Guinevere Pipelines and Stabilisation Materials Decommissioning

Environmental Appraisal Report

For Perenco Gas (UK) Limited

200605-S-REP-0005 Rev 7

03/06/2024

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ABBREVIATIONS

Abbreviation	Description
µg	Microgram
As	Arsenic
Ba	Barium
BAC	Background Ambient Concentration
BAP	Biodiversity Action Plan
BEIS	Business, Energy, and Industrial Strategy (Formerly Department of Energy and Climate Change)
BOEPD	Barrels Of Oil Equivalent Per Day
CA	Comparative Assessment
Cd	Cadmium
CEFAS	Centre For Fisheries and Aquaculture Science
CH_4	Methane
CO	Carbon monoxide
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
Cr	Chromium
CSQG	Canadian Sediment Quality Guidelines
Cu	Copper
DAS	Discretionary Advice Service
DEFRA	Department for Environment, Food and Rural Affairs
DepCon	Deposit Consent
DESNZ	Department for Energy Security & Net Zero
DP	Decommissioning Programme
e.g.	For example
EA	Environmental Appraisal
EC	European Council
EEC	European Economic Council
EF	Emission Factor
EIA	Environmental Impact Assessment
ENVID	Environmental Impacts Identification
ERL	Effects Range Low
EU	European Union
EUNIS	European Nature Information System
FBE	Fusion Bonded Epoxy
Fe	Iron

Abbreviation	Description
HCF	Hydrocarbon Free
Hg	Mercury
HGV	Heavy Good Vehicles
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
INNS	Invasive Non-Native Species
ISO	International Organisation for Standardisation
IUCN	International Union for the Conservation of Nature
JNCC	Joint Nature Conservation Council
kg	Kilograms
km	Kilometre
KP	Kilometre Point
LAT	Lowest Astronomical Tide
m	Metre
MCZ	Marine Conservation Zones
mg	Milligrams
mm	Millimetre
MMMU	Marine Mammal Management Units
MoD	Ministry of Defence
MPA	Marine Protected Area
N_2O	Nitrous oxide
N/A	Not applicable
ND	No Data
Ni	Nickel
NOx	Nitrogen oxides
NSTA	North Sea Transition Authority (Formerly Oil and Gas Authority)
OEUK	Offshore Energies UK (Formerly Oil and Gas UK (OGUK))
OPRED	Offshore Petroleum Regulator for Environment and Decommissioning
OSPAR	Oslo Paris Convention
p	Probability
PAH	Polycyclic aromatic hydrocarbons
Pb	Lead
PEL	Probable Effect Levels

Abbreviation	Description
PETS	Portal Environmental Tracking System
PL	Pipeline
POMS	PUK Operating Management System
PUK	Perenco Gas (UK) Limited
PWA	Pipeline Works Authorisation
Q	Quarter
R	Correlation Coefficient
SAC	Special Area of Conservation
SCANS	Small Cetacean Abundance of the North Sea
SE	Standard Error
SD	Standard Deviation
SEMS	Safety and Environmental Management System
SNS	Southern North Sea
SO_2	Sulphur dioxide
SOSI	Seabird Oil Sensitivity Index
spp.	Species
Tba	Barium by Fusion
te	Tonnes (UK)
TEL	Threshold Effect Levels
THC	Total Hydrocarbon Content
TOC	Total Organic Carbon
UK	United Kingdom
UKCS	United Kingdom Continental Shelf
UKOOA	United Kingdom Offshore Operators Association
VOC	Volatile Organic Compound
w/w	Wet Weight
Zn	Zinc
%	Percentage
£	Pound Sterling
>	Greater than
<	Less than
^{2}	Cubic
^{3}	Square
°C	Degree Celsius

HOLDS

Section	Hold	

EXECUTIVE SUMMARY

In accordance with the Petroleum Act 1998, Perenco Gas (UK) Limited (PUK) are applying to the Offshore Petroleum Regulator for Environment and Decommissioning (OPRED) to obtain approval for the decommissioning of the Guinevere Pipeline (PL) 874 and PL 875.

The Guinevere pipeline system was made Hydrocarbon Free (HCF) in December 2017, flooded with seawater and left in-situ (Table 4-1). The Guinevere platform was decommissioned and removed from the seabed in January 2020 with the pipeline ends at the base of the Guinevere jacket cut subsea and removed under Pipeline works Authorisation (PWA) (PA2548). Approximately, 12.9m of PL 874 and 13.3m of PL 875 free span sections were cut and removed at the former Guinevere platform location. At the eastern extent, the pipelines remain connected to the Lancelot riser.

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

Through the CA process it was determined that the preferred decommissioning option would be to leave in situ.

This EA Report sets out to describe, in a proportionate manner, the potential environmental impacts of the proposed activities associated with the Guinevere pipelines and stabilisation materials 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 Guinevere pipelines and stabilisation materials 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 Guinevere pipelines 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 a 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 Field and Infrastructure Description

The Guinevere pipelines and stabilisation materials fall entirely within United Kingdom Continental Shelf (UKCS) block 48/17 within the Southern North Sea (SNS) (Figure 1-1, Figure 1-2). Table 4-1 provides details of the Guinevere pipelines that will be subject to the DP and this EA.

The Guinevere pipeline system (PL 874/PL 875) was made HCF in December 2017, flooded with seawater and left in-situ (Table 4-1). The Guinevere platform was decommissioned and removed from the seabed in January 2020 with the pipeline ends at the base of the Guinevere jacket cut subsea and removed under PWA (PA2548). Approximately, 12.9m of PL 874 and 13.3m of PL 875 were cut and removed at the former Guinevere platform location. At the eastern extent, the pipelines remain connected to the Lancelot riser.

Recent geotechnical surveys indicate that the western extent of the pipelines, on approach to the former Guinevere jacket, are covered by historical rock placement. Additionally, in Quarter (Q) 1 2022 the North Sea Transition Authority (NSTA) (formerly the Oil and Gas Authority) authorised additional rock placement to cover and secure the exposed cut end of the pipelines. This involved the deposition of 942te of additional rock at that location (Deposit Consent (DepCon): 15/D/22)) forming a berm that was designed with a 1:3 slope to make it overtrawlable.

The PL 874/PL 875 pipeline mattresses were installed in 1993 and in total consist of four concrete mattresses within the Guinevere 500m zone (Table 4-1).

Approximately 50 grout bags were used to stabilise Guinevere pipelines. Recent surveys have not recorded the presence of grout bags; therefore, they are assumed to be completely buried below the seabed.

Figure 1-1: Guinevere and surrounding fields in SNS

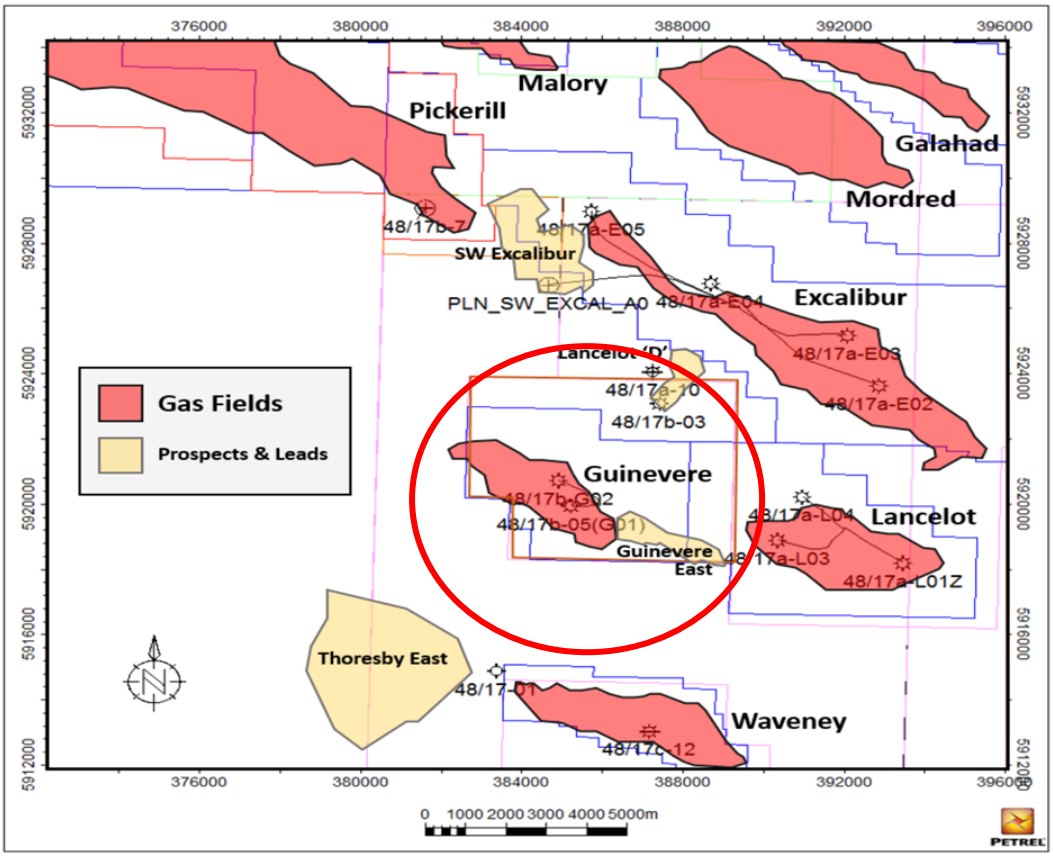
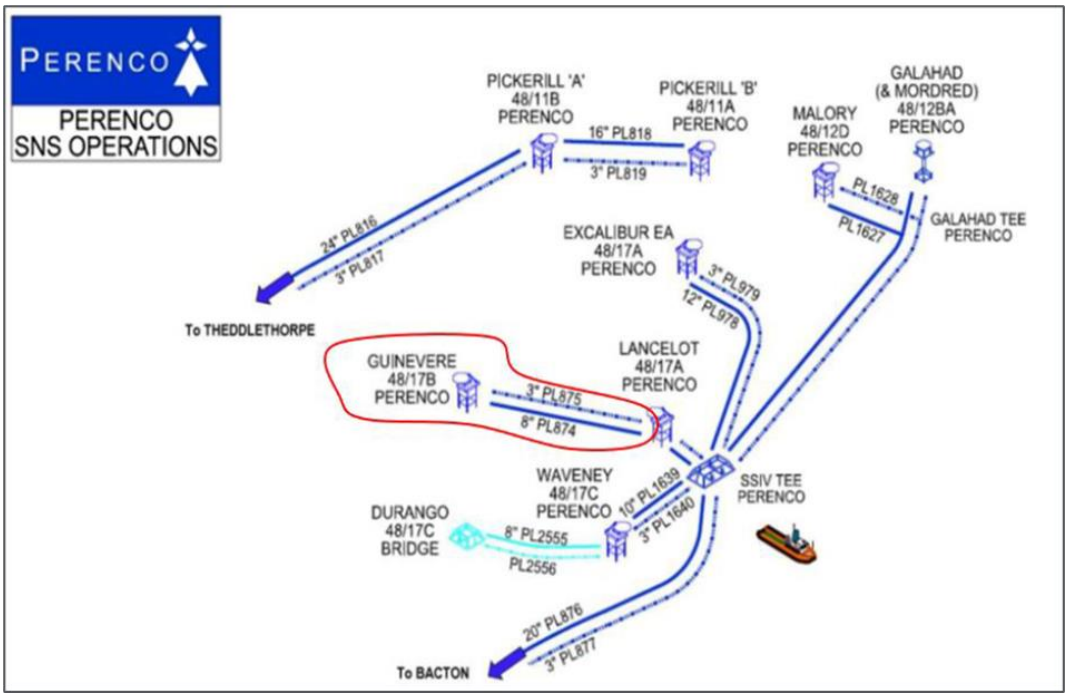


Figure 1-2: Guinevere Pipelines and surrounding PUK assets



1.3 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 operates 17 offshore fields, 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. 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 Oslo Paris Convention (OSPAR) for the protection of the Marine Environment of the Northeast Atlantic. 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, The 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 CA process.

The decision does not apply to pipelines or stabilisation materials, however despite this OPRED require operators to apply the same framework to pipeline decommissioning projects.

"A comparative assessment (CA) is a mandatory requirement for any potential OSPAR derogation candidate or for all pipeline decommissioning." [13].

Guidance published by the Offshore Energies United Kingdom (OEUK) [53] provides detail on regulatory expectations in regard to the decommissioning of pipelines and stabilisation materials:

"Any removal or partial removal of a pipeline should be performed in such a way as to cause no significant adverse effects upon the marine environment and any decision that a pipeline may be left in place should have regard to the likely deterioration of the material involved and its present and possible future effect on the marine environment."

While each case will be considered on its merits and in the light of a comparative assessment of the alternative options the following have been identified as possible candidates for in situ decommissioning:

- ***"Those [pipelines] which are adequately buried or trenched and which are not subject to development of spans and are expected to remain so;***
- ***Those which were not buried or trenched at installation but which are expected to self-bury over a sufficient length within a reasonable time and remain so buried;***
- ***Those where burial or trenching of the exposed sections is undertaken to a sufficient depth and it is expected to be permanent;***
- ***Those which are not trenched or buried but which nevertheless are candidates for leaving in place if the comparative assessment shows that to be the preferred option (e.g. trunk lines);***
- ***Those where exceptional and unforeseen circumstances due to structural damage or deterioration or other cause means they cannot be recovered safely and efficiently. [53]***

Additional Guidance from OPRED states:

"Where rock-dump has previously been used to protect a pipeline it is recognised that removal of the pipeline is unlikely to be practicable and it is generally assumed that the rock-dump and the pipeline will remain in place. Where this occurs, it is expected that the rock-dump will remain undisturbed." [13]

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 [44]. 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.

In addition to the CA, the primary guidance for offshore decommissioning [13] 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) [21].

3 Consultee responses

Table 3-1 provides details of stakeholder responses in response to a scoping letter [71] produced and distributed by PUK detailing decommissioning options being considered and a list of items to be scoped in and out.

Table 3-1: Consultee responses

Stakeholder	Response	PUK comment
Global Marine Group	Many thanks for submitting the pipeline DP of Guinevere. As there are no telecommunication cables within Block 48/17. I have no comments.	Not applicable (N/A)
National Federation of Fishermans Organisations	No response	
OPRED Environmental Management Team	No response	
Centre for Environment, Fisheries and Aquaculture Science	No response	
Joint Nature Conservation Council (JNCC)	Thank you for contacting JNCC in regard to the Guinevere Environmental Appraisal Scoping Report. JNCC launched its Discretionary Advice Service (DAS) in April 2020. This service delivers discretionary nature conservation advice to industry in the UK offshore environment. The requested activity is now captured as part of the chargeable JNCC Discretionary Advice Service (DAS). To request our Discretionary Advice Service (DAS), please complete the DAS request form and follow the instructions for submission within the form. Please note, that by returning the DAS request form you are agreeing JNCCs Terms and Conditions. For more information on the DAS service please see our Discretionary Advice Service webpage Please return the form to JNCC Offshore Industries Advice OIA@jncc.gov.uk On processing of the DAS form we will provide a nominated contact at JNCC to discuss or join a meeting on the proposed scope of the environmental baseline survey	

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

Table 4-1 provides details on the infrastructure relevant to the Guinevere pipelines DP and EA. As the pipelines are currently still connected to the Lancelot installation the scope of the current DP and EA will exclude pipeline sections and associated stabilisation materials located within the Lancelot 500m exclusion zone. Infrastructure located within the Lancelot 500m exclusion zone will form part of the Lancelot DP at the appropriate time.

Table 4-1: Details of Guinevere pipelines and stabilisation material subject to Guinevere pipelines DP

Note 1 – Length represents current pipeline length as per PWA [57] minus 500m section within Lancelot 500m exclusion zone.

Pipeline no.	Type	Size (inch)	Length (km) Note 1	Components	Status
PL 874	Hydrocarbon export	8"	6.560	Outside diameter: 219.1mm Wall thickness: 18.3mm Anti-corrosion: Fusion Bonded Epoxy (FBE), 0.55mm, 1400kg/m^3	Flushed and cut subsea at Guinevere. HCF verification December 2017. Trenched and buried.
PL 875	Mono Ethylene Glycol import	3"	6.537	Outside diameter: 88.9mm Wall thickness: 12.7mm Anti-corrosion: FBE, 0.55mm, 1400kg/m^3	Flushed and cut subsea at Guinevere. HCF verification December 2017. Trenched and buried.

Stabilisation feature	Total no.	Weight (te)	Location	Type
Concrete mattresses	4	Unknown	Guinevere 500m zone: 4	2 x Articulated (Poly Rope) 2.4m x 5.8m x 0.48m 1 x Flexible (Poly Rope) 2.0m x 10m x 0.30m 1 x Unknown (Poly Rope) 2.0m x 10m x 0.30m.
Grout bags	50 (estimated)	Unknown	Unknown	Unknown
Rock placement	2	1 x 942te (C. 22m) 1 x unknown (C.120m)	Guinevere 500m zone Guinevere 500m zone	N/A

4.1.1 Location

PL 874 and PL 875 are located entirely within the UKCS block 48/17.

4.1.2 Pipelines

The scope of the Guinevere pipelines DP will cover the pipelines (PL 874 and PL 875) located within UKCS block 48/17 from the former Guinevere platform location to the edge of the 500m exclusion zone at Lancelot. The remaining part of PL 874/PL 875 and associated stabilisation materials within the Lancelot 500m zone will be considered as part of the Lancelot decommissioning scope.

4.1.3 Stabilisation Materials

Recent surveys have not identified the presence of the approximately 50 grout bags used during pipeline installation. There are four concrete mattresses located within the Guinevere 500m exclusion zone. Grout bags and mattresses are buried under rock placement as described in section 4.1.4.

4.1.4 Rock Placement

Recent geotechnical surveys indicate that the western extent of the pipelines, on approach to the former Guinevere jacket, are covered by historical rock placement. Additionally, in Q1 2022 the NSTA authorised additional rock placement to cover and secure the exposed cut end of the pipelines at the western end. This involved the deposition of 942te of additional rock at that location (DepCon: 15/D/22). This rock placement fully covers the 4 concrete mattresses within the Guinevere 500m zone with an over trawlable berm.

4.1.5 Pipeline Crossings

There are no known crossings along the entire length of the pipelines from Guinevere to Lancelot.

4.2 Decommissioning Option

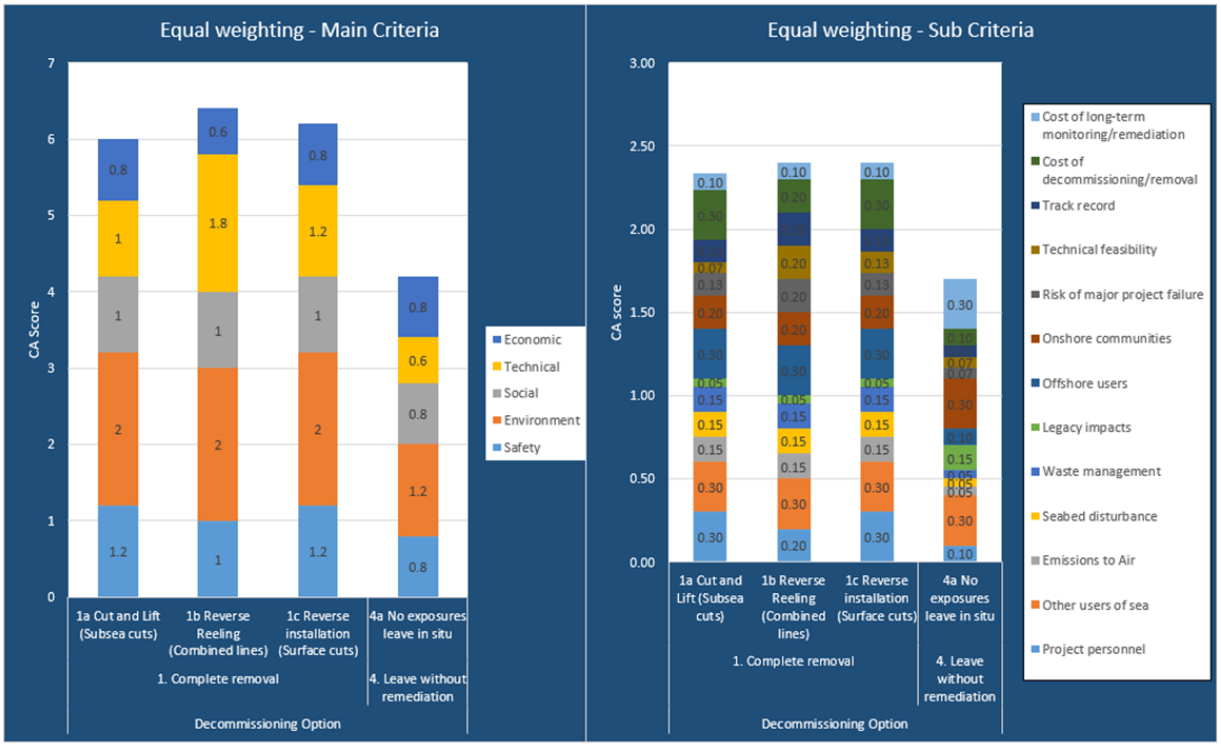
In line with current guidance, PUK completed a CA of several potential pipeline decommissioning options. The outcome of the CA process identified the preferred decommissioning option for PL 874/ PL 875 to be to leave in situ (Table 4-2, Figure 4-1). Full details of the CA process and result are presented in the CA report [70] and associated documents.

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

Table 4-2: Selected Decommissioning options as a result of the CA

Infrastructure	Decommissioning option
PL 874 within Guinevere 500m zone	Leave in situ under existing rock placement
PL 875 within Guinevere 500m zone	Leave in situ under existing rock placement
PL 874 within Lancelot 500m zone	To be considered in Lancelot DP
PL 875 within Lancelot 500m zone	To be considered in Lancelot DP
PL 874 Remaining section	Leave in situ
PL 875 Remaining section	Leave in situ
Concrete Mattress	Leave in situ under existing rock placement
Rock placement	Leave in situ

Figure 4-1: CA output on selected decommissioning options



4.2.1 Schedule

Table 4-3: Schedule of Guinevere pipelines Decommissioning activities

Year	2021				2022				2023				2024				2025			
Quarter	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Pipeline Decommissioning Programe																				
Submission of DP																				
Consultation																				
Approval of DP																				
Post Decommissioning Activities and Surveys																				
Post Decommissioning Surveys																				
Remediation (if required)																				
Obtain Clear Seabed Certification																				
Close Out report																				

LEGEND	
	Earliest date task could be completed
	Period in which task is to be completed
	Date Tasks were 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 Guinevere development, and highlights any key sensitivities.

