 pp. https://tinyurl.com/3ynt6swa

26. Hammond, P.S., MacLeod, K., Berggren, P., Borchers, D.L., Burt, L., Canadas, A (2013). Cetacean abundance and distribution in European Atlantic shelf waters to inform conservation and management. Biological conservation. 107-122

27. HSE (2001). Bird guano accumulations and their effect on offshore helicopter operations. Offshore technology report 2000/131.

28. Humber Nature Partnership, 2015. Humber Management Scheme 2015 – Introduction. Available from: http://www.humbernature.co.uk/admin/resources/2016-hms-1.-introduction.pdf [Access September 2023].

29. Review of Management Unit boundaries for cetaceans in UK waters (2023). JNCC report 734. Available from: https://data.jncc.gov.uk/data/b48b8332-349f-4358-b080-b4506384f4f7/jncc-report-734.pdf [Accessed December 2023].

30. IUCN (2021) The IUCN Red List of Threatened Species. [Online] Available from: http://www.iucnredlist.org/ [Accessed July 2023].

31. JNCC (2018). Contributing to a Marine Protected Area Network. Available from: http://jncc.defra.gov.uk/page-4549 [Accessed April 2023].

32. KIS-ORCA Offshore Renewable & Cable Awareness. Available from https://kis-orca.org/map/ [Accessed July 2023].

33. Kober, K., Webb, A., Win, I., Lewis, M., O'Brien, S., Wilson, L.J. & Reid, J.B. (2010). An analysis of the numbers and distribution of seabirds within the British Fishery Limit aimed at identifying areas that qualify as possible marine SPAs, JNCC Report No. 431. JNCC, Peterborough, ISSN 0963-8091.

34. Kunzlik, P.A. (1988) The Basking Shark. Scottish Fisheries Information Pamphle Number 14, 1988.

35. Leterme S.C., Seuront L. & Edwards M. (2006) Differential contribution of diatoms and dinoflagellates to phytoplankton biomass in the NE Atlantic and the North Sea. Mar. Ecol. Prog. Ser. 312: 57 – 65.

36. Laflamme, R.E. and Hites, R.A., 1978. The global distribution of polycyclic aromatic hydrocarbons in recent sediments. Geochim Cosmochim Acta. 42: 289-303.

37. Long, E. R., MacDonald, D. D., Smith, S. L. and Calder, F. D. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuary sediments. Environmental Management 19: 81-97.

38. Marine Scotland (2021). Final 2021 effort data by ICES rectangle. Available from: https://data.marine.gov.scot/dataset/2021-scottish-sea-fisheries-statistics-fishing-effort-and-quantity-and-value-landings-ices [Accessed August 2023].

39. Marine Scotland (2021). Final 2021 landings data by ICES rectangle – 2017 to 2021. Available from: https://data.marine.gov.scot/dataset/2021-scottish-sea-fisheries-statistics-fishing-effort-and-quantity-and-value-landings-ices [Accessed September 2023].

40. McBreen, F., Askew, N., Cameron, A., Connor, D., Ellwood, H. and Carter, A. (2011). UK SeaMap 2010. Predictive mapping of seabed habitats in UK waters. JNCC Report No. 446. Available online at http://jncc.defra.gov.uk/PDF/jncc446_web.pdf [Accessed August 2023].

41. MMO (2014). East Inshore and East Offshore Marine Plans. London: Department for Environment, Food and Rural Affairs. Available from: https://www.gov.uk/government/publications/east-inshore-and-east-offshore-marine-plans [Accessed July 2023].

42. MMO (2019). Receiver of wreck: protected wrecks https://www.gov.uk/government/publications/receiver-of-wreck-protected-wrecks [Accessed July 2023].

43. Minerals Management Service, 1999. Marine Aggregate Mining Benthic & Surface Plume Study. Final Report to the United States Department of the Interior, Minerals Management Service & Plume Research Group.

44. Neff, J.M. (2005) Composition, environmental fates, and biological effects of water based drilling muds and cuttings discharged to the marine environment. Prepared for Petroleum Environmental Research Forum (PERF) and American Petroleum Institute (2005) (73 pp.)

45. Newell RC, Seiderer LJ & Hitchcock DR (1998). The impact of dredging works in coastal waters: A review of the sensitivity to disturbance and subsequent recovery of biological resources on the seabed. Oceanography and Marine Biology: An Annual Review 36: 127-178.

46. NMPI, 2018. National Marine Plan Interactive. Available at: http://www.gov.scot/Topics/marine/seamanagement/nmpihome [Accessed September 2023].

47. N Sea Decommissioning Seabed Surveys, 2020 (Volume 1A, 1B, 1C and 1D).

48. NSTF (1993). North Sea quality status report 1993 – London (Oslo and Paris commissions) & Fredensborg, North sea task force, Denmark.

49. NSTA (2016) 29th Licensing Round Information – Levels of Shipping Activity. https://www.nstauthority.co.uk/media/1419/29r_shipping_density_table.pdf [Accessed July 2023].