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 Offshore Energy Strategic Environmental Assessment programme) and site-specific investigations commissioned as part of the exploration and development processes and pre-decommissioning survey work at Guinevere.

5.1.1 Guinevere Pre-Decommissioning Surveys

A pre-decommissioning environmental baseline survey of the Guinevere platform and pipelines area was completed in 2017 [23; 24]. The survey involved the collection of benthic grab samples and camera transects of the former Guinevere platform location and along the PL 874/PL 875 route (Figure 5-1).

5.1.2 Guinevere Post Platform Decommissioning Surveys

A post-decommissioning environmental baseline survey of the Guinevere platform and pipelines area was completed in 2022 [25]. The survey involved the collection of benthic grab samples and camera transects of the former Guinevere platform location and along the PL 874/PL 875 route (Figure 5-2).

Data acquired from these surveys and supplemented by data from other published sources has been used in the preparation of this baseline study.

Figure 5-1: Overview of 2017 Pre-Decommissioning survey

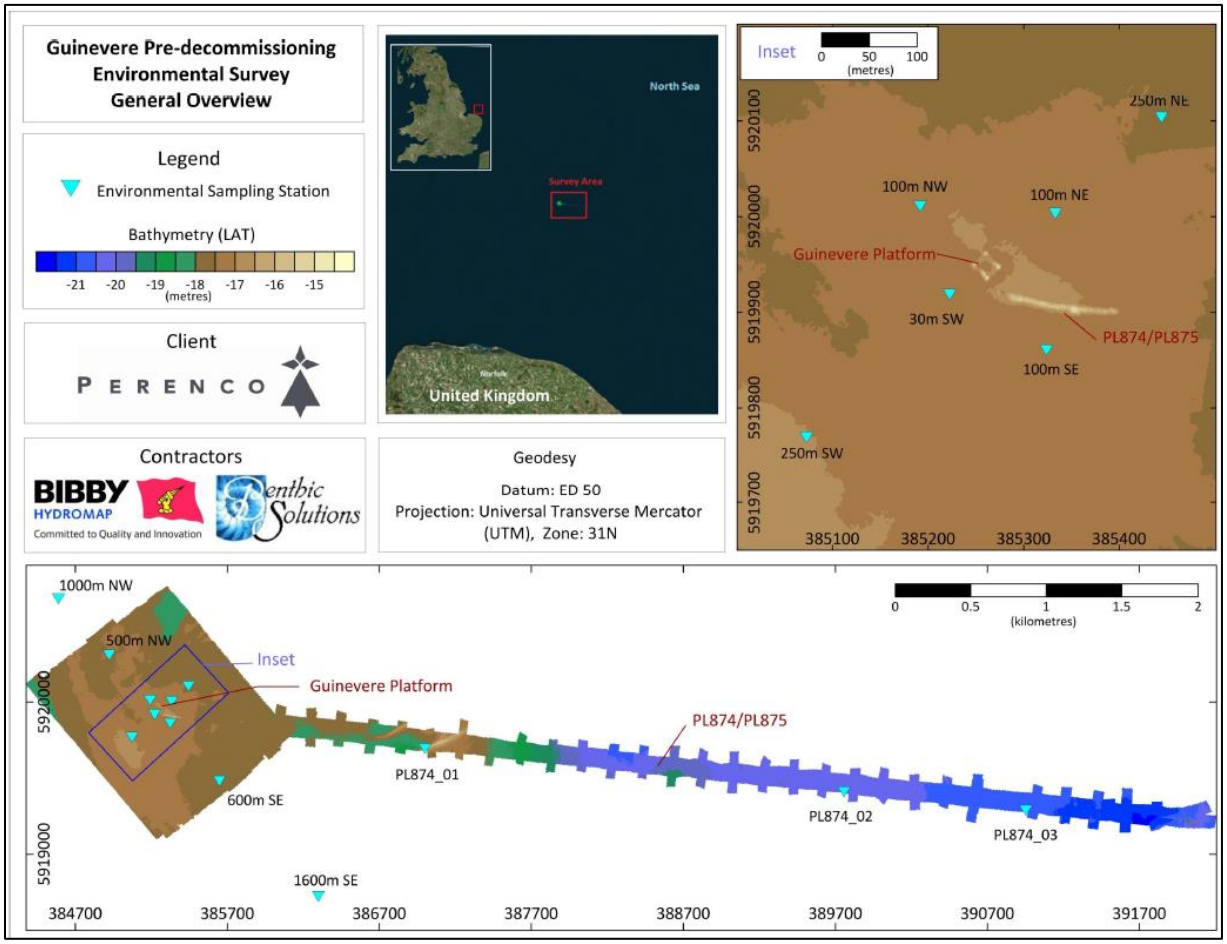
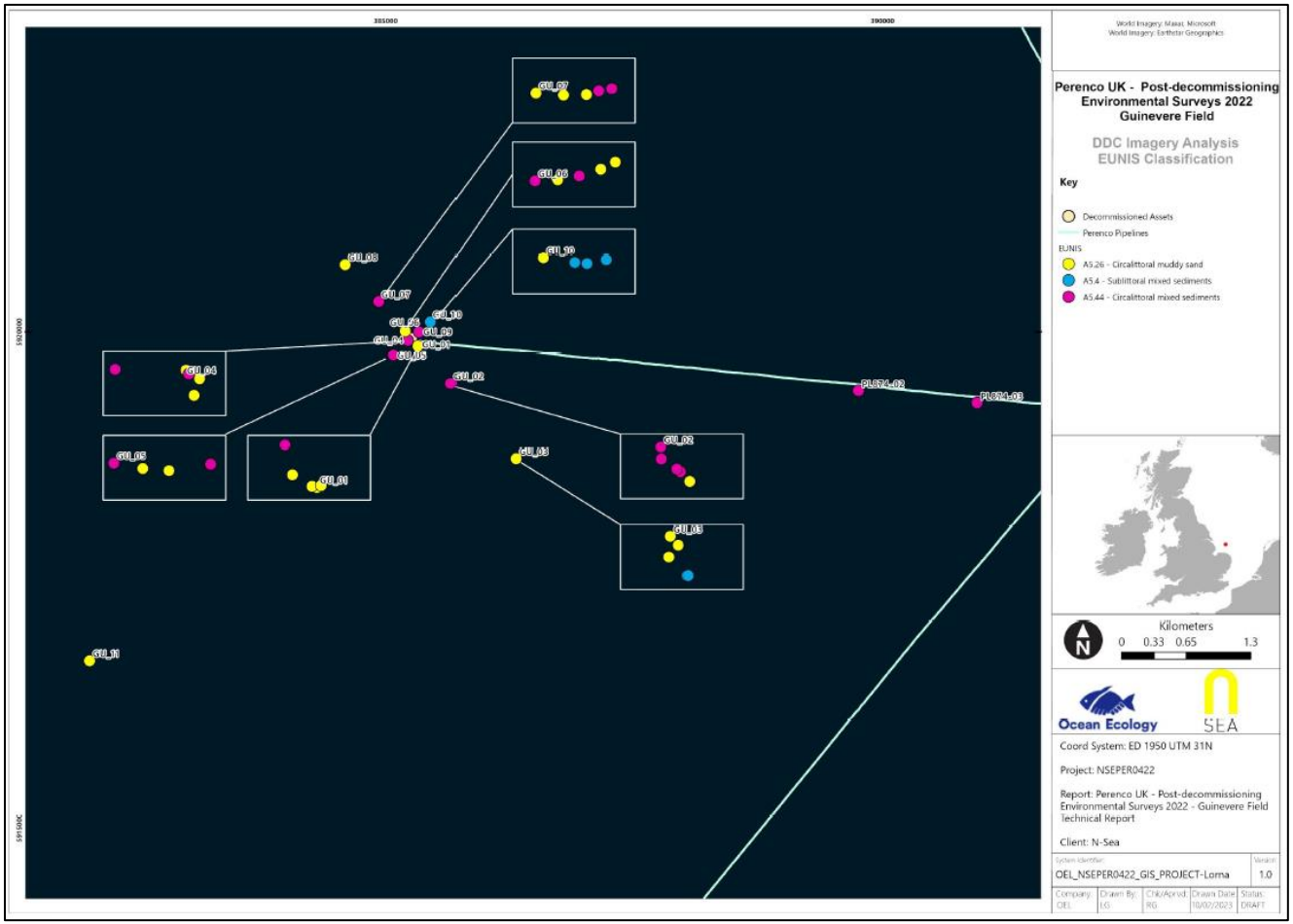


Figure 5-2: 2022 Post Platform decommissioning surveys



5.2 Physical Environment

5.2.1 Bathymetry

The SNS extends from the Flamborough front in the south to north of the Dover Strait in the south, with a transition from south sea water to Atlantic water. This region is shallow (generally 0-50m), with a predominantly sandy seabed [12]. Mapped information [43] 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 European Union (EU) Habitats Directive (92/43/EEC) such as Dogger Bank Special Area of Conservation (SAC) and the North Norfolk Sandbanks SAC [12].

The water depth at the former Guinevere platform location is 17.3m Lowest Astronomical Tide (LAT). The seabed within the Guinevere platform area appears generally flat, with slightly raised middle and western parts and marginally deeper eastern edges of the site. Water depths at the Guinevere platform area range from 15.3m to 18.1m LAT, with an average of approximately 16.7m LAT (Figure 5-3).

In 2022 the PL 874/P PL875 pipeline route was surveyed from Kilometre Point (KP) 0.0 at Guinevere location to KP 6.589 at Lancelot location (Figure 5-4). Overall, the seabed level ranges from 15.3m to 21.6m LAT. For the entire length of the route, the water depth gradually increases, with slight rise and dip between approximately KP 1.5 and KP 3.0, due to seabed morphology and a single sand wave.

Figure 5-3: Overview of the Guinevere platform bathymetry

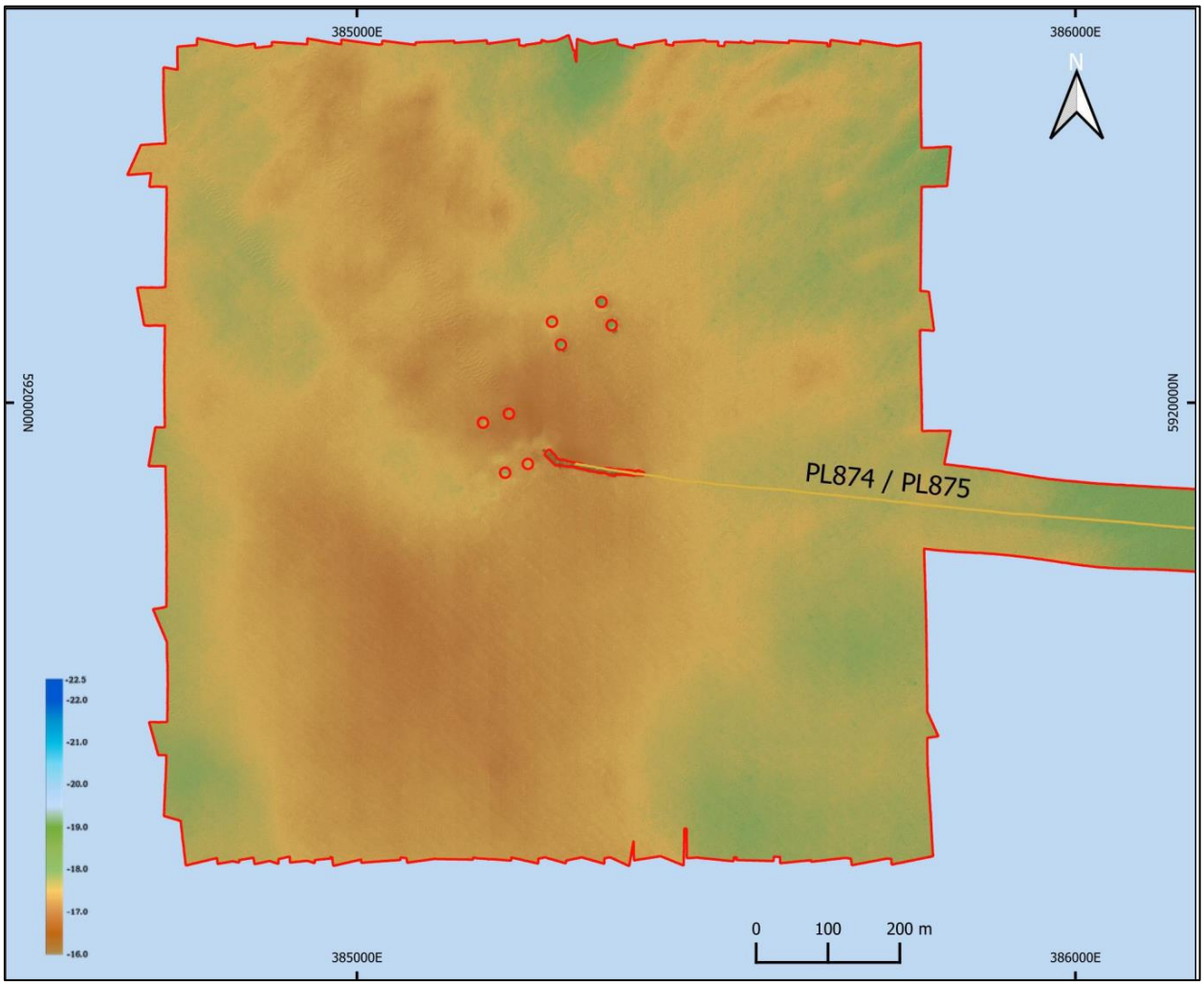
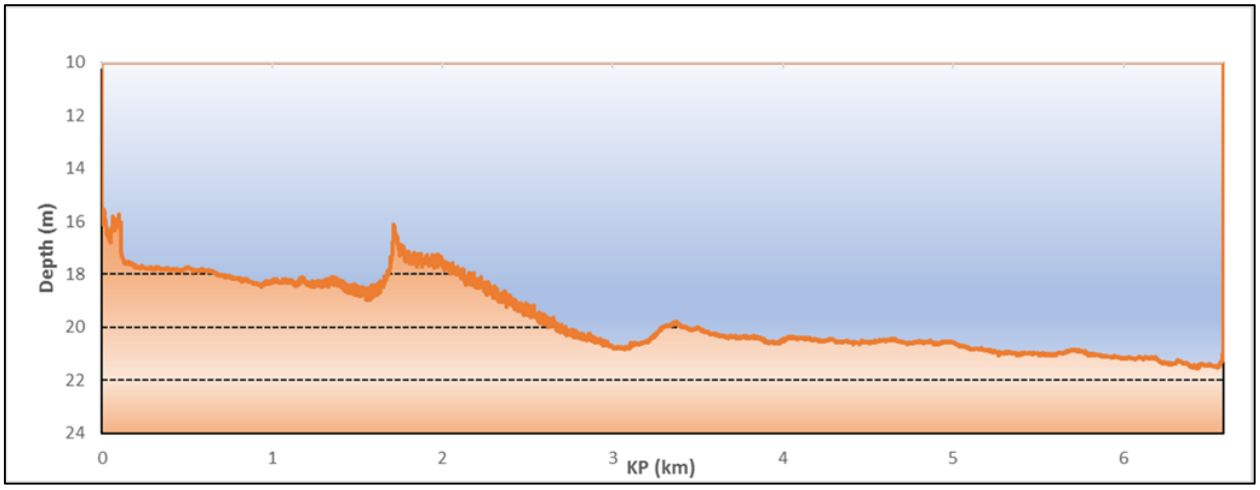


Figure 5-4: PL 874/ PL 875 route seabed profile



5.2.2 Seabed Sediments

The following European Nature Information System (EUNIS) seabed classifications have been identified in the vicinity of the PL 874/PL 875 (Figure 5-8) [9; 12; 33]. The predominant broadscale habitat is circalittoral coarse sediment (A5.14). To the east and west, the habitat transitions through deep circalittoral coarse sediment (A5.37) and deep circalittoral sand (A5.27) to circalittoral fine sand or circalittoral muddy sand (A5.25 or A5.26).

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)*.

A5.25/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.

A5.27 Deep circalittoral sand - Offshore (deep) circalittoral habitats with fine sands or non-cohesive muddy sands. Very little data is available on these habitats however they are likely to be more stable than their shallower counterparts and characterised by a diverse range of polychaetes, amphipods, bivalves and echinoderms.

A5.37 Deep circalittoral mud - In mud and cohesive sandy mud in the offshore circalittoral zone, typically below 50-70m, a variety of faunal communities may develop, depending upon the level of silt/clay and organic matter in the sediment. Communities are typically dominated by polychaetes but often with high numbers of bivalves such *as Thyasira* species *(spp*.), echinoderms and foraminifera.

Sediment samples for chemical analysis were collected from 13 grab stations sampled across the Guinevere field for the 2017 Pre-Decommissioning survey (Figure 5-1). The dominant sediment type throughout the surveyed area was interpreted to be sand, with some stations falling into the slightly gravelly sand category, according to the Folk classification. Several stations revealed a slightly coarser sediment type, and their sediment was classified as sandy gravel, but the video footage recorded during the sampling campaign did not support this interpretation showing any discernible difference from the surrounding gravelly sand stations.

An additional 13 samples were collected across the Guinevere field as a part of the 2022 Post platform decommissioning surveys (Figure 5-2), 10 in proximity of the decommissioned platform, including reference station GU_11_REF, and three along pipeline PL 874. Example grab photographs are presented in Figure 5-5. The mean (± Standard Error (SE)) proportion of sand across all survey stations was 73.47 ± 5.04 %, mean (± SE) gravel content was 21.07 ± 4.08 % and mean (± SE) mud content was 5.46 ± 2.84 %.

Figure 5-5: Examples photographs of sediment samples collected during the Guinevere post-decommissioning survey 2022.

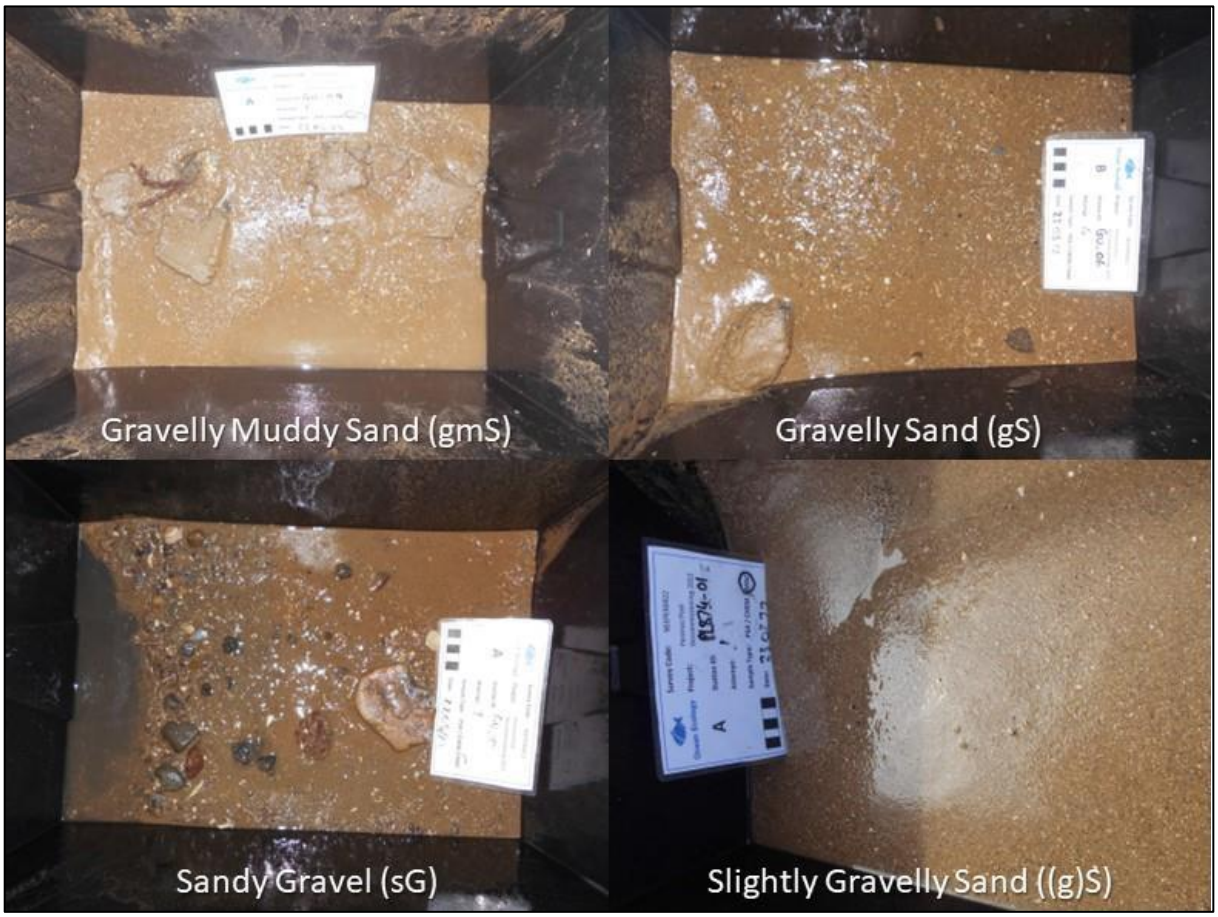
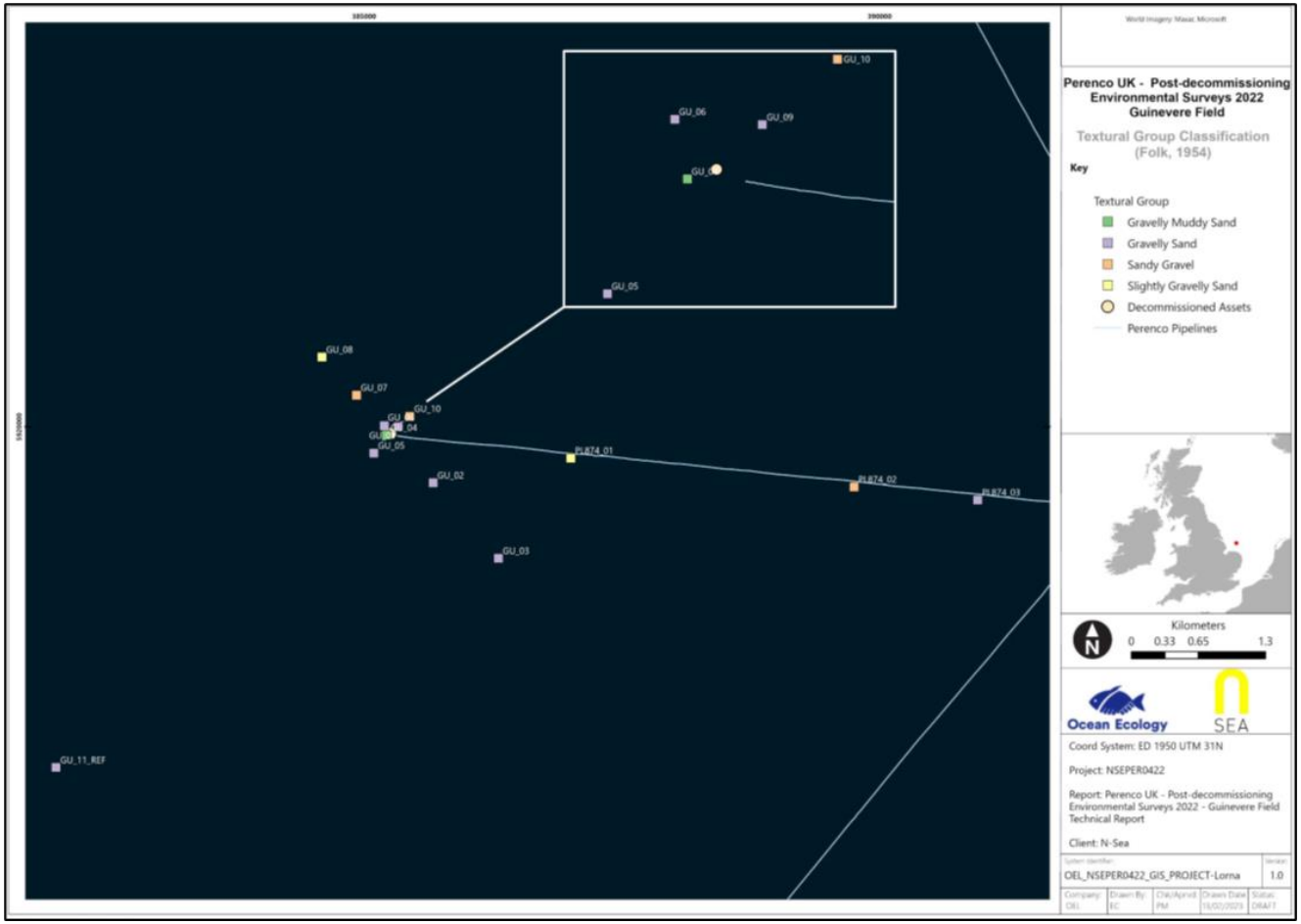
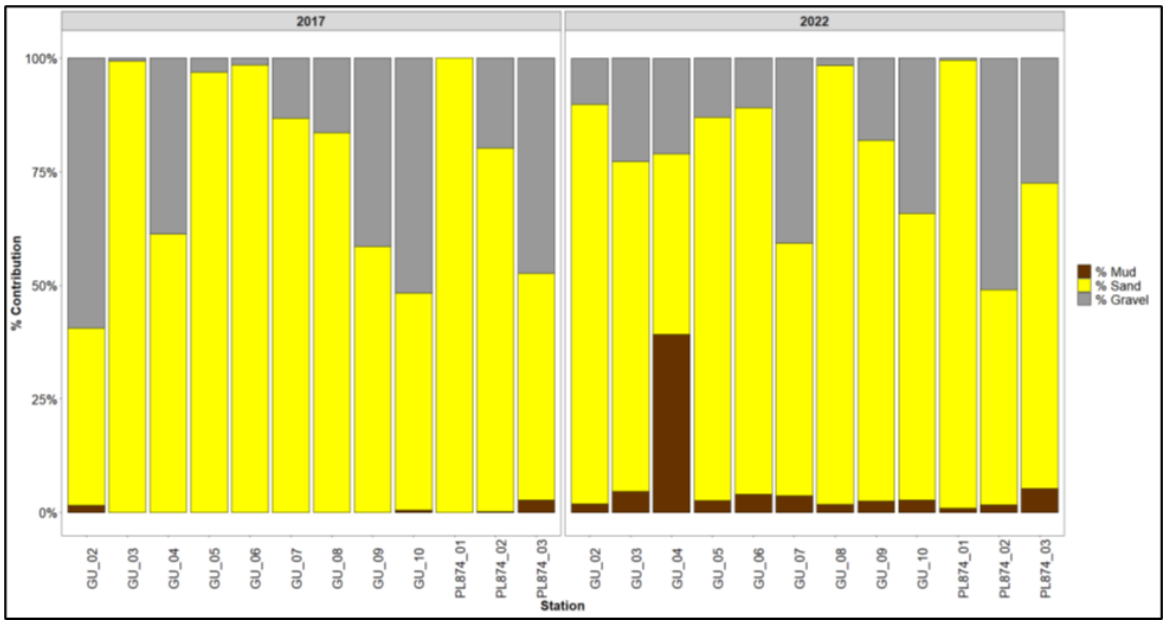


Figure 5-6: Sediment types as determined from particle size distribution analysis of samples acquired across the Guinevere post-platform decommissioning survey area. White lines indicate pipelines.



Key sediment characteristics were compared between samples collected during the 2017 pre-decommissioning surveys and the 2022 post-platform decommissioning surveys within the Guinevere field. A more heterogeneous substrate was observed in the 2017 pre-decommissioning survey, whilst a more homogeneous substrate was observed in post-platform decommissioning surveys. Additionally, temporal changes in sediment composition were assessed by comparing the relative contribution of mud, sand, and gravel at each station between pre- and post-decommissioning surveys (Figure 5-7). Despite some changes observed in the relative contribution of gravel and mud over time, a one-way ANOSIM test revealed that these were not statistically significant (R = -0.026, p = 0.552).

Figure 5-7: Comparison of percentage contribution of gravel , sand and mud at each sampling station across the Guinevere field between 2017 pre- and 2022 post-decommissioning surveys

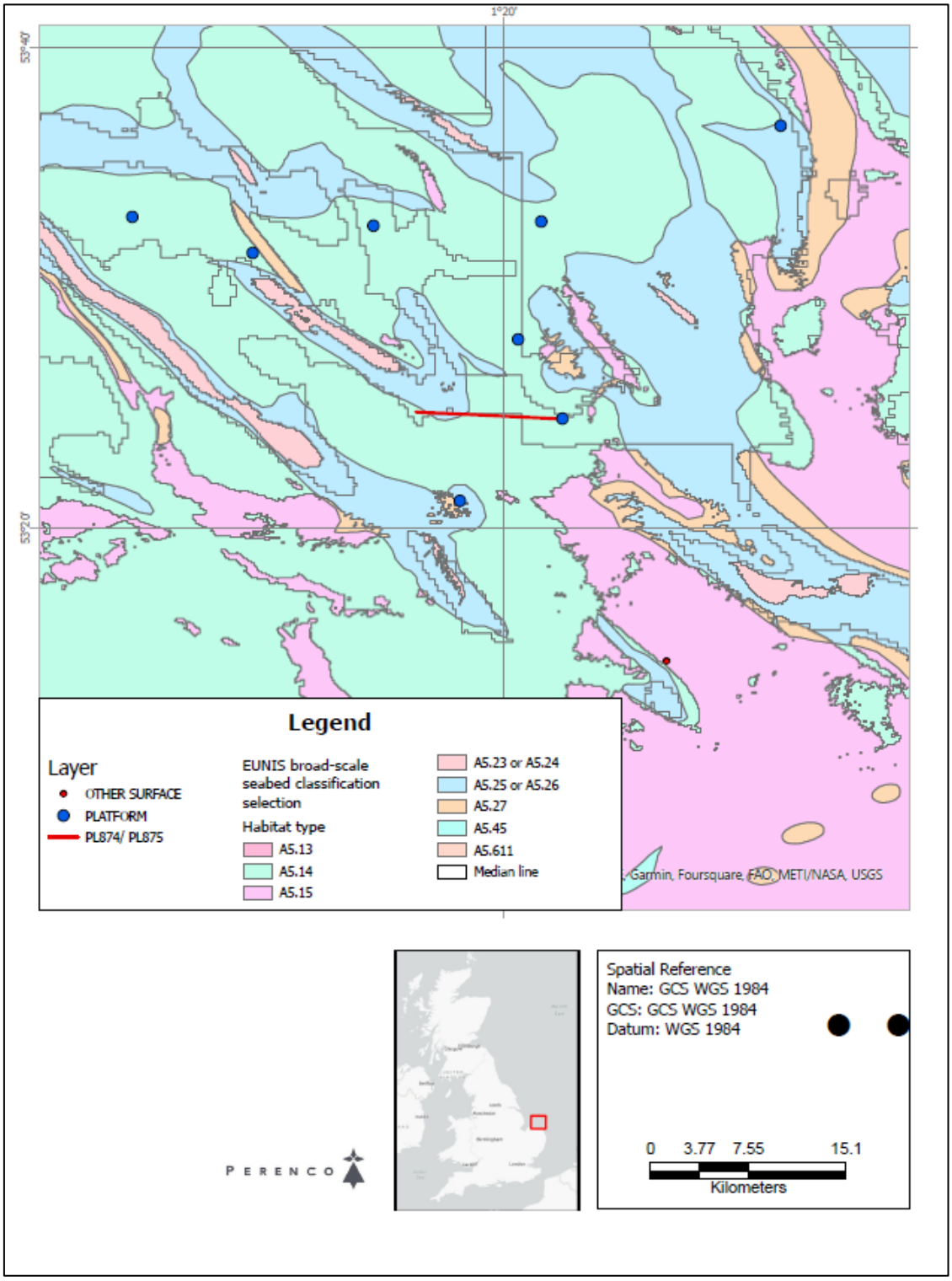


European Council (EC) Habitats Directive Annex I habitats

The formerly located Guinevere platform, its associated wells and pipeline routes are all located outside designated areas in the SNS. However, the site is near an area of potential Annex I habitats, mainly due to the presence of sandbanks and areas of biogenic reefs within the North Norfolk Sandbanks and Saturn Reef SAC/Marine Protected Area (MPA). The most likely sensitive habitat (Annex I, UK Biodiversity Action Plan (BAP) and OSPAR), other than sandbanks, is the biogenic reefs formed by the ross worm *Sabellaria spinulosa*, which comprise of dense subtidal aggregations of this small, tube-building polychaete worm. The *S. spinulosa* reef habitats of greatest nature conservation significance occur on predominantly sediment or mixed sediment areas allowing the settlement and growth of other biotas on the reef surface.

There are no noted reefs or potential reefs within the Sandbanks, however, biogenic reefs have been known to form on exposed sections of pipelines, taking advantage of the presence of hard substrate. No EC Habitats Directive Annex I habitats or other protected habitats/species were encountered during the Guinevere pre- and post-decommissioning surveys.

Figure 5-8: Seabed EUNIS broad-scale seabed classification



5.2.3 Seabed Chemistry

5.2.3.1 Total Organic Carbon (TOC)

Sediment samples from surveys were analysed for TOC and moisture content, the results of which are presented in Table 5-1. TOC represents the proportion of biological material and organic detritus within the substrate. This method is less susceptible to the interference sometimes seen using crude combustion techniques, such as analysing Total Organic Matter by loss on ignition.

TOC in surface sediments is an important source of food for benthic fauna, although an overabundance may lead to reductions in species richness and number of individuals 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 elevated adsorption on increased sediment surface areas [65].

The TOC results were below the limit of detection throughout the Guinevere pre-decommissioning environmental survey area 2017 (<0.10%), except for station 30m southwest where TOC was 0.29% (mean in the area was 0.07%+0.07 Standard Deviation (SD)). This reflects an organically-deprived environment and a possible low-level influence of the platform on the immediate surrounding sediment (at least at 30m of distance).

Table 5-1: Summary of TOC and Moisture Content

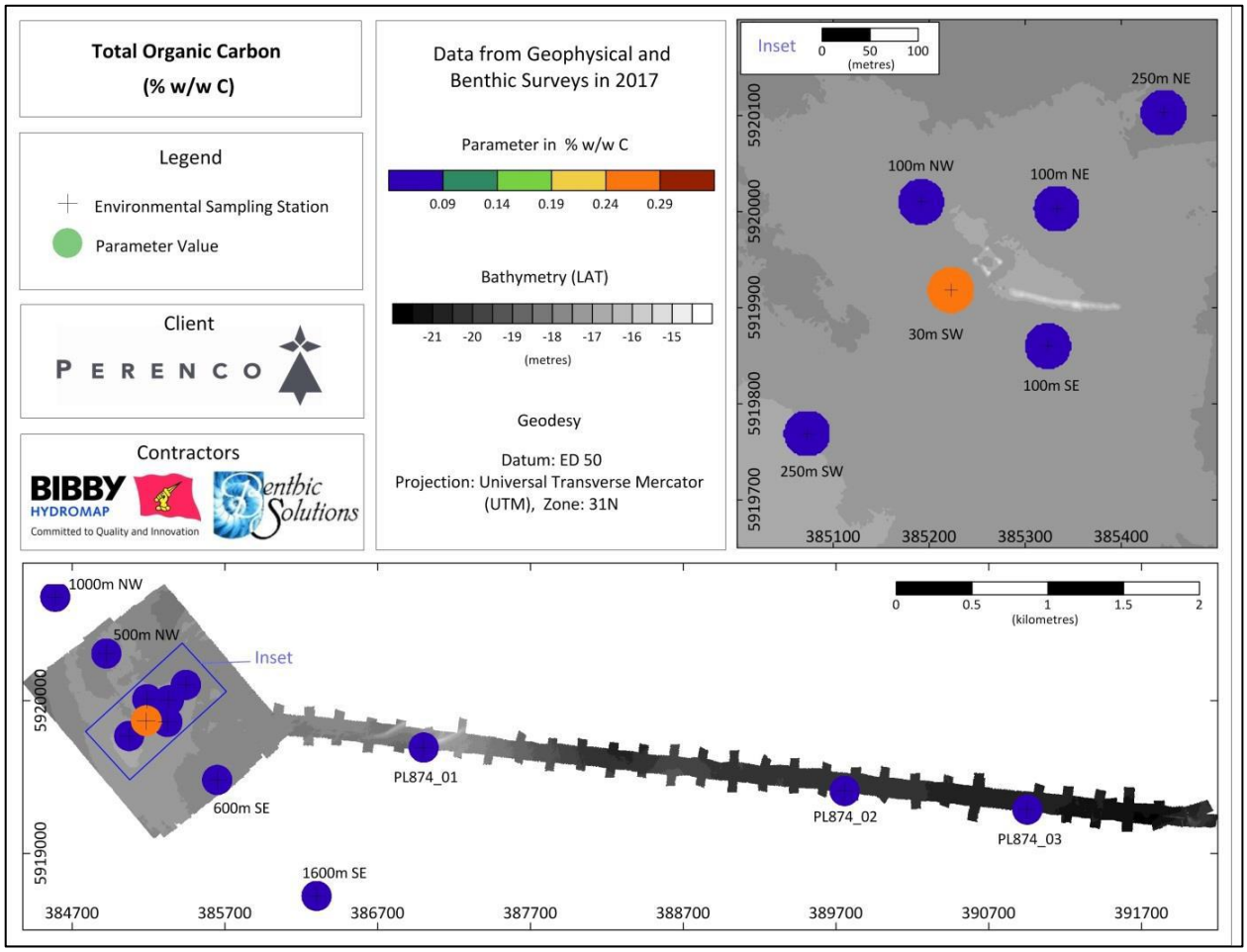
Station	Moisture Content (% w/w)	TOC (% w/w)
100m southeast	17.6	<0.1
600m southeast	21	<0.1
1600m southeast	20.5	<0.1
30m southwest	17.6	0.29
250m southwest	19.4	<0.1
100m northwest	19.3	<0.1
500m northwest	21	<0.1
1000m northwest	20.3	<0.1
100m northeast	21.2	<0.1
250m northeast	21.1	<0.1
PL 874/01	18.6	<0.1
PL 874/02	18.1	<0.1
PL 874/03	13.7	<0.1
Mean	19.18	0.07
SD	2.12	0.07
Variance (%)	11.06	97.23

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

In addition to TOC, the sediments were also analysed for moisture content (Table 5-1). The results were consistent at all sampling stations (mean 19.18%±2.12SD), indicative of similar texture and consolidation throughout. As would be expected, stations with more fines showed high moisture levels (i.e. 600m southeast and 250m northeast). However, station PL 874/03 showed low moisture content despite the highest percentage of fines in the area.

Post platform decommissioning surveys confirm TOC content in sediments was low overall compared to the average content of 0.5% for the deep ocean of 2% for coastal seas [62], ranging between 0.11 at station GU_03 and 0.30% at station GU_04, with an average value of 0.16 ± 0.01%. However, it was higher than the TOC content measured during the pre-decommissioning survey.

Figure 5-9: TOC pre-decommissioning environmental survey



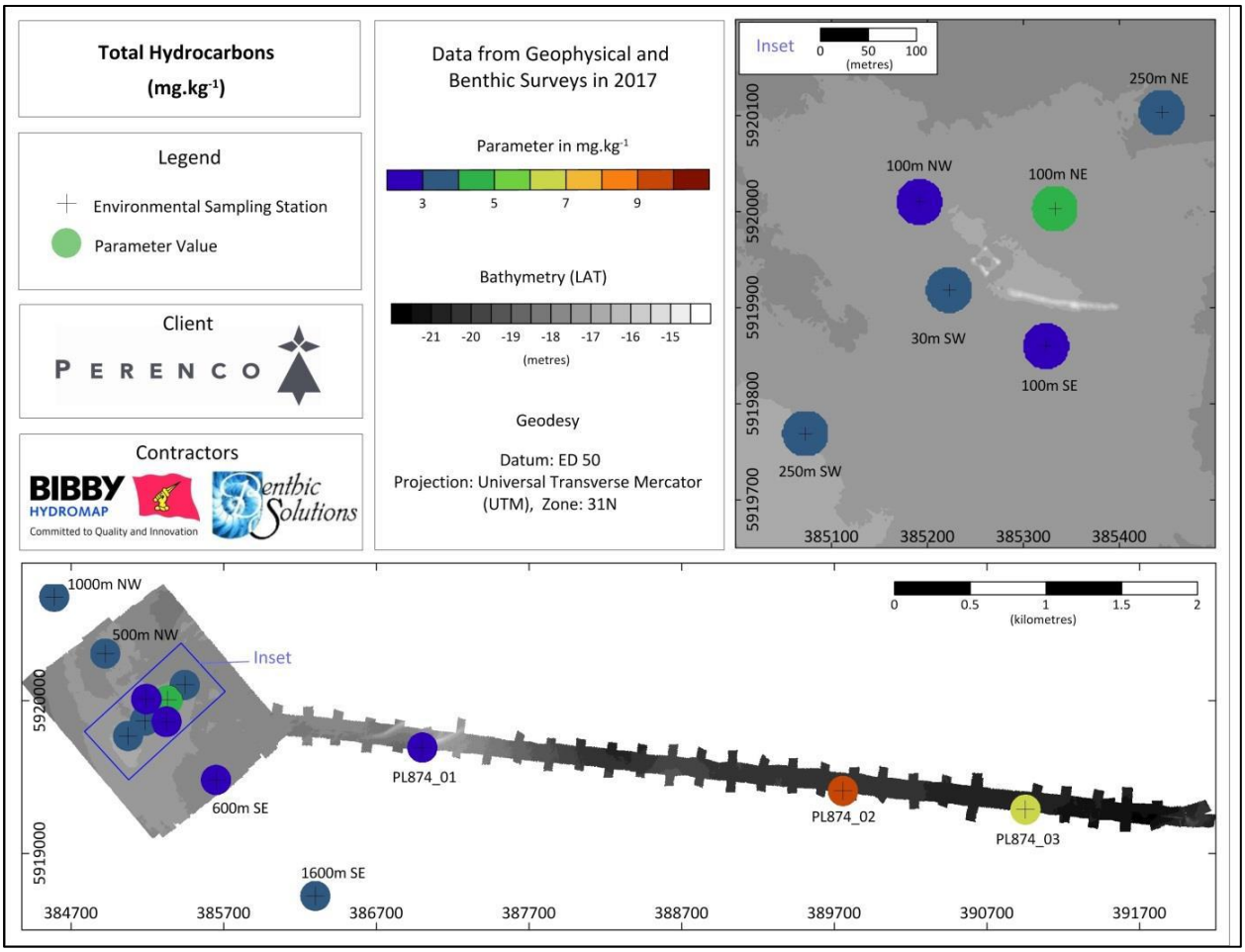
5.2.3.2 Total Hydrocarbon Content (THC)

The THC of the sediments was measured by the integration of all non-polarised components within the Gas Chromatography trace. The 2017 pre-decommissioning survey results showed generally low levels ranging from 2.194µg.g^{-1} to 4.544µg.g^{-1} near the Guinevere platform and higher concentrations of 9.754µg.g^{-1} and 6.424µg.g^{-1} recorded along the pipeline at stations PL 874_02 and PL 874_03 respectively (Table 5-2 and Figure 5-10). The mean THC for the Guinevere survey (including the pipeline) was 3.99µg.g^{-1} (±2.05SD), with notable variability recorded between stations, resulting in a percentage variance (SD over the mean) of 51.38%. The mean background THC levels for surface sediments from the SNS was estimated by the UK Offshore Operators Association (UKOOA) in 2001 to be 4.34µg.g^{-1}, with an upper 95th percentile concentration of 11.39 µg.g^{-1} for stations located over 5km from oil and gas platforms. Whilst the THC concentrations at stations PL 874/02 and PL 874/03 were slightly elevated above typical background levels for the SNS [67], higher concentrations of up to 450µg.g^{-1} have been reported around oil and gas installations [11], or between 30,000µg.g^{-1} and 150,000µg.g^{-1} on surveys of cuttings piles around offshore platforms in the central and northern North Sea [67].