50. NSTA Mapper (2020). Available at https://www.arcgis.com/apps/webappviewer/index.html?id=f4b1ea5802944a55aa4a9df0184205a5 [Accessed September 2023].

51. OSPAR Commission (2014) List of Threatened and/or Declining Species & Habitats. [Online] Available from: https://www.ospar.org/work-areas/bdc/species-habitats/list-of-threatened-declining-species-habitats [Accessed June 2024].

52. Paez-Osuna, F., and Ruiz-Fernandez, C., 1995. Comparative Bioaccumulation of Trace Metals in Penaneus stylirostris in Estuarine and Coastal Environments. Estuarine, Coastal and Shelf Science 40: 35-44.

53. PUK: Ornithological Support Perenco Asset Survey 2024. Doc: A-304100-S00-A-REPT-001

54. PUK mattresses burial assessment- ROCK (24.08.23)

55. PUK Amethyst Design Fabrication & Installation Resume, 1999. Reference: R-2034-81204-1A

56. Reid, J.B., Evans, P.G.H. and Northridge, S.P. (2003). Atlas of Cetacean distribution in north-west European waters. Peterborough: Joint Nature Conservation Committee (JNCC).
57. Russell, D.J.F., Jones, E.L. and Morris, C.D. (2017). Updated Seal Usage Maps: The Estimated at-sea Distribution of Grey and Harbour Seals. Scottish Marine and Freshwater Science, 8 (25).
58. Schaule, B.K., and Patterson, C.C., (1983) Perturbations of the Natural Lead Depth Profile in the Sargasso Sea by Industrial Lead. Trace Metals in Sea Water pp 487-503.
59. SCOS (Special Committee On Seals) (2015). Scientific advice on matters related to the management of seal populations. http://www.smru.st-andrews.ac.uk/files/2016/08/SCOS-2015.pdf [Accessed July 2023].
60. Scottish Online bird report https://www.the-soc.org.uk/about-us/online-scottish-bird-report [Accessed November 2024].
61. Sheahan, D., Rycroft, R., Allen, Y., Kenny, A., Mason, C. and Irish, R., 2001. Contaminant status of the North Sea. Technical Report TR_004. Report produced for Strategic Environmental Assessment – SEA2. 101pp.
62. Snelgrove, P.V.R. and Butman, C.A. (1994) Animal-Sediment Relationships Revisited: Cause versus Effect. Oceanography and Marine Biology: An Annual Review, 32, 111-177.
63. SNH and HES (2018). Environmental Impact Assessment Handbook - Guidance for competent authorities, consultation bodies, and others involved in the Environmental Impact Assessment process in Scotland. Version 5, April 2018. Scottish Natural Heritage and Historic Environment Scotland.
64. The Crown Estates (2018). The Crown Estates Offshore Activity. Available from: https://www.thecrownestate.co.uk/en-gb/what-we-do/on-the-seabed/minerals-dredging/ [Accessed September 2023].
65. Thompson, B. and Lowe, S. (2004). Assessment of macrobenthos response to sediment contamination in the San Francisco Estuary, California, USA. Environmental toxicology and chemistry.
66. UKOOA, 2001. An analysis of U.K Offshore Oil & gas Environmental Surveys 1975-95, pp. 141.
67. Waggitt JJ, Evans PGH, Andrada K, Banks AN, Boisseau O, Bolton M, Bradbury G, Brereton T, Camphuysen CJ, Durinck J, Felce T, Fijn RC, Garcia-Baron I, Garthe S, Geelhoed SCV, Gilles A, Goodall M, Haelters J, Hamilton S, Hartny-Mills L, Hodgins N, James K, Jessopp M, Kavanagh AS, Leopold M, Lohrengel K, Louzao M, Markones N, Martínez-Cedeia J, Cadhla OÓ, Perry SL, Pierce GJ, Ridoux V, Robinson KP, Santos MB, Saavedra C, Skov H, Stienen EWM, Sveegaard S, Thompson P, Vanermen N, Wall D, Webb A, Wilson J, Wanless S, and Hiddink JG, 2019. Distribution maps of cetacean and seabird populations in the Northeast Atlantic. Journal of Applied Ecology, 57: pp.253-269.
68. Webb, A., Elgie, M., Irwin, C., Pollock, C. and Barton, C. (2016). Sensitivity of offshore seabird concentrations to oil pollution around the United Kingdom: Report to Oil & Gas UK. Available from: http://jncc.defra.gov.uk/page-7373 [Accessed July 2023].
69. Whalley, C., Rowlatt, S., Bennett, M. and Lovell, D, 1999.- Total Arsenic in Sediments from the Western North Sea and the Humber Estuary, Marine Pollution Bulletin, Vol. 38, No. 5, pp. 394-400.
70. Youngblood, W.W. and Blumer, M., 1975. Polycyclic aromatic hydrocarbons in the environment: homologues series in soils and recent marine sediments. Geochim Cosmochim Acta, 39:1303-1314.