Table 5-2: Summary of hydrocarbon concentrations in 2017 pre-decommissioning survey

Station	THC (µg.g^{-1})	Total n-alkanes (ng.g^{-1})	Carbon Preference Index	Pristane/ Phytane Ratio	Proportion of Alkanes (%)	Total Polycyclic Aromatic Hydrocarbons (PAH) (ng.g^{-1})	NPD (ng.g^{-1})
100m southeast	2.19	132	1.37	2.3	6.05	47	25
600m southeast	2.65	149	1.37	2.7	5.64	48	22
1600m southeast	3.19	167	1.33	6.0	5.24	42	19
30m southwest	3.75	215	1.25	9.9	5.73	45	24
250m southwest	3.51	244	1.04	7.4	6.94	62	31
100m northwest	2.34	132	1.31	5.2	5.63	55	37
500m northwest	3.63	253	1.32	5.9	6.97	76	33
1000m northwest	3.76	263	1.35	15.1	7.00	58	26
100m northeast	4.54	265	1.10	8.4	5.84	93	42
250m northeast	3.67	203	1.21	9.6	5.52	57	24
PL 874/01	2.49	188	1.23	10.9	7.54	62	24
PL 874/02	9.75	761	1.23	3.2	7.81	205	90
PL 874/03	6.42	278	1.27	3.9	4.33	108	55
Mean	3.99	250.14	1.26	6.96	6.17	73.59	34.65
SD	2.05	161.96	0.10	3.74	1.00	43.88	19.26
Variance (%)	51.45	64.75	8.04	53.76	16.24	59.63	55.57

Figure 5-10: THC in 2017 pre-decommissioning survey



Samples collected at the post-platform decommissioning surveys show similar THC concentrations. THC varied from 1,620µg.kg^{-1} at station GU_06 to 6,630µg.kg^{-1} at station PL_874_03, with no obvious pattern observed between THC and proximity to the platform. No pattern emerged when comparing THCs with the correspondent TOC or mud content, which could have been related to transportation and deposition of hydrocarbons across the survey area. All the sediment sampling results over time suggest that decommissioning activities across the Guinevere field did not have an impact on local sediments.

5.2.3.3 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 [55]. Rivers, coastal discharges, and the atmosphere are the principal modes of entry for most metals into the marine environment [60], 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) [46], 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 [5], 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 heavy metals as impurities, including Cadmium (Cd), Cr, Copper (Cu), Pb, Mercury (Hg), and Zn. Heavy metals, either as impurities or additives are also present in other mud components.

Table 5-3 displays the results of Heavy metal analysis from 2017 pre-decommissioning activities and Table 5-4 displays heavy metal analysis results from the 2022 post decommissioning surveys.

Although not directly related to the oil and gas industry, all Cd levels were below the limit of detection (<0.1mg.kg^{-1}) except for PL 874/03 which gave a low concentration of 0.1mg.kg^{-1}.

Similar to the results obtained for Cd, Hg concentrations remained at low levels of between <0.01mg.kg^{-1} to 0.02mg.kg^{-1} at stations 100m southeast and 30m southwest using inductively coupled plasma - mass spectrometry (mean 0.01±0.01SD). The Effects Range Low (ERL) threshold given for this metal is 0.1mg.kg^{-1}.

The concentrations of Pb were moderately low, ranging from 5.4mg.kg^{-1} to 8.20mg.kg^{-1} (mean 6.52±0.67SD), with all stations within the background levels reported for the SNS [67]. These values were below the ERL threshold of 47mg.kg^{-1}, that can produce a harmful effect on the biota. No significant correlation was found between Pb and sediment composition.

Ba levels were very consistent and low within the survey area (mean 29.33mg.kg-1±19.81SD), ranging from 13mg.kg^{-1} to 78mg.kg^{-1}. Station PL 874/03 recorded the highest level of 78mg.kg^{-1}, slightly higher than the background level of 70.14mg.kg^{-1} for this sector of the North Sea as outlined by UKOOA in their 2001 document. This elevated level of Ba, however, does not correlate with the highest levels of THC and PAH recorded, which were instead found at Station PL 874/02. A further fusion technique was applied at all stations in order to analyse insoluble Ba, revealing a mean value of 142.15mg.kg^{-1} (±47.41SD). The levels of Ba recorded during the 2017 pre-decommissioning environmental survey are substantially lower than the mean levels of Ba (1,754.7mg.kg^{-1}) and total Ba (33,562.1mg.kg^{-1}) seen within 500m of active platforms [67].

Post-platform decommissioning survey in 2022 confirmed the negligible impact of the heavy metals and trace metal concentrations within the sediments at the Guinevere platform and pipelines. Among all metals measured during the post-decommissioning survey, only Arsenic (As) exceeded reference levels at one location (Table 5-4).

When comparing the concentrations of key metals with post and pre-decommissioning data, no statistically significant differences were found between the concentrations of Pb, Ba and Barium by fusion (Tba) over time, suggesting that the decommissioning of the Guinevere field did not have a negative impact on local sediments.

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.

Table 5-3: Total Heavy and Trace Metal Concentrations (mg.kg^{-1}) in 2017 pre-decommissioning survey

Station	AS (AR-MS)	Cd (AR-MS)	Cr (AR-MS)	Cu (AR-MS)	Pb (AR-MS)	Hg (Tot.MS)	Nickel (Ni) (AR-MS)	Vanadium (AR-MS)	Zn (AR-MS)	Aluminium (Sediments AR-OES)	Fe (Sediments AR-OES)	BA (Sediments AR-OES)	Tba (Sediments - Fusion)	Tin (AR MS)
100m southeast	9.00	<0.1	6.30	7.00	6.40	0.02	4.40	14.60	17.40	2,510	8,170	23	107	<0.5
600m southeast	10.50	<0.1	5.80	6.30	6.70	0.01	3.40	14.50	13.90	1,830	7,410	25	119	<0.5
1600m southeast	9.50	<0.1	5.30	5.50	6.70	0.01	3.10	13.50	14.00	1,360	6,810	17	145	<0.5
30m southwest	10.00	<0.1	5.50	6.10	6.70	0.02	3.20	14.40	14.80	1,400	7,280	21	118	<0.5
250m southwest	8.60	<0.1	4.80	5.60	5.80	0.01	2.90	12.90	12.10	1,120	6,640	15	162	<0.5
100m northwest	9.10	<0.1	5.10	6.00	6.20	0.01	3.10	13.40	14.30	1,220	6,930	17	94.1	<0.5
500m northwest	9.20	<0.1	5.30	5.40	6.50	<0.01	3.20	13.70	13.80	1,370	7,030	21	195	<0.5
1000m northwest	6.40	<0.1	5.00	6.00	5.40	0.01	2.60	10.80	12.70	1,340	6,100	27	110	<0.5

Station	AS (AR-MS)	Cd (AR-MS)	Cr (AR-MS)	Cu (AR-MS)	Pb (AR-MS)	Hg (Tot.MS)	Nickel (Ni) (AR-MS)	Vanadium (AR-MS)	Zn (AR-MS)	Aluminium (Sediments AR-OES)	Fe (Sediments AR-OES)	BA (Sediments AR-OES)	Tba (Sediments - Fusion)	Tin (AR MS)
100m northeast	11.90	<0.1	10.00	7.40	6.50	0.01	10.60	23.00	23.20	3,450	25,600	54	134	<0.5
250m northeast	8.60	<0.1	5.50	6.60	6.00	<0.01	3.20	12.00	12.50	1,220	7,220	18	94.9	<0.5
PL 874/01	16.70	<0.1	5.60	5.50	7.10	<0.01	3.80	16.70	16.20	1,490	9,160	13	118	<0.5
PL 874/02	13.20	<0.1	10.40	8.90	8.20	0.01	10.10	25.50	29.20	3,870	16,000	54	200	<0.5
PL 874/03	10.60	0.10	23.20	12.30	6.60	<0.01	28.40	35.40	28.70	10,700	19,900	78	251	0.50
Mean	**10.25**	**0.05**	**7.52**	**6.82**	**6.52**	**0.01**	**6.31**	**16.95**	**17.14**	**2,529.23**	**10,326.92**	**29.33**	**142.15**	**0.27**
SD	**2.55**	**0.01**	**5.05**	**1.91**	**0.67**	**0.01**	**7.15**	**6.96**	**5.98**	**2,610.73**	**6,169.76**	**19.81**	**47.41**	**0.07**
Variance (%)	**24.88**	**25.75**	**67.13**	**28.06**	**10.31**	**50.00**	**113.42**	**41.08**	**34.86**	**103.22**	**59.74**	**67.53**	**33.35**	**25.75**
ERL*	8.2	1.2	81	34	47	0.1	21	n.a.	150	n.a.	n.a.	n.a.	n.a.	n.a.

n.a: not available
Note: where levels were below the detection limit, a value of half the detection limit was applied in the calculations.
**Lowest concentration of metal that can produce a harmful affect*

Table 5-4: Heavy and trace metals (mg.kg^{-1}) in sediments at 2022 post platform decommissioning surveys.

Analyte	As	Cd	Cr	Cu	Pb	Hg	Ni	Zn
Centre For Fisheries and Aquaculture Science (CEFAS) Action level (AL1)	20	0.4	40	40	50	0.3	20	131
CEFAS AL2	100	5	400.0	400.0	500	3.00	200.0	800.0
OSPAR Background Ambient Concentration (BAC)	25	0.31	81	27	38	0.07	36	122
OSPAR ERL	8.2*	1.2	81	34	47	0.15	21*	150
TEL	7.24	0.7	52.3	18.7	30.2	0.13	-	124
PEL	41.6	4.2	160	108	112	0.7	-	271
Min	*10*	*0.06*	*5.1*	*2.3*	*4.9*	*0.01*	*4.3*	*15.4*
Max	*24.1*	*0.09*	*13.2*	*8.3*	*7*	*0.02*	*13.8*	*37.2*
Mean	*14.41*	*0.07*	*9.15*	*4.45*	*6.18*	*0.02*	*8.70*	*22.89*
SE	*1.08*	*0.01*	*0.89*	*0.52*	*0.16*	*0.00*	*0.98*	*1.90*
GU_02	13.3	<0.04	11.0	4.0	6.1	<0.01	10.1	21.0
GU_03	12.3	<0.04	8.1	3.1	5.8	<0.01	6.2	18.2
GU_04	12.0	<0.04	11.1	6.8	6.8	<0.01	11.5	27.6
GU_05	10.0	<0.04	5.7	2.4	4.9	<0.01	5.2	15.5
GU_06	13.9	<0.04	6.8	5.2	6.9	<0.01	6.3	23.3
GU_07	12.2	<0.04	5.8	2.9	6.0	<0.01	4.9	17.4
GU_08	11.7	<0.04	5.1	2.5	6.1	0.02	4.3	15.4
GU_09	12.3	0.08	8.4	4.9	5.7	<0.01	9.2	20.2
GU_10	17.3	0.09	12.9	6.4	7.0	<0.01	13.4	37.2
GU_11_REF	24.1	0.06	12.5	4.2	5.9	<0.01	11.6	28.4
PL_874_01	19.7	0.06	5.4	2.3	6.4	0.02	4.7	15.4
PL_874_02	15.3	0.06	13.2	4.9	6.6	0.01	11.9	28.9
PL_874_03	13.2	<0.04	13.0	8.3	6.1	<0.01	13.8	29.1

*The ERLs for As and Ni are below the BACs therefore As and Ni concentrations are usually assessed only against the BAC.
Red shading indicates values above CEFAS AL1

Table 5-5: Number of stations across the Guinevere survey area exhibiting elevated heavy and trace metals levels in comparison with OSPAR, CEFAS and Canadian Sediment Quality Guidelines (CSQG).

Metal	CEFAS		OSPAR BAC		CSQG	
	AL1	AL2	BAC	ERL	TEL	PEL
As	1	0	0	13*	13	0
Cd	0	0	0	0	0	0
Cr	0	0	0	0	0	0
Cu	0	0	0	0	0	0
Pb	0	0	0	0	0	0
Hg	0	0	0	0	0	0
Ni	0	0	0	0	0	0
Zn	0	0	0	0	0	0

*The ERLs for As is below the BAC therefore As concentrations are usually assessed only against the BAC.
TEL – Threshold Effect Levels
PEL - Probable Effect Levels

5.2.4 Waves

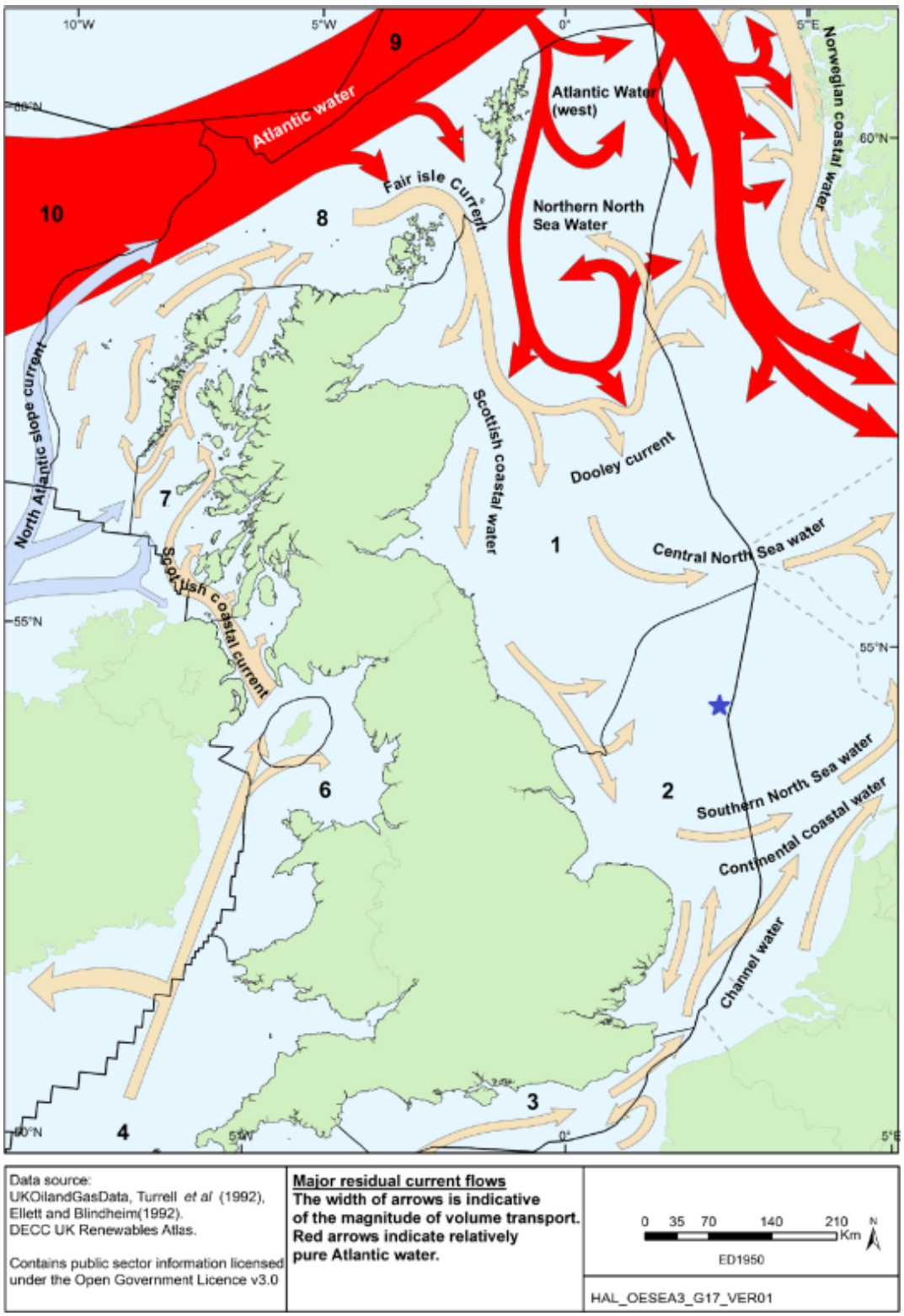
Waves are the result of energy being transferred between two fluids moving at different rates [15]. They are caused at sea by the differential motion of the air (wind) and the seawater. The height of a wave is the distance from the crest to trough, but as the waves at any one time are not of equal size, 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.

Significant wave heights in the vicinity of Guinevere field UKCS Block 48/17 are 1.5 – 2.5m for only 10% of the time but exceed 0.5m 75% of the time [66]. Annual mean significant wave heights in this area of the SNS varies between 1.2 and 1.5m.

5.2.5 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 northern North Sea. As a result, residual water currents near the sea surface tend to move in a south-easterly direction along the coast towards the English Channel [48;12]. Tidal stream velocities in the vicinity of the UKCS Block 48/17 range between 0.3 and 1.7m per second during spring tides and 0 and 0.9m per second for neap tides [28]. It is important to note that significant variations in local currents occur in the vicinity of the UKCS Block 48/17 which can influence near bottom flow and current amplification around these features [27;8]. The shallow bathymetry and relatively fast water circulation in this area of the SNS lead to a relatively well-mixed water column throughout the year [12]. This leads to a consistent level of biological productivity throughout the year, with only minor peaks seen in spring and late summer, which are typical of deeper waters.

Figure 5-11: Major Current flows around the UK [12]



5.2.6 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 [18]. Sea surface temperatures in the vicinity of UKCS Block 48/17 is low from January to April (6 - 7°C) and warmer between May and December (9 - 15°C) with peak sea surface temperatures occurring in August and September.

Salinities decrease both towards the south and towards the coastline, reflecting the influence of freshwater inputs from the adjacent landmasses.

5.3 Biological Environment

5.3.1 Benthic Biodiversity

Benthic faunal communities were assessed during the Guinevere pre-decommissioning survey in 2017 (Table 5-6; Figure 5-12; Figure 5-13). A total of 451 individuals (infauna species) were recorded from 26 samples collected at 13 stations. The sediment was relatively consistent throughout the survey area, predominantly composed of sand with varying levels of gravel/shell material and regular bedforms such as sand ripples and megaripples created by boundary currents and wave action (Section 5.2.2).

The macrofauna throughout the Guinevere survey area showed some small-scale variability in terms of abundance, richness and species composition associated with the sediment composition across the survey area. The most abundant phyla group identified within the samples are the crustaceans, representing 51.8% by 16 species, followed by annelids by 16 species (24.9%), molluscs by 14 species (18.2%), and echinoderms by three species (1.6%). Despite crustaceans were the dominant group, the infauna community was dominated by annelids in terms of species richness, followed by crustaceans and molluscs. The faunal assemblage was similar across all samples, with multivariate analyses finding no significant difference between groups, however, some intra-station samples showed up to 60% dissimilarity. The species richness and diversity were also similar across the survey area, with only small-scale variations recorded. *S. spinulosa* individuals were recorded at 5 stations, however, only 15 individuals were recorded across the survey area, and there was no evidence of biogenic reef in either the grab or image data. Additionally, no evidence of biogenic reef was recorded.

Table 5-6: Overall species ranking (top 15 species) 2017 pre-decommissioning survey.

Overall Top 15 Rank	Species/Taxon	Total rank score (out of 260)	Phylum	Numerical Abundance (26 replicates)	Numerical Top 15 rank
1	*Urothoe elegans*	139	Crustacea	113	1
2	*Abra alba*	122	Mollusca	42	3
3	*Nephtys cirrosa*	107	Annelida	23	4
4	*Bathyporeia guilliamsoniana*	88	Crustacea	50	2
5	*Abludomelita obtusata*	68	Crustacea	18	5

Overall Top 15 Rank	Species/Taxon	Total rank score (out of 260)	Phylum	Numerical Abundance (26 replicates)	Numerical Top 15 rank
6	*Sabellaria alveolata*	65	Annelida	15	7
7	*Crepidula fornicata*	57	Mollusca	11	8
8	*Bathyporeia tenuipes*	54	Crustacea	18	5
9	*Nebalia bipes*	44	Crustacea	7	13
10	*Ophelia limacina*	39	Annelida	6	16
11	*Lepidonotus squamatus*	35	Annelida	7	13
12	*Ammothella longipes*	35	Crustacea	5	18
13	*Scoloplos (Scoloplos) armiger*	33	Annelida	11	8
14	*Syllis cornuta*	33	Annelida	5	18
15	*Abra prismatica*	33	Mollusca	6	16

Figure 5-12: Proportion of individual abundance by main taxonomic group for each station, pre-decommissioning survey, 2017

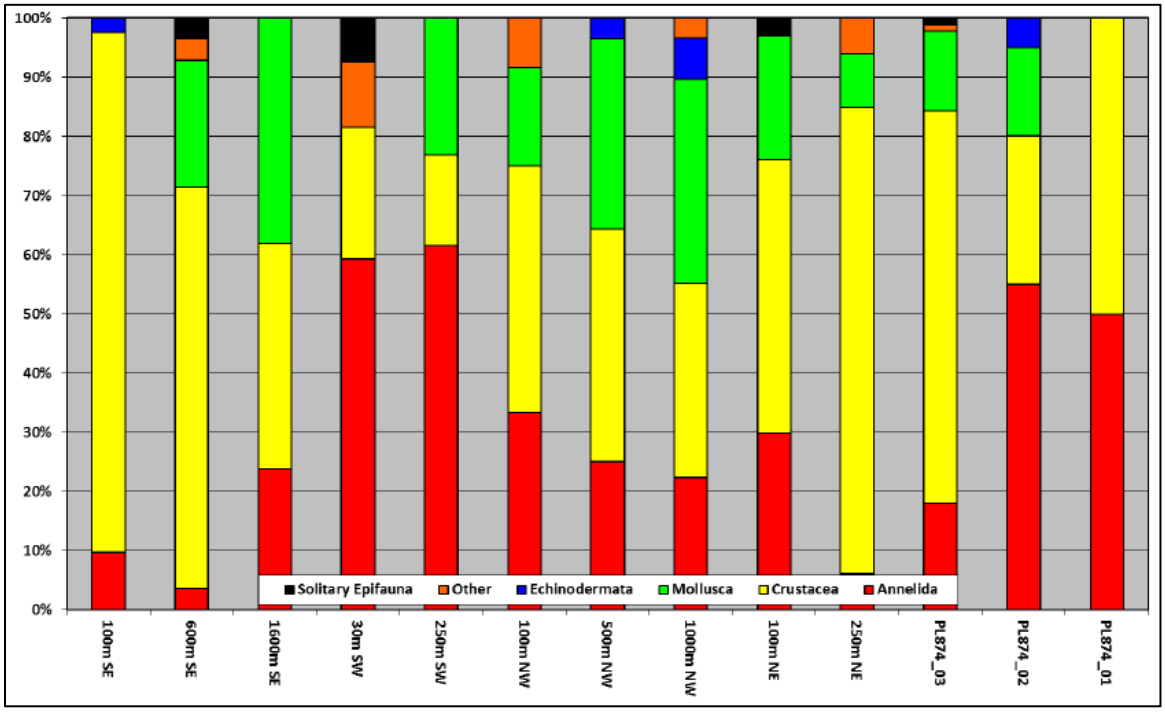
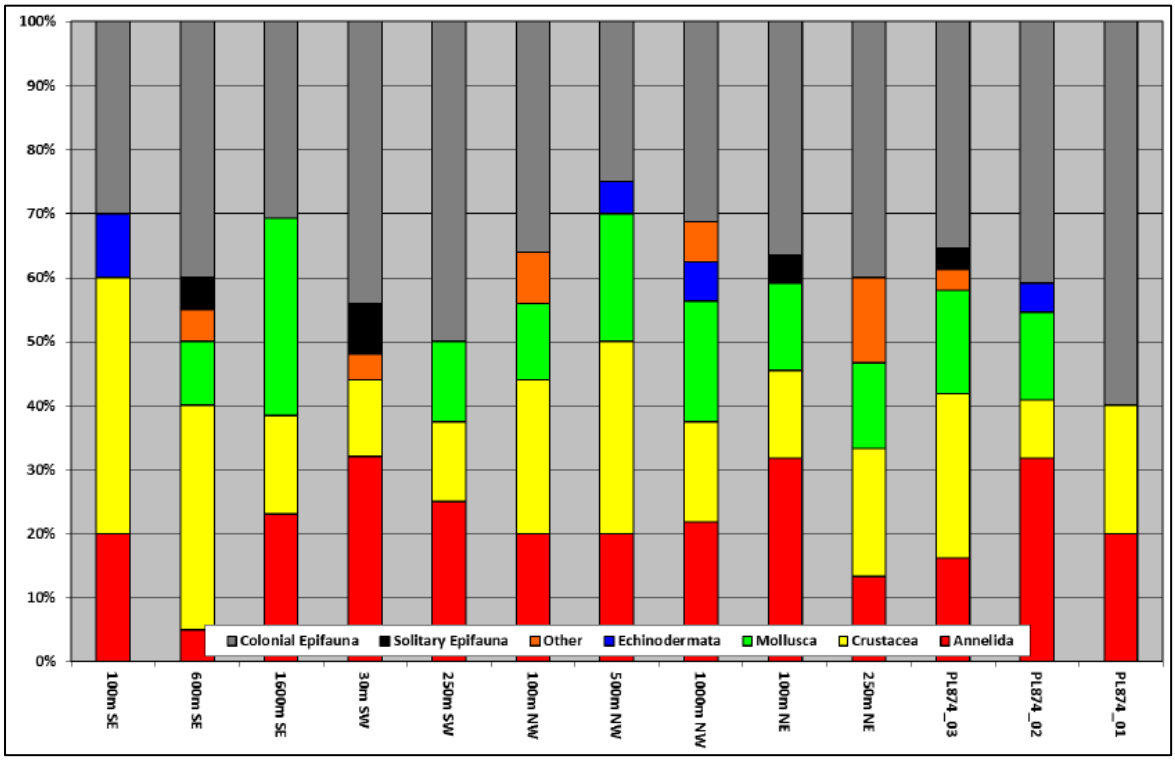


Figure 5-13: Proportion of individual diversity by main taxonomic group for each station, pre-decommissioning survey, 2017



There appeared to be no distinct macrofaunal groupings or impact coming from the Guinevere infrastructure based on their relative position to the platform. Benthic communities in the vicinity of the Guinevere survey area are therefore likely to be representative of those found in similar environmental conditions in the SNS.

Of note, *Sabellaria alveolata* was not conspicuous in the video/photographic data and just 15 individuals were recovered throughout the entire survey. As such, its presence does not require further consideration under the protected 'reef' status. Furthermore, no EC Habitats Directive Annex I habitats or other protected habitats/species were encountered during the 2017 Guinevere pre-decommissioning environmental survey.

A further 26 macrofauna samples obtained from the 13 grab sampling stations were assessed at the Guinevere post-platform decommissioning survey in 2022 (Figure 5-14; Figure 5-15; Figure 5-16). A total of 5,070 individuals and 237 taxa were recorded. Similar to the pre-decommissioning survey, limited variations in macrofauna mean abundance, diversity and biomass were observed per station across the survey area. However, on average, the annelids group contributed most to abundance, diversity and biomass as they accounted for about 54% of all individual recorded, 38% of all taxa recorded and 46% of all biomass recorded.

Figure 5-14: Proportion of individual abundance by major taxonomic group by station, post-platform decommissioning survey

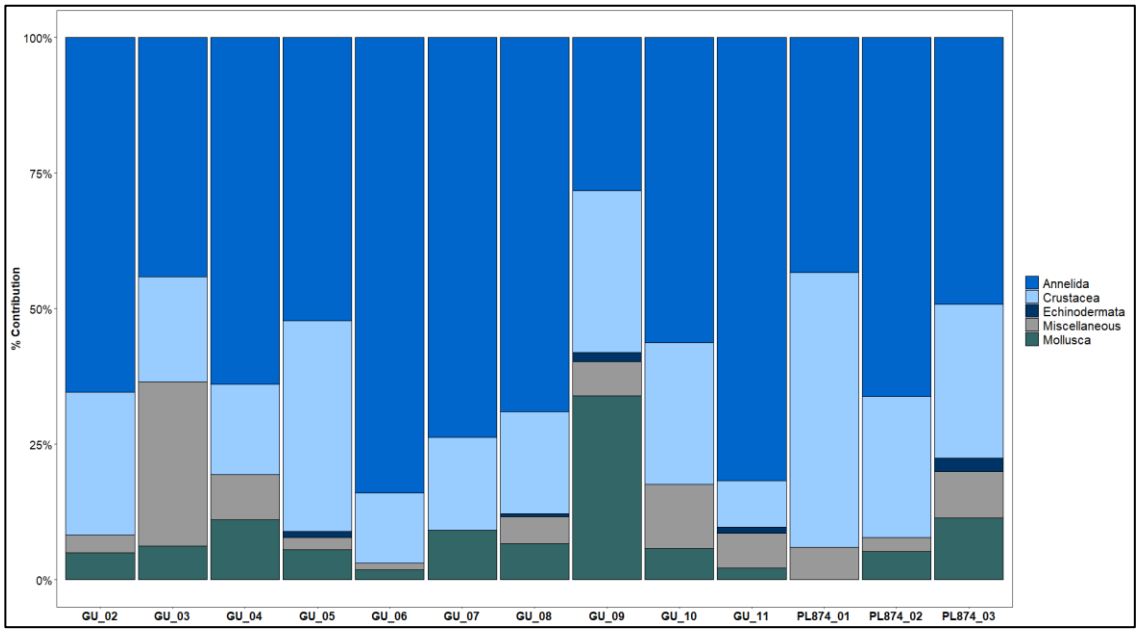
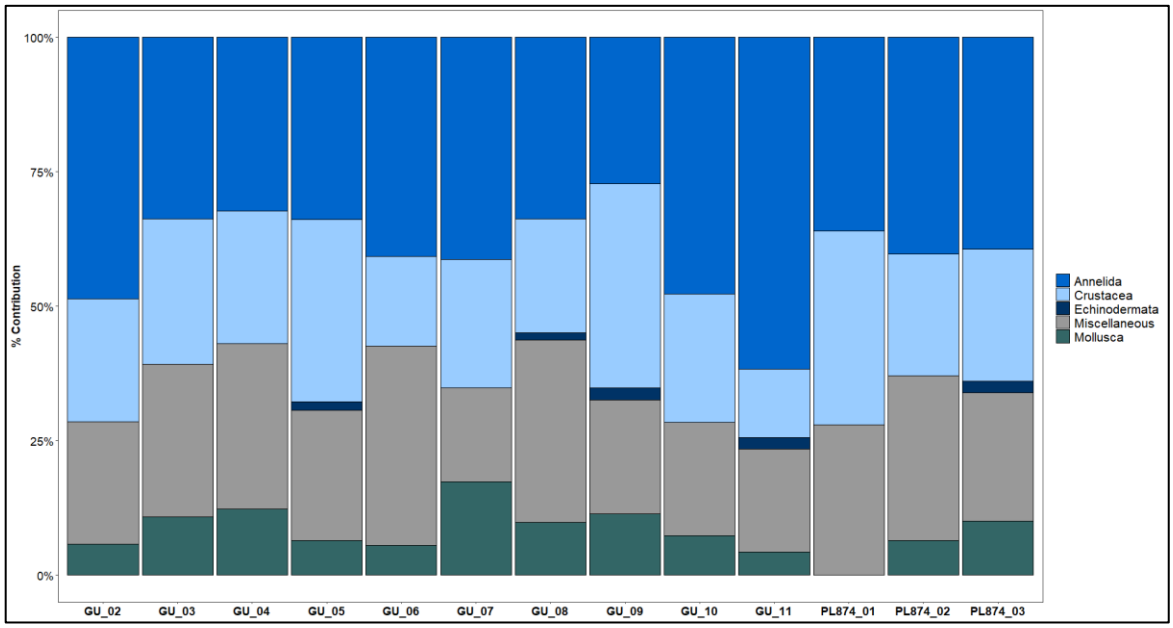


Figure 5-15: Proportion of individual diversity by major taxonomic group by station, post-platform decommissioning survey



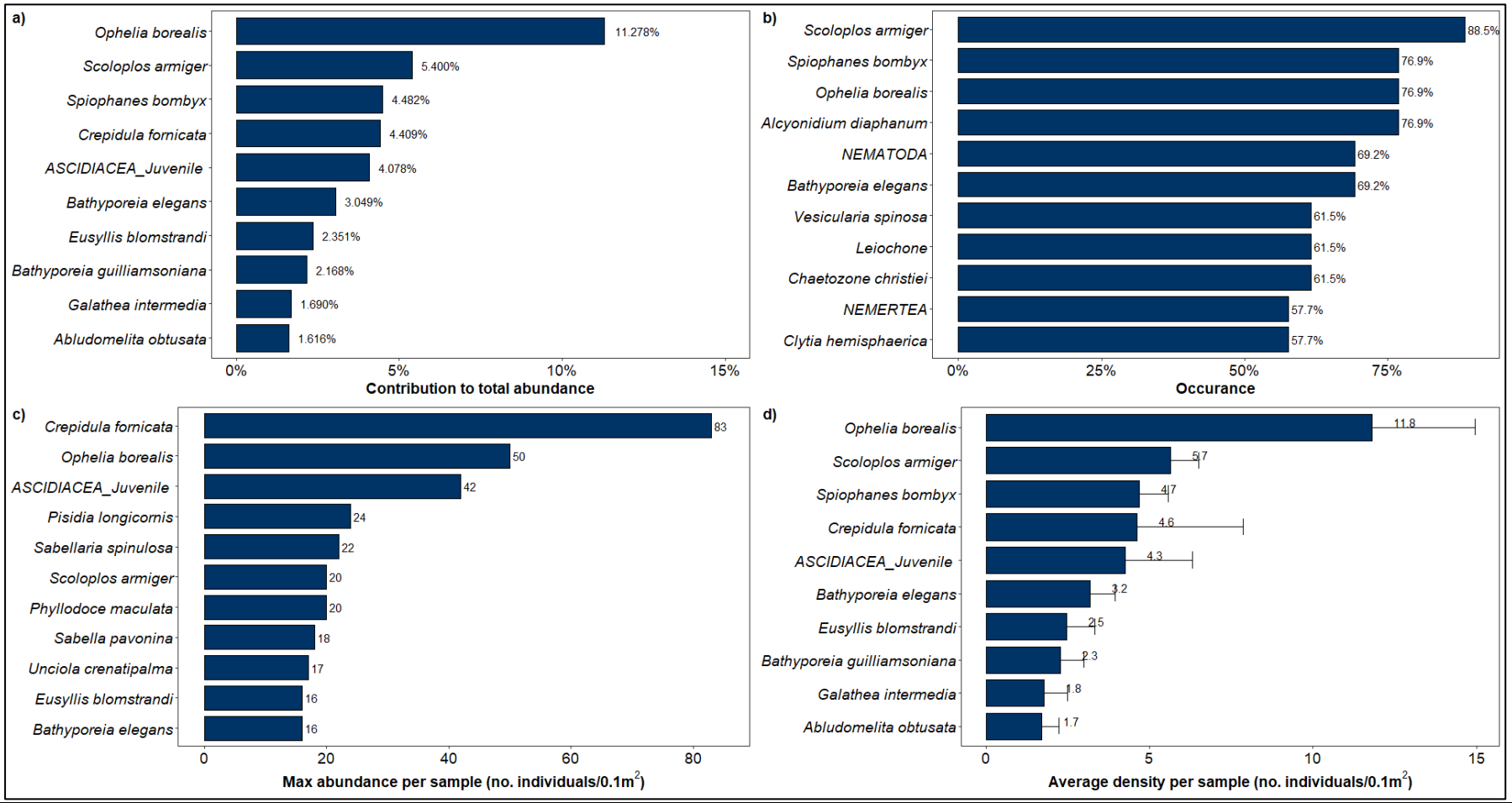
Most stations were characterised by the presence of the armoured bristleworm (*S. armiger*) which occurred at 88.5% of stations, while the bristleworm (*Ophelia. borealis*) exhibited the maximum abundance per sample of all taxa recorded across the survey area.

Two Invasive Non-Native Species (INNS) were found across the Guinevere field: the slipper limpet (*C. fornicata*) and the crustacean *Monocorophium sextonae*. *C. fornicata* is originally from the Eastern coast of North America and was accidentally introduced in the UK in 1872 as contaminant on other animals (e.g., on commercial oysters) and via ship/boat hull fouling. Slipper limpets can form dense colonies and compete for space and smother native species potentially changing local habitats [19]. A total of 120 individuals were counted across the survey area, with 83 individuals occurring at station GU_09B, however no evidence of *C. fornicata* colonies were observed in the seabed imagery collected at this location.

M. sextonae is originally from New Zealand and was first introduced to the UK in the 1930s. Effects on the environment due to the presence of this INNS seem negligible; however, *M. sextonae* has been observed competing with the native amphipod Crassicorophium bonellii [19]. Only four specimens were recorded across the Guinevere field all identified at station GU_09 (one individual in replicate A and three individuals in replicate B).

The Ross worm (*S. spinulosa*) is a protected species under the Habitats Directive and as a threatened and/or declining species in the OSPAR list. A total of 41 individuals were counted across the Guinevere field with 38 specimens recorded at station PL 874_03 (22 in replicate A and 16 in replicate B). Nevertheless, no evidence of reef forming features were observed in the seabed imagery. Similar aggregations of *S. spinulosa* were recorded during the pre-decommissioning survey; however, these were also deemed to not meet the reef qualifying criteria [22].

Figure 5-16: Percentage contributions of the top 10 macrobenthic taxa to total abundance (a) and occurrence (b) from samples collected across the Guinevere post-decommissioning survey area. Also shown are the maximum densities of the top 10 taxa per sample (c) and average densities of the top 10 taxa per sample (d). [25]



5.3.2 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 [12].

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 [37]. The phytoplankton community in the Regional Sea 2 area is dominated by the dinoflagellate genus Tripos (*T. fusus, T. furca, T. lineatus*), along with higher numbers of the diatom, Chaetoceros (subgenera Hyalochaete and Phaeoceros) than are typically found in the northern North Sea. From November to May when mixing is at its greatest, diatoms comprise a greater proportion of the phytoplankton community than dinoflagellates [12].

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*. There has been a marked decrease in copepod abundance in the SNS, which has been linked to changes in global weather phenomena [12]. However, the planktonic assemblage in the vicinity of the proposed deposit operations is not considered unusual.

5.3.3 Fish & Shellfish

The North Sea supports a diverse fish community, many species of which are umbrella species, providing an essential food source for larger marine predators (such as marine mammals and seabirds), or area of commercial importance. Several fish species of conservation importance also utilise the North Sea.

The migratory fish species that may be present in the North Sea include lampreys, shads, salmonids, European eel (*Anguilla Anguilla*), and smelt (*Osmerus eperlanus*) [20]. These species may utilise both freshwater river systems and saltwater sea areas for spawning before migrating to the sea. Commercially important fish species in the North Sea include Atlantic cod (*Gadus morhua*), European plaice (*Pleuronectes platessa*), Dover sole (*Solea solea*), lemon sole (*Microstomus kitt*), whiting (*Merlangius merlangus*), sprat (*Sprattus sprattus)*, thornback ray (*Raja clavate)*, blonde ray (*R. brachyura*), Atlantic mackerel (*Scomber scrombrus*), Atlantic herring (*Clupea harengus*), and sandeel species Ammodytidae. The latter 3 are of also high ecological importance, supporting wider populations of fish and other marine predators [20].

Generally, there is little interaction between fish and offshore developments, although some species congregate around platforms and along pipelines. However, spawning individuals and juveniles can be sensitive to seismic activities, seabed disturbance activities, discharges to sea and, in some cases, accidental spills.

The North-East Atlantic and North Sea is split into statistical grids called International Council for the Exploration of the Sea (ICES) Rectangles in order to map statistical information about the area. UKCS Block 48/17, in which the Guinevere pipelines are situated, is located within ICES Rectangle 35F1.

Species that spawn within ICES Rectangle 35F1 include herring (*Clupea harengus*), lemon sole (*Microstomus kitt*), mackerel (*Scomber scombrus*), sandeel (*Ammodytes* spp.), sole (*Solea solea*), and whiting (*Merlangius merlangus*). ICES Rectangle 35F1 is also a nursery ground for cod (*Gadhus morhua*), herring, horse mackerel (*Trachurus trachurus*), lemon sole, mackerel, plaice (*Pleuronectes platessa*), sandeels and whiting (Table 5-7) [6;16].

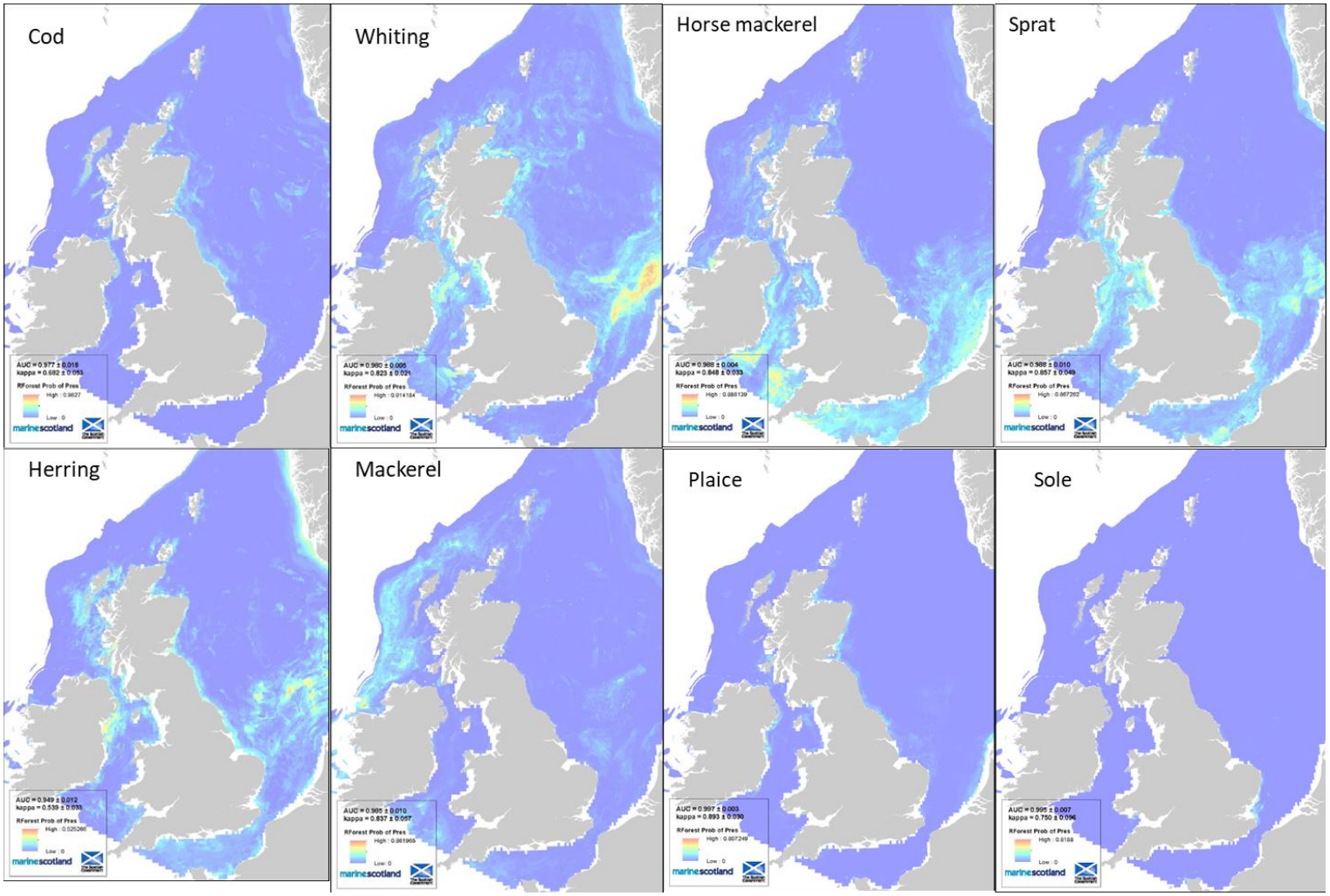
Table 5-7: Fish Spawning and Nursery Species within the Vicinity of the Guinevere Location (ICES 35F1)

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	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
Mackerel	N	N	N	N	N	N	N	N	N	N	N	N
Plaice	N	N	N	N	N	N	N	N	N	N	N	N
Sandeels	N	N	N	N	N	N	N	N	N	N	N	N
Sole												
Whiting	N	N	N	N	N	N	N	N	N	N	N	N
Key		Spawning				Peak Spawning			N	Nursery		

Spatial modelling of 0 group fish (aggregations of fish in the first year of their life) indicates that the area in the vicinity of Block 48/17 is generally not considered to be of high importance to juvenile fish species in their first year of development. Of the species mapped, there is a low to moderate probability of 0 group aggregations of sprat, plaice, herring, haddock and cod present within Block 48/17 (Table 5-7) [1].