Appendix A - Air Emissions Assessment

The following assumptions were used in this assessment:

- Emission factors (EF) for offshore vessel use have been taken from the Environmental and Emissions Monitoring System, Atmospheric Emissions calculations (Offshore Energies UK (OEUK) & DESNZ] - default EF for diesel consumption plant operations engines.
- 100% combustion efficiency.
- Sulphur content of fuel gas is 6.4ppm weight.
- Diesel specific gravity: 0.88te/m^3 (average).
- Fuel consumption for a typical expected MSV and HLJB: 5m^3/24hrs (Quayside), 20m^3/24hrs (Transit), 15m^3/24hrs (Dynamic positioning/On location).
- Full calculations presented in CAL-013b, Rev 1 [9].
- Emissions from onshore waste transportation and treatment has not been accounted.
- Operations for each Amethyst jacket is expected to last 10 days for jacket removal, 2 days for transportation between shore and other assets, and 4 days for activities at quayside (mobilisation/demobilisation).

Table 10-1: Vessel days and fuel consumption for all Amethyst jackets decommissioning operations

Vessel activity	Diesel consumption /24hrs (m^3)	Vessel days	Diesel (m^3)	Total diesel (te)
HLJB offshore days (Transit)	20.0	8	160.0	140.8
HLJB offshore days (Onsite)	15.0	40	600.0	528.0
HLJB days (Quayside)	5.0	16	80.0	70.4
MSV offshore days (Transit)	20.0	2	40.0	35.2
MSV Offshore days (Onsite)	15.0	5	75.0	66.0
MSV days (Quayside)	5.0	2.5	12.5	11.0
	Total	**73.5**	**967.5**	**851.4**

Table 10-2: Total offshore emissions from HLJB and MSV diesel consumption

Aspect	Total Fuel Use (te)	Emissions (te) Note 1							
		CO_2	CO	NO_X	N_2O	SO_2	CH_4	VOC	CO_2e Note 2
Vessels	851.4	2724.48	13.37	50.57	0.19	3.41	0.15	1.70	2778.41

Note 1: EEMS Atmospheric Emissions factors (OEUK&DESNZ)

Note 2: Values for the non-carbon dioxide (CO_2) Green House Gases (GHG), methane (CH_4) and nitrous oxide (N_2O), are presented as CO_2 equivalents (CO_2e), using Global Warming Potential (GWP) factors from the Intergovernmental Panel on Climate Change Fifth assessment report (GWP for CH_4 = 28, GWP for N_2O = 265).

A quantitative comparison between the predicted CO_2e emissions generated during the proposed decommissioning operations and the local, regional and UK total CO_2e emissions has been made in. Although there will be a short term and localised increase in emissions from the proposed operations, the total emissions will contribute a small percentage to the offshore and UK total CO_2e emissions <0.0185% and <0.0006%, respectively).

Table 10-3: Comparison of CO_2e emissions from the proposed operations

Emission Source	Estimated CO_2e Emissions (te) Note 1
Amethyst Jackets removal operations	2,778.41
UKCS Offshore CO_2 Emissions for 2021 Note 2	15,030,000.0
UK Net CO_2 Emissions 2021 Note 3	426,500,000.0

Note 1: EEMS Atmospheric Emissions factors (OEUK&DESNZ)

Note 2: Based on total offshore emissions from OEUK (2022).

Note 3: Based on UK net total CO_2 emissions for 2021 (DESNZ, 2023).

The Climate Change Act 2008 (as amended) requires the government to set legally-binding 'carbon budgets' to act as stepping-stones towards the 2050 Net Zero target. These carbon budgets restrict the total amount of GHG that the UK can emit over five-year periods, ensuring continued progress towards the UK's long-term climate target. Table 10-4 details the carbon budget of relevance to the proposed Amethyst jacket and Helvellyn riser decommissioning operations and confirms whether the UK is on track to meet these climate targets.

Table 10-4: UK Carbon Budgets (HM Government, 2021)

Carbon Budget	Carbon Budget Level	Reduction Below 1990 Levels	Due to Meet Target
4th carbon budget (2023 to 2027)	1,950 million tonnes CO_2e	51% by 2025	Off track

Table 10-5 presents the predicted CO_2e emissions generated from the proposed decommissioning operations against the fourth UK carbon budget. It can be seen from this that the CO_2e emissions generated during the operations, contribute only a very small amount to the fourth UK carbon budget, equal to ca. 0.0000552% of the UK budget.

Table 10-5: Comparison of the proposed operations CO_2e emissions against relevant UK carbon budgets

Emission Item	Carbon Accounting Period
	4th Carbon Budget (2023 to 2027)
UK Carbon Budget CO_2e Target	1,950,000,000te CO_2e
CO_2e Emissions Generated from Amethyst Jackets and Helvellyn riser decommissioning operations	2,778.4te CO_2e
% of UK Carbon Budget CO_2e emitted during Amethyst jackets decommissioning operations	1.4248e-04%

To minimise the emissions generated, PUK will look to reduce vessel time in the field as far as practicable. In addition, PUK's contractor selection process will aim to ensure that the engines, generators and other combustion plant on the HLJB are maintained and correctly operated to ensure that they work as efficiently as possible.

Given the above, the impact to the environment from atmospheric emissions has been scoped out from further assessment.