All of the species listed in Table 5-7, with the exception of lemon sole and sprat are listed as UK BAP priority marine species. Cod is on the OSPAR List of Threatened and/or Declining Species and Habitats [54]. In addition, cod is listed as 'Vulnerable' globally on the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species and should therefore be considered as a priority for protection. All other species from Table 5-7 are listed as Least Concern IUCN [31].

Figure 5-17: Sensitivity maps for selected species [16;1]



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 [36]. 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 was 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 Block 48/17, are listed in Table 5-8 [16].

Table 5-8: Elasmobranch Species likely to be found in the Vicinity of the Guinevere Location

Common Name	Latin Name	Depth Range (m)	Global IUCN Status Note 1
Blonde skate	*Raja brachyura*	10 – 900	Near Threatened
Common smoothhound	*Mustelus mustelus*	5 – 350	Endangered
Cuckoo skate	*Leucoraja naevus*	12 – 290	Least Concern
Small spotted catshark	*Scyliorhinus canicula*	< 400	Least Concern
Spiny dogfish	*Squalus acanthias*	15 – 528	Vulnerable
Spotted skate	*Raja montagui*	< 530	Least Concern
Starry smoothhound	*Mustelus asterias*	0 – 100	Vulnerable
Thornback skate	*Raja clavata*	10 – 300	Near Threatened
Tope shark	*Galeorhinus galeus*	0 – 2000	Critically Endangered
Undulate skate	*Raja undulata*	50 – 200	Endangered

Note 1: Status as of April 2023.

Of these species, blonde skate, common smooth-hound, spiny dogfish, starry smooth-hound, thornback skate and tope shark are of most concern due to their unfavourable conservation status [31]. In addition, spotted skate, thornback skate, and spiny dogfish are listed on the OSPAR list of threatened and/or declining species and habitats [54].

5.3.4 Seabirds

The offshore waters of the SNS are visited by numerous seabirds, mainly for feeding purposes in and around the shallow sandbanks [12]. Regional Sea 2 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. Therefore, individuals found offshore in the vicinity of the Guinevere location may originate from onshore colonies or be passing migrants. Numbers of seabirds are generally lower in Regional Sea 2 compared to further north [12].

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*) [35] (Figure 5-18).

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 [12].

5.3.4.1 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.

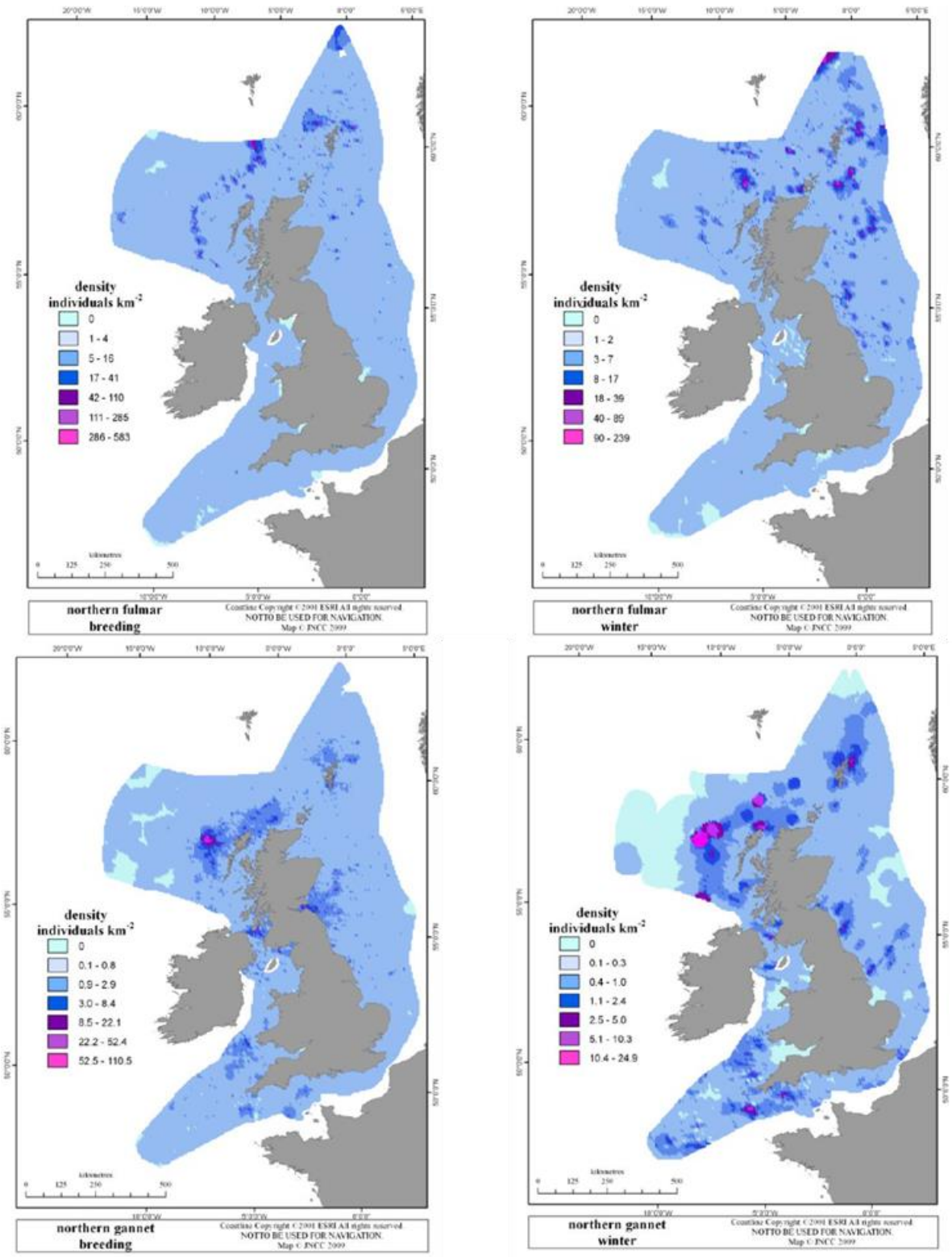
The Seabird Oil Sensitivity Index (SOSI) has been developed to identify areas where seabirds are likely to be most sensitive to oil pollution [69]. The SOSI combines seabird data collected between 1995 and 2015 and individual seabird species sensitivity index values to create a single measure of seabird 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). An assessment of the median SOSI scores indicates that the sensitivity of seabirds to oil pollution in UKCS Block 48/17 is ‘extremely high’ during November; ‘very high’ during October; ‘high’ from December to April and in August; ‘medium’ during September; ‘low’ from May to July (Table 5-9).

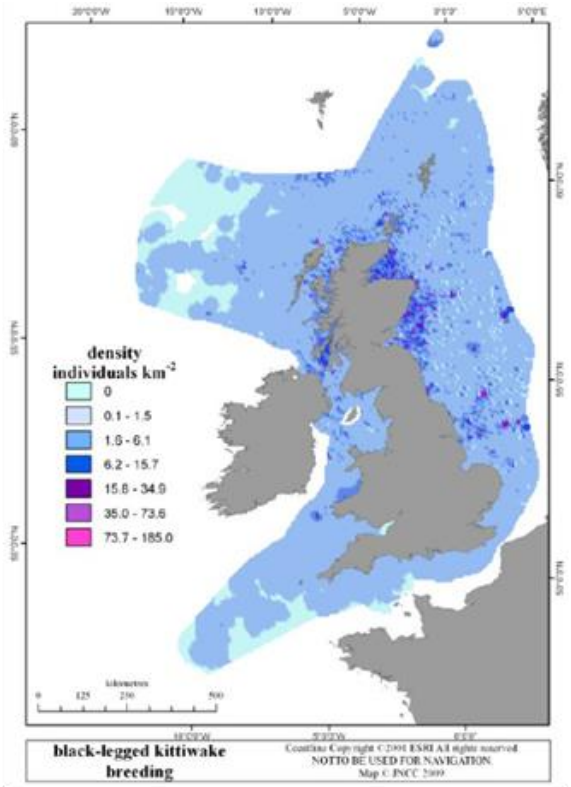
Table 5-9: SOSI scores for UKCS Block 48/17 [69]

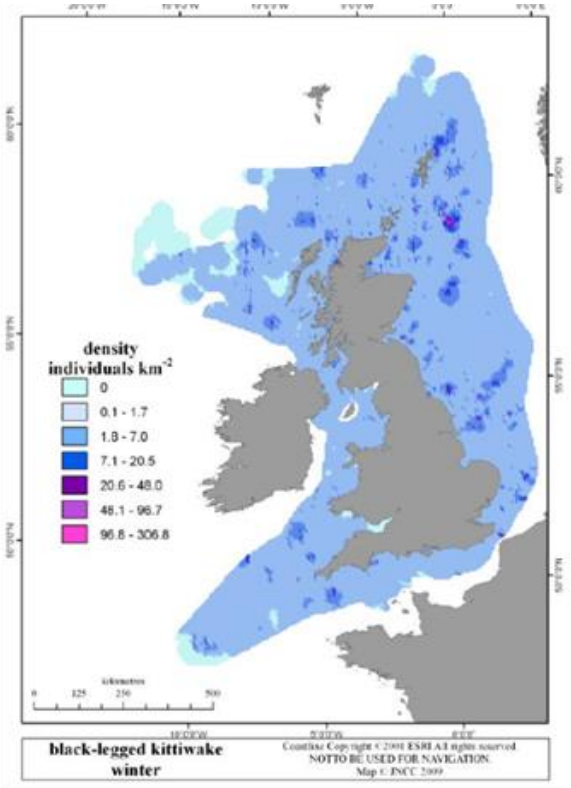
Month	January	February	March	April	May	June	July	August	September	October	November	December
Seabird vulnerability	3	3	3	3	5	5	5	3	4	2	1	3

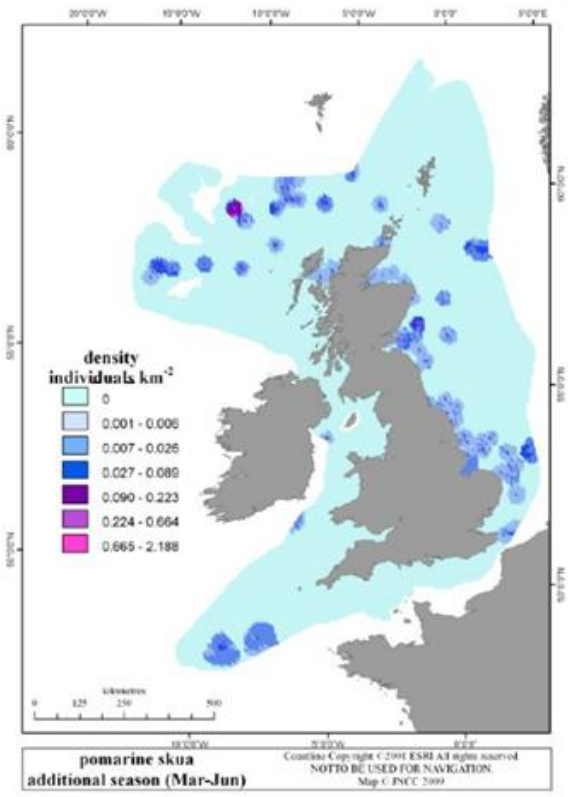
Vulnerability index	5 = low	4 = medium	3 = high	2 = very high	1 = extremely high	ND = No data

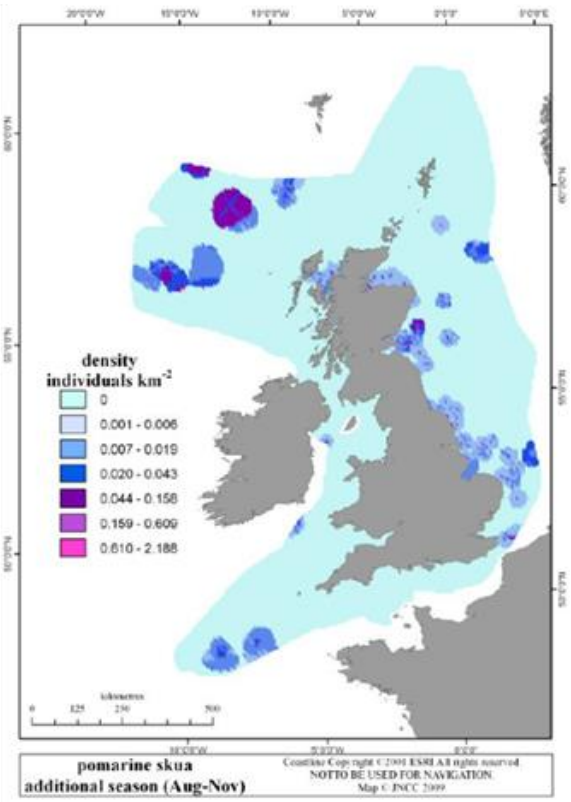
Figure 5-18: Seabird density surface maps for the species identified as frequently occurring in the SNS [35].

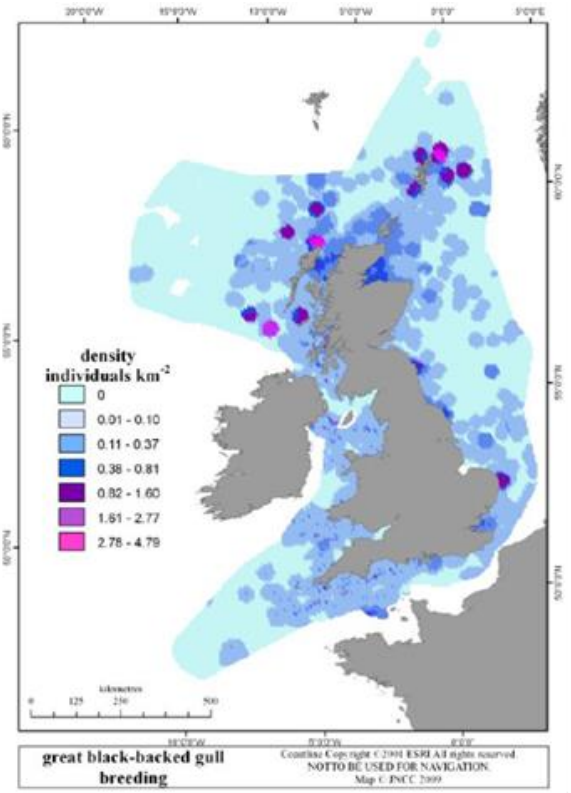


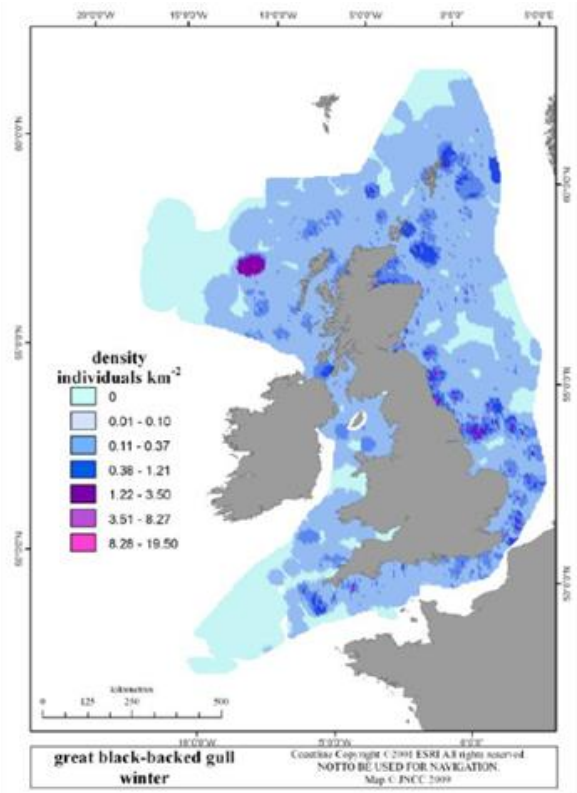

density
individuals km-2
0
0.1 - 1.5
1.6 - 6.1
6.2 - 15.7
15.8 - 34.9
35.0 - 73.6
73.7 - 185.0
black-legged kittiwake
breeding

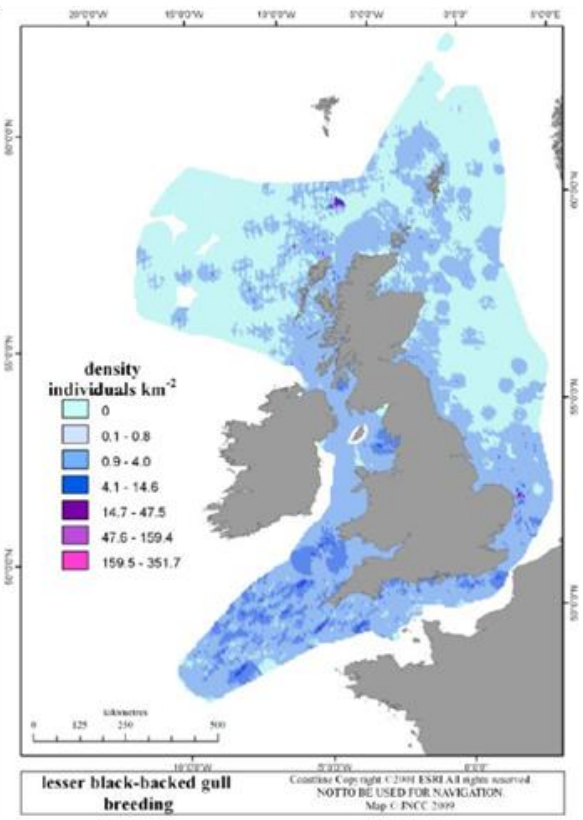

density
individuals km-2
0
0.1 - 1.7
1.8 - 7.0
7.1 - 20.5
20.6 - 48.0
48.1 - 96.7
96.8 - 306.8
black-legged kittiwake
winter

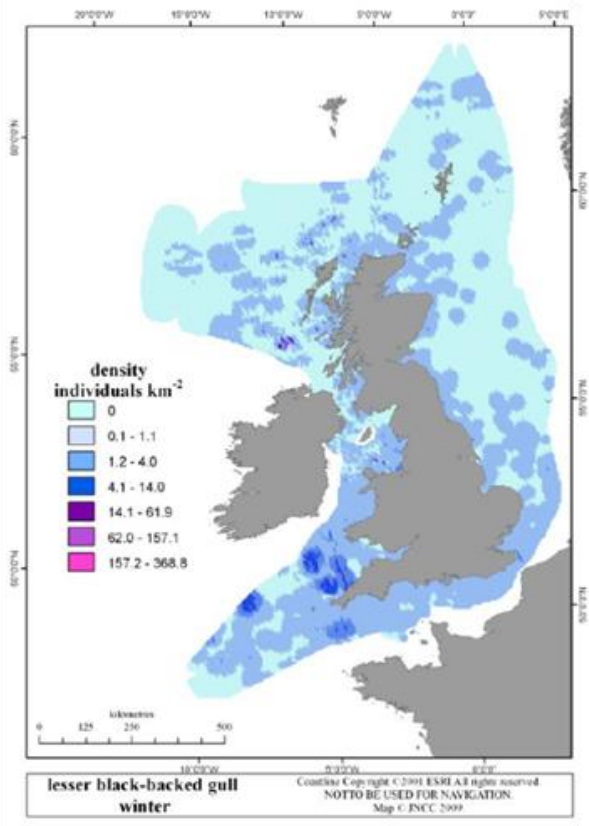

density
individuals km-2
0
0.001 - 0.006
0.007 - 0.026
0.027 - 0.089
0.090 - 0.223
0.224 - 0.664
0.665 - 2.188
pomarine skua
additional season (Mar-Jun)

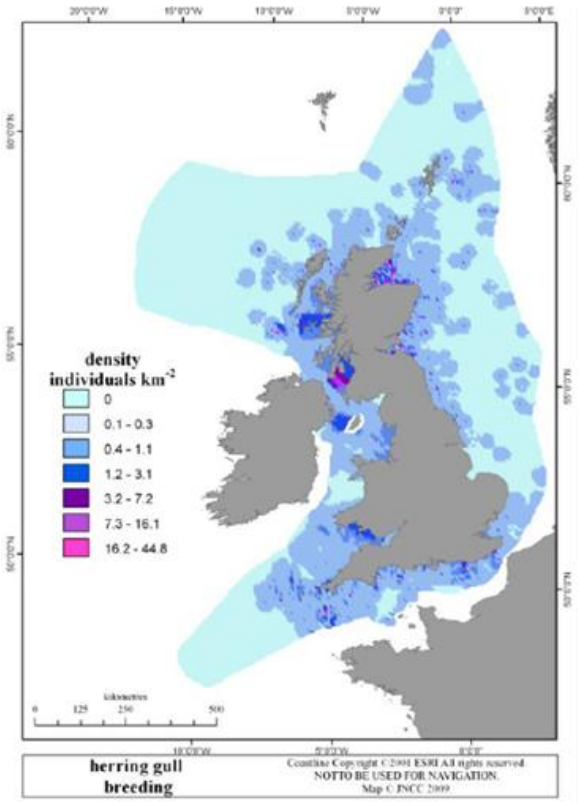

density
individuals km-2
0
0.001 - 0.006
0.007 - 0.019
0.020 - 0.043
0.044 - 0.158
0.159 - 0.609
0.610 - 2.188
pomarine skua
additional season (Aug-Nov)

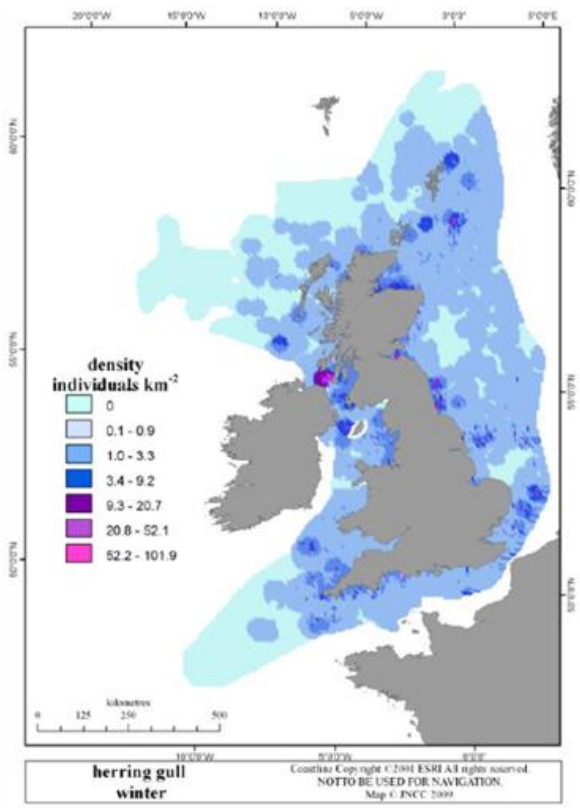

density
individuals km-2
0
0.01 - 0.10
0.11 - 0.37
0.38 - 0.81
0.82 - 1.60
1.61 - 2.77
2.78 - 4.79
great black-backed gull
breeding

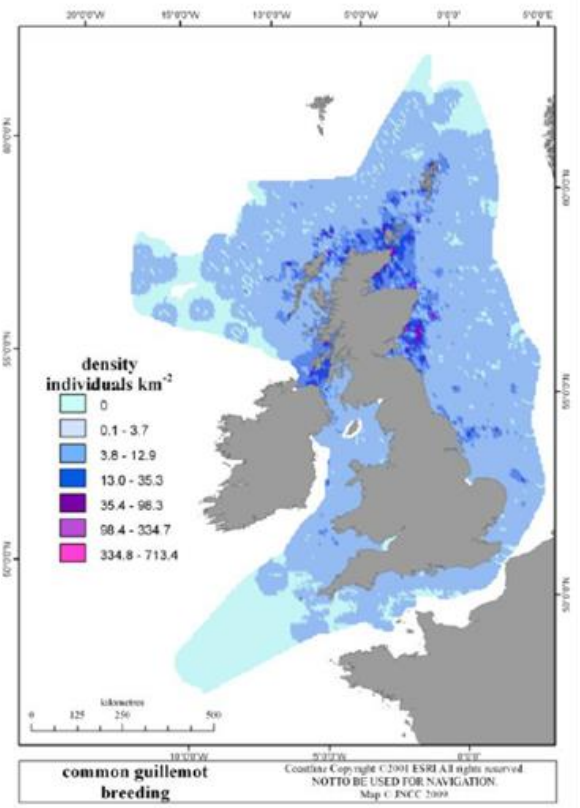

density
individuals km-2
0
0.01 - 0.10
0.11 - 0.37
0.38 - 1.21
1.22 - 3.50
3.51 - 8.27
8.28 - 19.50
great black-backed gull
winter

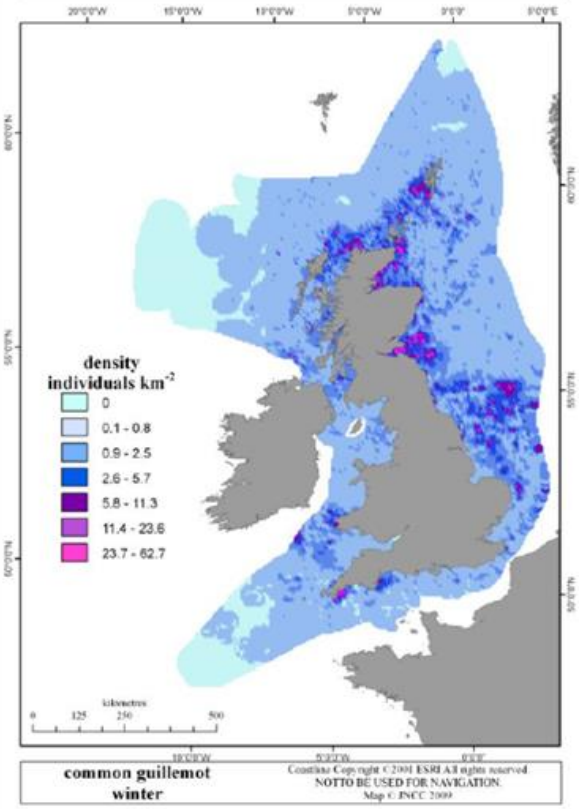

density
individuals km-2
0
0.1 - 0.8
0.9 - 4.0
4.1 - 14.6
14.7 - 47.5
47.6 - 159.4
159.5 - 351.7
lesser black-backed gull
breeding

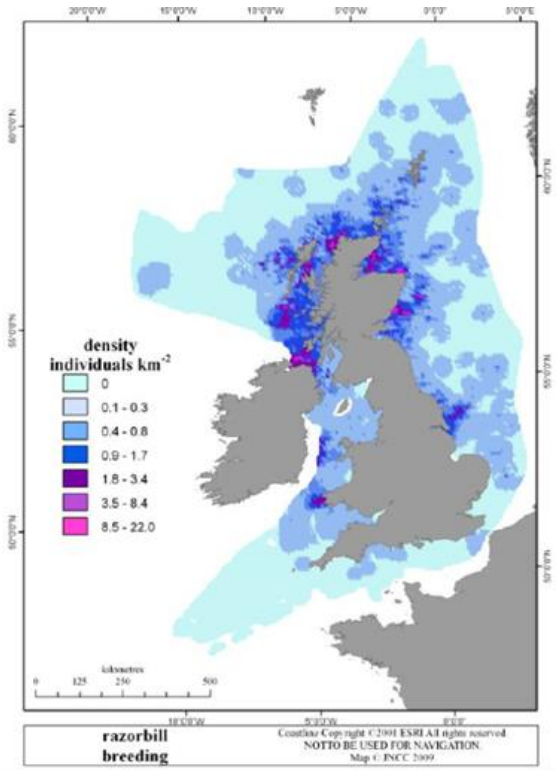

density
individuals km-2
0
0.1 - 1.1
1.2 - 4.0
4.1 - 14.0
14.1 - 61.9
62.0 - 157.1
157.2 - 368.8
lesser black-backed gull
winter

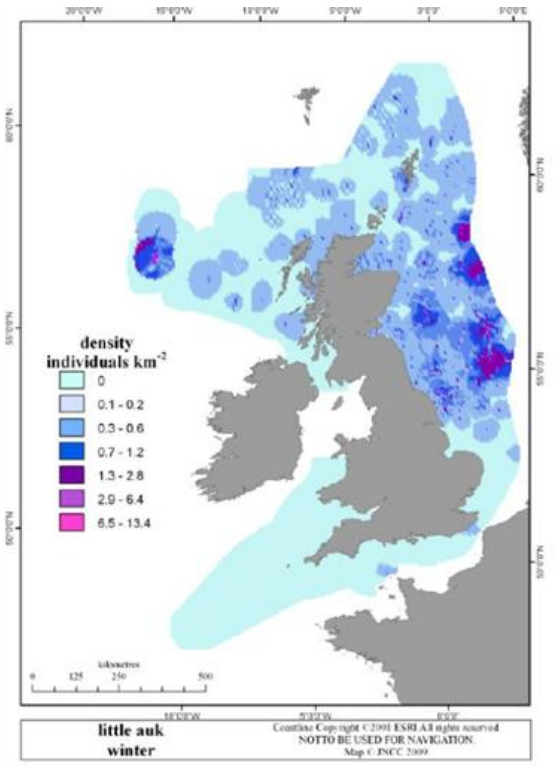

density
individuals km-2
0
0.1 - 0.3
0.4 - 1.1
1.2 - 3.1
3.2 - 7.2
7.3 - 16.1
16.2 - 44.8
herring gull
breeding

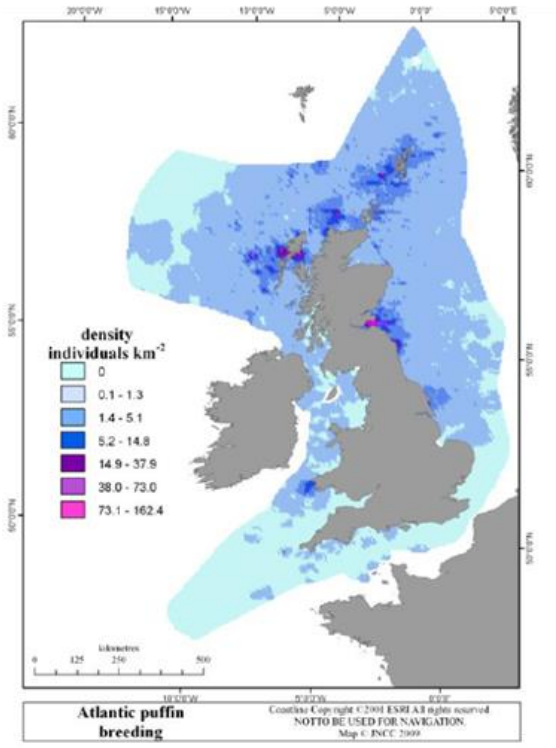

density
individuals km-2
0
0.1 - 0.9
1.0 - 3.3
3.4 - 9.2
9.3 - 20.7
20.8 - 52.1
52.2 - 101.9
herring gull
winter

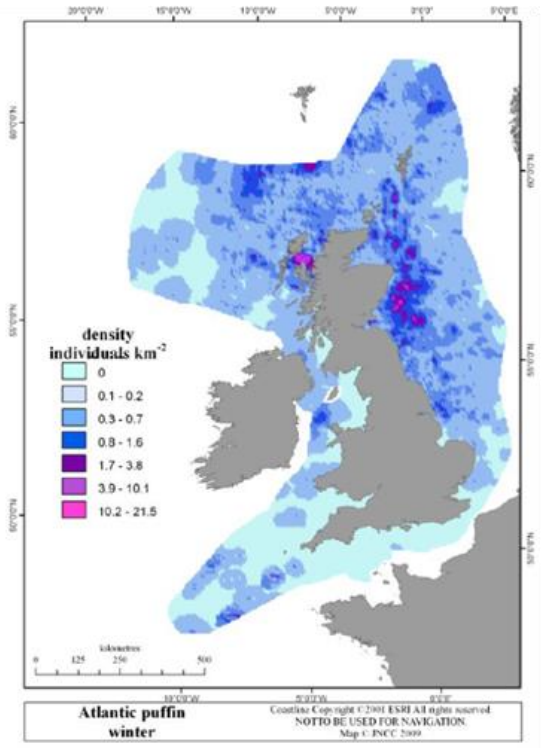

density
individuals km-2
0
0.1 - 3.7
3.8 - 12.9
13.0 - 35.3
35.4 - 98.3
98.4 - 334.7
334.8 - 713.4
common guillemot
breeding

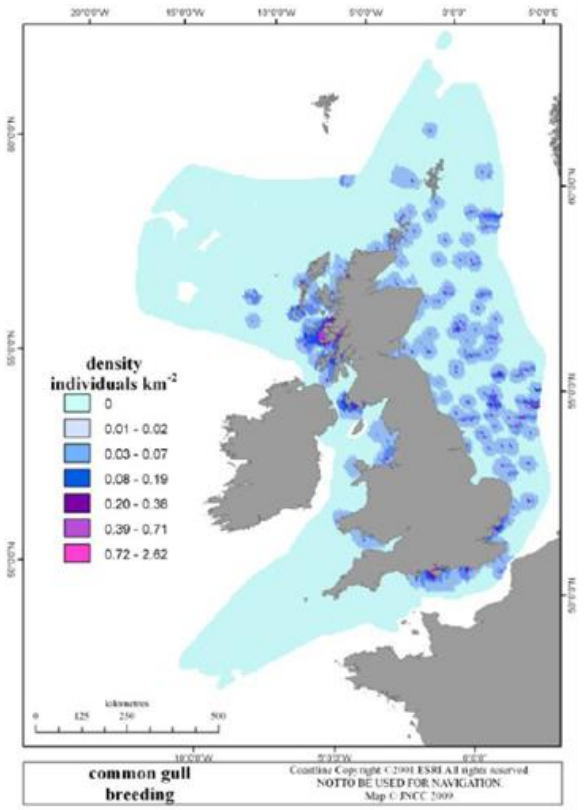

density
individuals km-2
0
0.1 - 0.8
0.9 - 2.5
2.6 - 5.7
5.8 - 11.3
11.4 - 23.6
23.7 - 62.7
common guillemot
winter

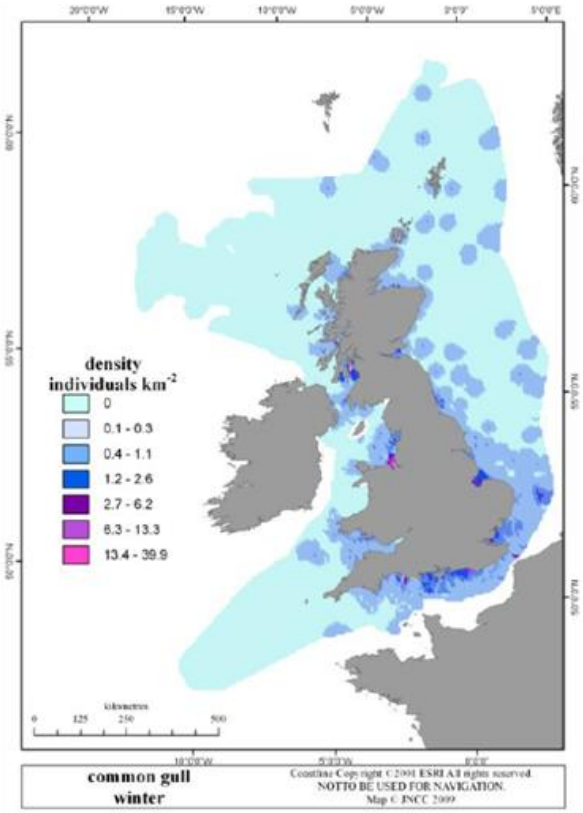

density
individuals km-2
0
0.1 - 0.3
0.4 - 0.8
0.9 - 1.7
1.8 - 3.4
3.5 - 8.4
8.5 - 22.0
razorbill
breeding
NOTTO BE USED FOR NAVIGATION

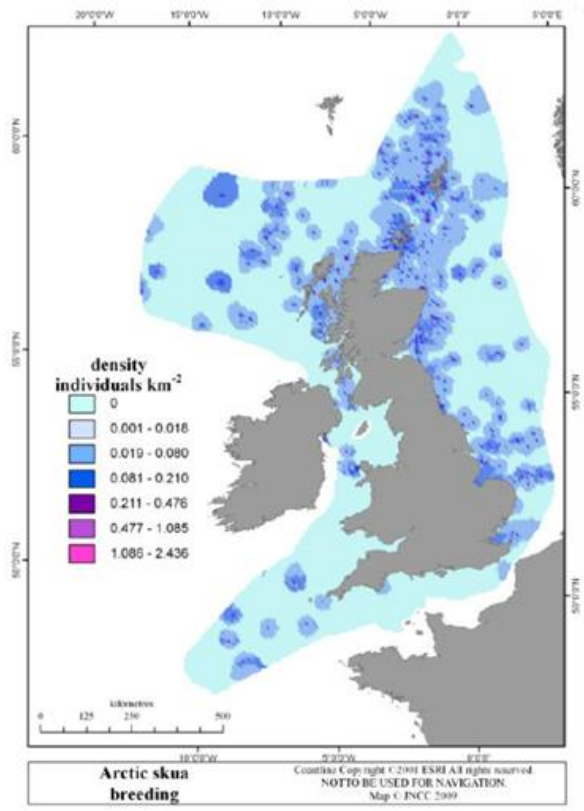

density
individuals km-2
0
0.1 - 0.2
0.3 - 0.6
0.7 - 1.2
1.3 - 2.8
2.9 - 6.4
6.5 - 13.4
little auk
winter
NOTTO BE USED FOR NAVIGATION

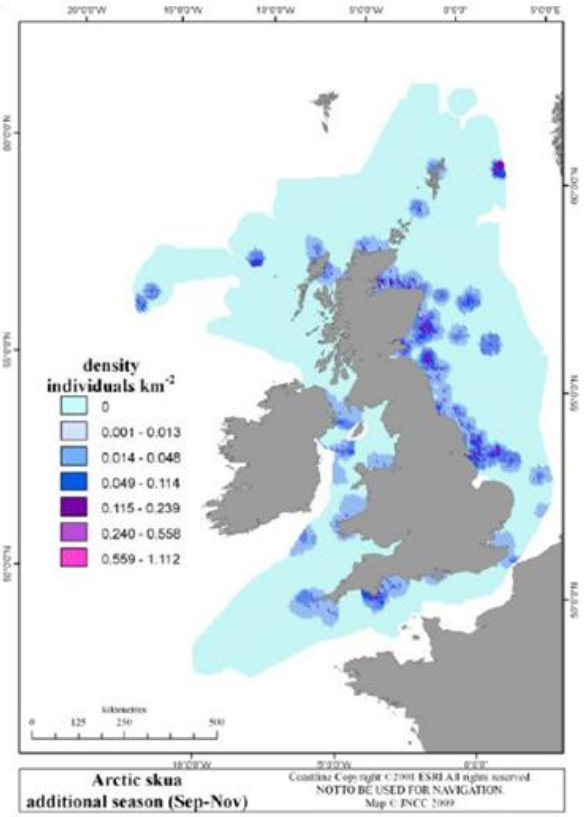

density
individuals km-2
0
0.1 - 1.3
1.4 - 5.1
5.2 - 14.8
14.9 - 37.9
38.0 - 73.0
73.1 - 162.4
Atlantic puffin
breeding
NOTTO BE USED FOR NAVIGATION


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
NOTTO BE USED FOR NAVIGATION


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
NOTTO 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
NOTTO 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
NOTTO 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)
NOTTO BE USED FOR NAVIGATION.

5.3.5 Marine Mammals

5.3.5.1 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 Guinevere location can be derived from data obtained during the Small Cetacean Abundance of the North Sea (SCANS-III) aerial and ship-based surveys. This project identified the abundance and density of cetacean species within predefined sectors of the North Sea and North-East Atlantic. The Guinevere location is situated within SCANS-III Block 'O' (Table 5-10), in which harbour porpoise, minke whale and white-beaked dolphin have been recorded [26]. The density of the harbour porpoise within the SCANS-III Block 'O' 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 [68]. These include the Atlantic white-sided dolphin (*Lagenorhynchus acutus*), Risso's dolphin (*Grampus griseus*), short-beaked common dolphin (*Delphinus delphis*).

Table 5-10: Cetacean Abundance and Density Recorded in SCANS-III Aerial Survey Area Block 'O [26]

Species	SCANS-III Block 'O'		Total (Aerial Survey Blocks)	
	Abundance	Density Note1	Abundance	Density Note1
Harbour porpoise	53,485	0.868	424,245	0.351
White-beaked dolphin	143	0.002	36,287	0.030
Minke whale	603	0.010	13,101	0.011
Note1: Density is the number of animals per km^2				

The 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 [29]. The abundance of cetacean species within their respective MMMU is shown in Table 5-11.

It is evident that harbour porpoises are the most abundant species in the North Sea compared to other species identified in Table 5-11, despite its MMMU being smaller in area. White-sided dolphins are the next most abundant within the UK sector of its MMMU; however, these were not recorded in significant numbers in SCANS-III Aerial Survey Area Block 'O.

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

Species	Management unit	Abundance of animals	95% Confidence Interval	Density Note 1
Bottlenose dolphin	Greater North Sea (639,886km^2)	0	-	-
Harbour porpoise	North Sea (678,206km^2)	227,298	176,360 – 292,948	0.335
Risso's dolphin Note 2	Marine Atlantic Note 3	-	-	-
Common dolphin	Celtic and Greater North Sea (1,560,875km^2)	56,556	33,014 – 96,920	0.036
Minke whale		23,528	13,989 - 39,572	0.015
White-beaked dolphin		15,895	9,107 – 27,743	0.010
White-sided dolphin		69,293	34,339 – 139,828	0.044

Note 1: Density (individuals per km) was calculated using the total area of the Management Unit (MU) and the abundance of animals within that MU
Note 2: There is no current abundance estimate available for Risso's dolphin
Note 3: 'Marine Atlantic' Management Unit comprises all UK waters and extends to the seaward boundary used by the EC for Habitats Directive reporting

Additional to the above marine mammal abundance surveys, the Atlas of Cetacean Distribution in northwest European Water [58] provides a comprehensive review of cetacean sightings in northwest European waters. The seasonal sightings data for ICES Rectangles 35F1 is summarised in Table 5-12. Of the species identified during the survey, only the harbour porpoise has been observed in ICES Rectangle 35F1 [58].

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.

Table 5-12: Cetacean Sightings in ICES Rectangle 35F1 [58]

Species	January	February	March	April	May	June	July	August	September	October	November	December
White-beaked dolphin												
Key	ND = No data		Very Low (< 0.01)		Low (0.01-10)			Medium (10-100)		High (>100)		

5.3.5.2 Pinnipeds

Two species of seals; grey seal (*Halichoerus grypus*) and the harbour (or common) seal (*Phoca vitulina*) are found in the North Sea around the English east coast (Figure 5-19; Figure 5-20). 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 from the coast) and listed as UK BAP priority marine species.

On the east coast of England, established colonies of grey seals are present at Donna Nook, at the mouth of the Humber, and around Blakeney on the North Norfolk coast [61]. 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 [61]. 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 pipelines, particularly at their western most extent. Models of marine usage by grey seals show that there are high levels of foraging activity along the east coast of England. The Guinevere platform was located 52km from the nearest coastline, and thus the distribution of grey seals in the vicinity of Guinevere pipelines is very low (1 individual per 25km^2) [59].

Harbour seals are the smaller of the two species and tend to be found closer to the coast [61]. 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 east coast of England [61]. Harbour seals are restricted to their haul-out sites and the surrounding waters during pupping (June and July) and during their annual moult (August) [61]. 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. Therefore, the harbour seal distribution in the vicinity of the Guinevere location is considered low (5-10 individual per 25km^2) [59].

Figure 5-19: Grey seal (*Halichoerus grypus*) at sea density (Marine Scotland, 2020).

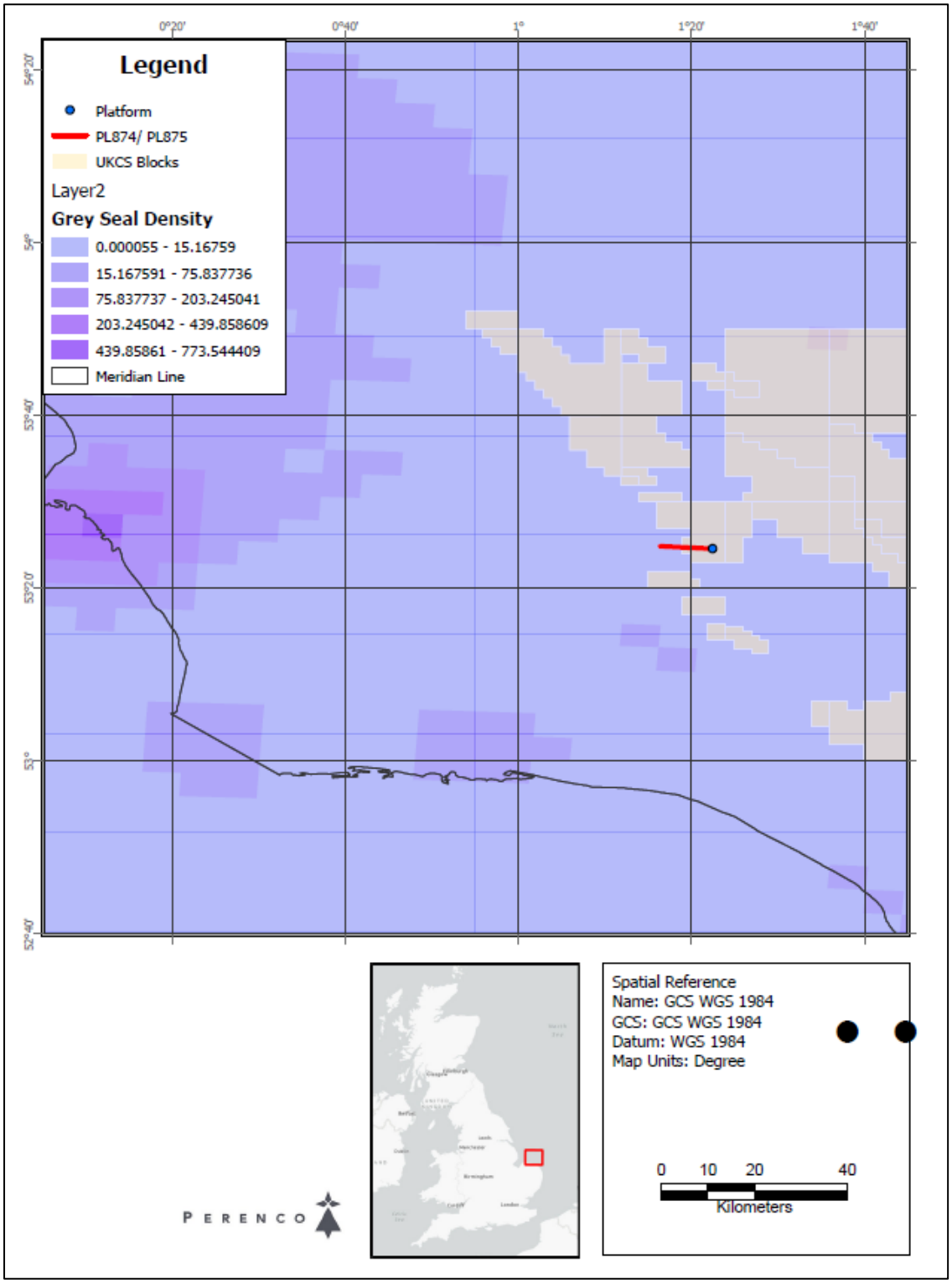
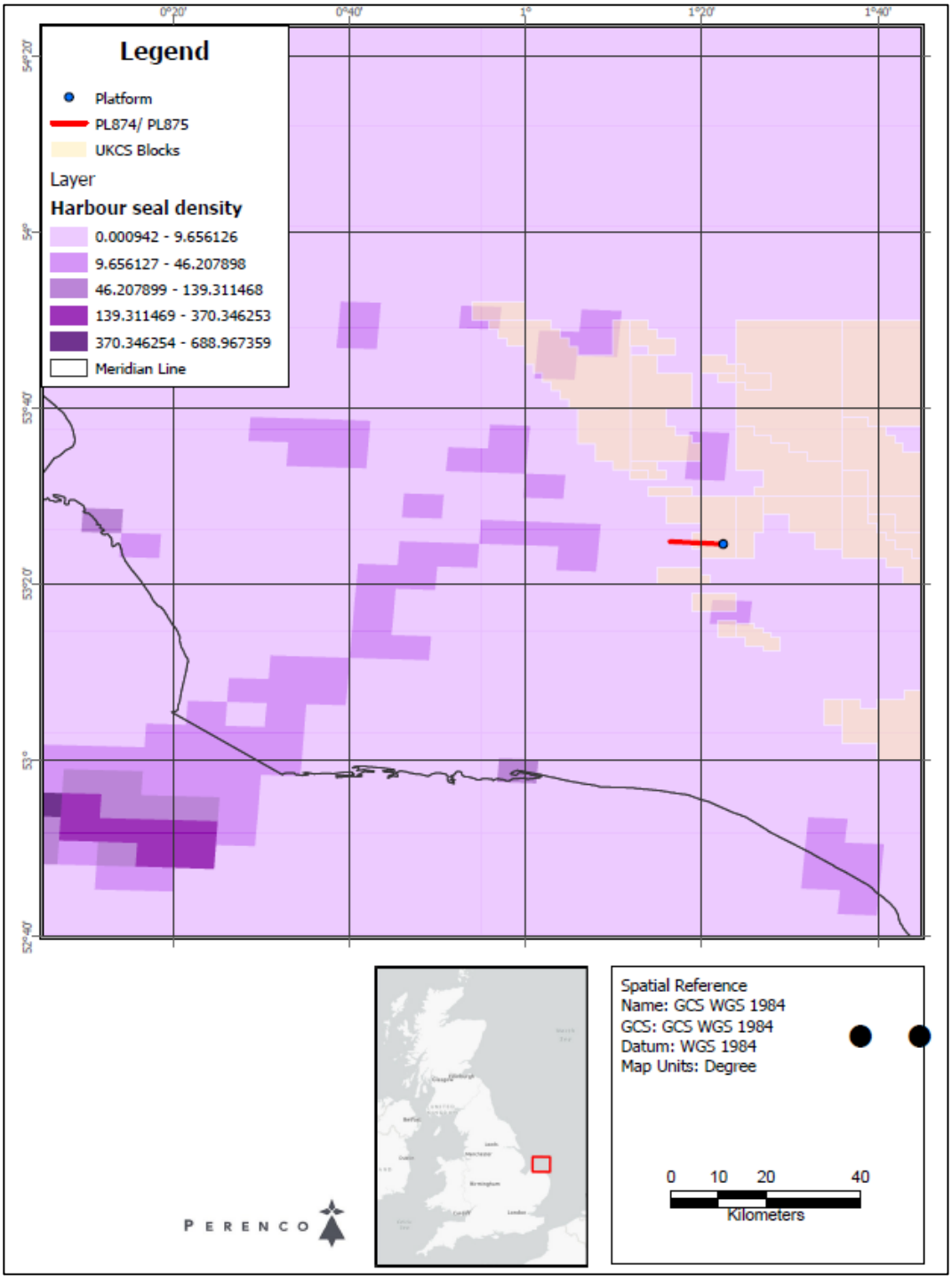


Figure 5-20: Harbour seal (*Phoca vitulina*) at sea density.



5.4 Management

5.4.1 Conservation Areas

The UK is party to a number of international agreements to establish an ecologically network of MPA's in UK waters. As a signatory to the OSPAR Convention the UK must establish an ecologically coherent and well-managed network of MPAs across the North-East Atlantic by 2016 [32]. These commitments are transposed through national legislation and regulations. The main types of MPA's in UK waters are:

- SAC's (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) [32]. In the UK there are 115 SAC's with marine components [32].
- 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 [32].
- 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 [32]. To date there are 97 designated MCZ's in UK waters [32].

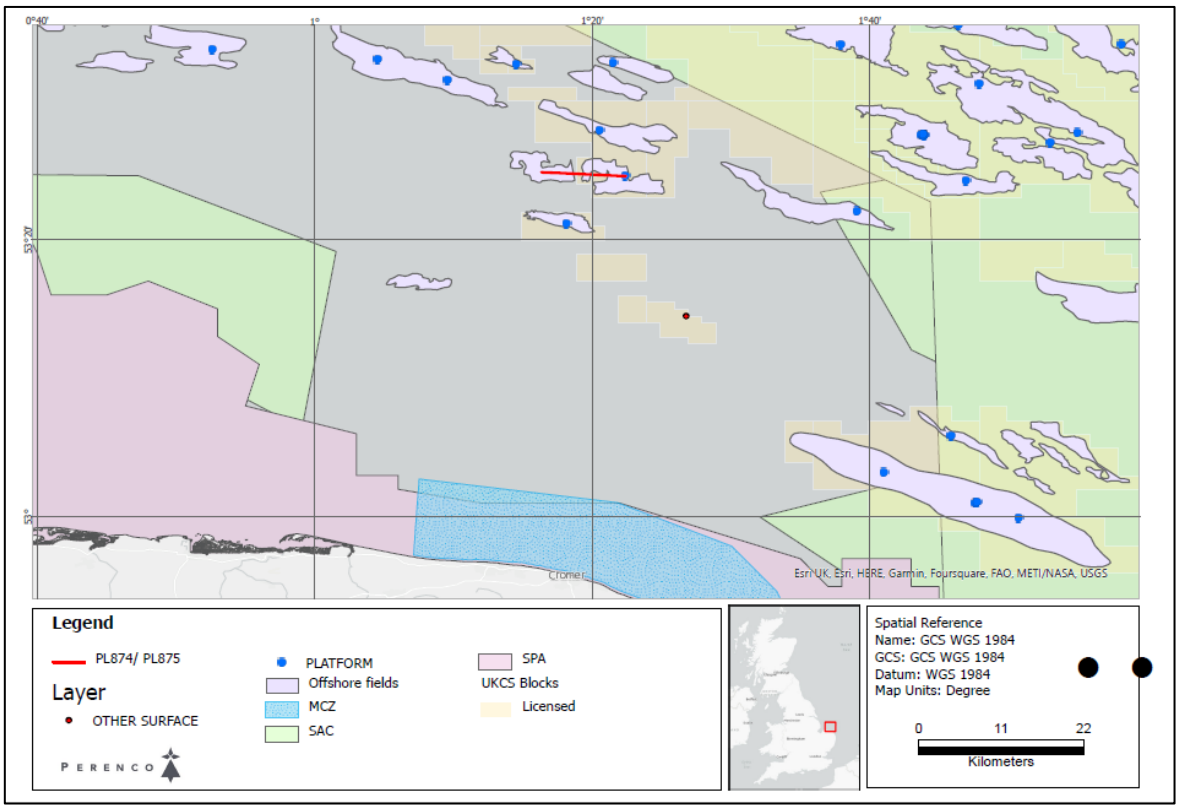
SAC's and SPA's form part of the European Natura 2000 network. Other international designations such as Ramsar Wetlands of International Importance (hereafter referred to as Ramsar sites), and national designations such as Sites of Special Scientific Interest also form part of the UK MPA network through their protection of marine, coastal terrestrial and geological features [32]. OSPAR MPA's encompass existing MPA's designated under existing legislation and Conventions including SAC's, SPA's and MCZ's [32].

The Guinevere location is not located within the boundary of any MPAs; however, there are five MPAs located within 40km of Guinevere pipeline, as shown in Table 5-13 and Figure 5-21.

Table 5-13: MPA's within 40km of Guinevere Pipelines (PL 874/PL 875)

Site Name	Distance and Direction	Qualifying Features and Site Description
North Norfolk Sandbanks and Saturn Reef SAC	23km east	**Features:** Annex I habitats; Sandbanks which are slightly covered by sea water all the time (1110) and Reefs (1170). **Description**: The North Norfolk Sandbanks are the most extensive example of the offshore linear ridge sandbank type in UK waters. The site encloses a series of 10 main sand banks and associated smaller banks. Invertebrate communities are typical of sand sediments in the SNS such as polychaete worms, isopods, crab, and starfish. Areas of *S. spinulosa* biogenic reef are present within the site, consisting of thousands of fragile sand-tubes mad by ross worms (polychaetes) which have consolidated together to create solid structures rising above the seabed.
Southern North Sea SAC	17km northeast	**Features:** Annex II species; Harbour porpoise (*Phocoena phocoena*) (1351). **Description**: The site has been identified as an area of importance for harbour porpoise and supports 17.5% of the UK North Sea Management Unit (MU) population. This site covers an area of 36,951km^2. The majority of this site lies offshore, though it does extend into coastal areas of Norfolk and Suffolk. The northern two thirds of the site are recognised as important for porpoises during the summer season (April – September), whilst the southern part supports persistently higher densities during the winter (October – March).
Inner Dowsing, Race Bank and North Ridge SAC	19km southwest	**Features:** Annex I Habitat: Sandbanks which are slightly covered by sea water all the time and reefs. **Description:** The tops of the sandbanks are characterised by low diversity communities of polychaete worms and amphipod crustaceans. The trough areas between the sandbank features contain a diverse mosaic of biotopes on mixed and gravelly sands. Biogenic reef created by ross worm (*S. spinulosa*) has been recorded within the site. The complex reef habitats support a variety of bryzoans, hydroids, sponges and anemones as well as the common lobster and the commercially fishery targeted pink shrimp.
The Greater Wash SPA	32km southwest	**Features:** Seabirds and waterbirds. **Description:** The Greater Wash SPA straddles the 12 nautical mile limit and is proposed to protect different tern species during the breeding season (Sandwich tern, little tern and common tern) as well as a range of seabird species during the non-breeding season (red-throated diver, common scoter and little gull).
Holderness Offshore MCZ	37km northwest	**Features:** Two broad-scale habitats**.** **Description:** The seafloor consists of mixed and coarse sediment interspersed with small cobbles and ross worm reef. This area is significant for crustaceans, including edible crabs and common lobster. Harbour porpoises and grey and harbour seals are regularly seen foraging here. In addition, there are records of basking sharks within the site and it falls within the foraging radius for certain seabird species (e.g. Atlantic puffin and great skua). The site is also in an area that provides spawning and nursery grounds for a number of fish species.

Figure 5-21: Pipelines location in relation to UK Offshore infrastructure and MPAs.



5.4.2 National Marine Plans

Table 5-14 details policies and objectives contained within relevant marine plans and highlights how these have been addressed by the proposed decommissioning strategy [44].

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.

Relevant Objectives	Associated Policies	Addressed by Project
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 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 which would be limited to vessel fuel inventory during short surveys.
Biodiversity - To protect, conserve and, where appropriate, recover biodiversity that is in or dependent upon the East marine plan areas.	**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 and species that are protected or of conservation concern in the East marine plans and adjacent areas (marine, terrestrial).	The proposed decommissioning strategy reduces any potential impact on biodiversity in the East marine plan and terrestrial areas.

Relevant Objectives	Associated Policies	Addressed by Project
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	Refer to Section 5.4.1. The decommissioning strategy will not significantly impact the objectives of MPAs.
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 5.5
	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 5.5

5.5 Societal

5.5.1 Commercial Fisheries

Guinevere is located within ICES Rectangle 35F1. Annual fishing effort in ICES Rectangle 35F1 is only available for 2012 and 2013, with an average of 726 days [42]. This annual mean is consistent with large areas of the SNS. Monthly fishing effort is generally low but is highest between March and July. The most frequently used gear type is static gears, particularly traps which target shellfish species. 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 and value (over 95% for both). The most frequently caught species include the Norway lobster (*Nephrops norvegicus*), crabs, lobsters and scallops [42].

5.5.2 Oil & Gas Activities

The Guinevere Field infrastructure lies towards the southwest edge of a collection of gas fields in the SNS and therefore oil and gas activity surrounding the former Guinevere platform location is considered to be moderate to high [51]. The nearest platforms are the PUK operated Excalibur, Lancelot and Waveney Normally Unattended Installations, located 7km to the northeast, east and southeast, respectively (Figure 5-22). The UKCS Block 48/17 is crossed by 14 pipelines [51].

5.5.3 Marine Aggregates

The licenced aggregate production area Outer Dowsing (Licence No. 515/2, in operation 01/01/2015 – 31/12/2029), licenced to Westminster Gravels Ltd is located approximately 3km to the west of the proposed Guinevere pipeline (PL 874/PL 875) deposit area. There are currently no ‘active’ or ‘under construction’ windfarms within UKCS Block 48/17. However, the Dudgeon Extension Area which is in the ‘pre-planning’ stages extends into the southern portion of Block 48/17 approximately 7km to the south of the proposed Guinevere pipeline (PL 874/PL 875) deposit area. Dudgeon is the nearest ‘active’ windfarm to the Guinevere location, approximately 12km south in Block 48/22 [10] (Figure 5-23).

5.5.4 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 [12].

However, the waters surrounding the Guinevere location are described as having ‘Moderate’ shipping activity [49].

5.5.5 Telecommunications & Cables

No telecommunications cables pass through Block 48/17 [34].

5.5.6 Military Activity

Block 48/17 does not lie within a known military practice and exercise area [12]. However, a licence condition identified by the Ministry of Defence (MoD) exists for Block 48/17 as it lies within MoD training ranges [50]. The licence condition stipulates that the MoD must be consulted 12 months in advance of placement of any installation (fixed or resting on the seabed or floating) related to oil and gas activity within the block.

5.5.7 Wrecks

There are no wrecks recorded within block 48/17 [45].

5.5.8 Tourism

Due to the distance between the project area and the nearest landfall, no recreational vessel use is known to occur in the area.

Figure 5-22: PL 874/ PL 875 in relation to surrounding Oil and Gas activity

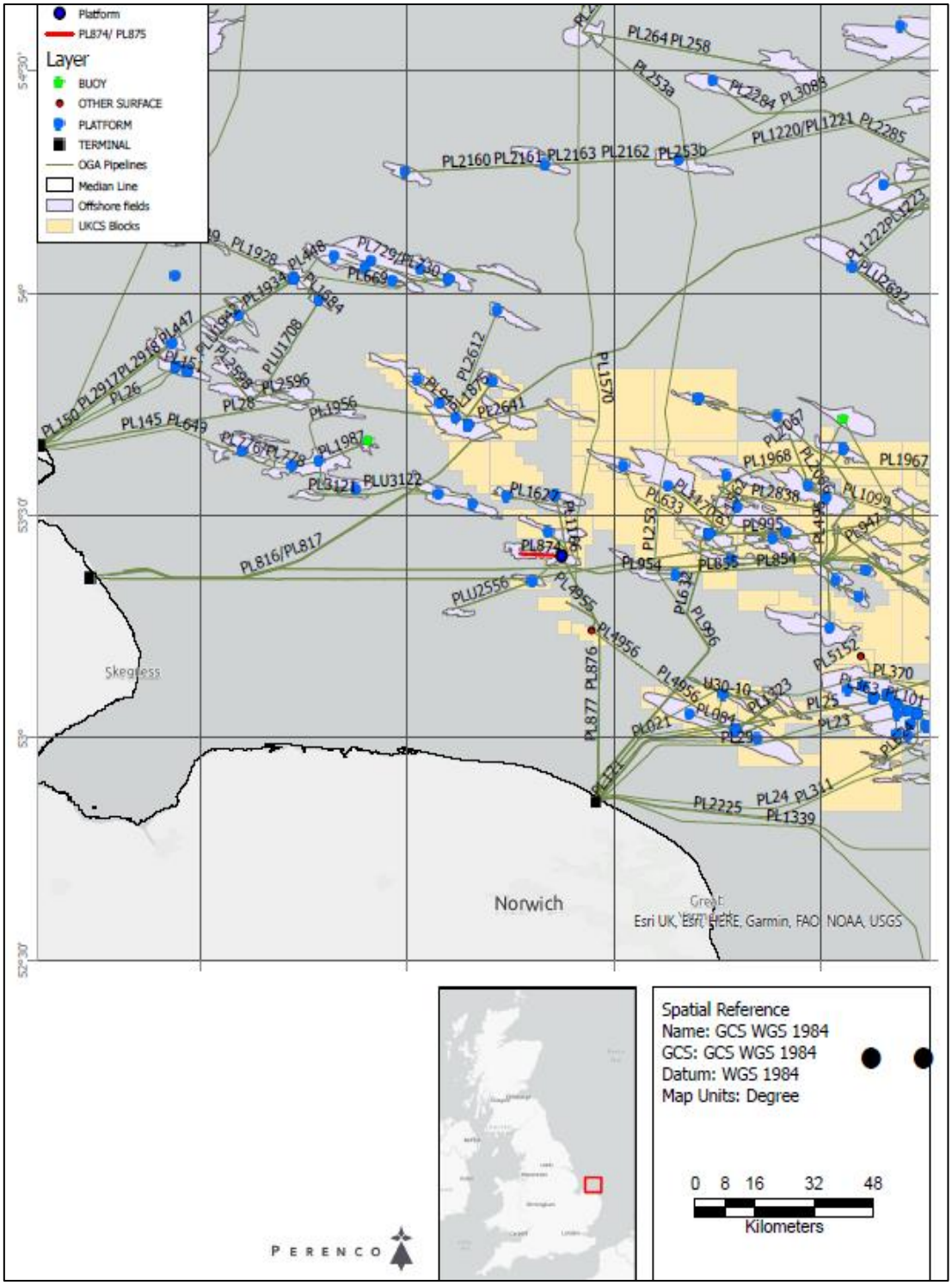
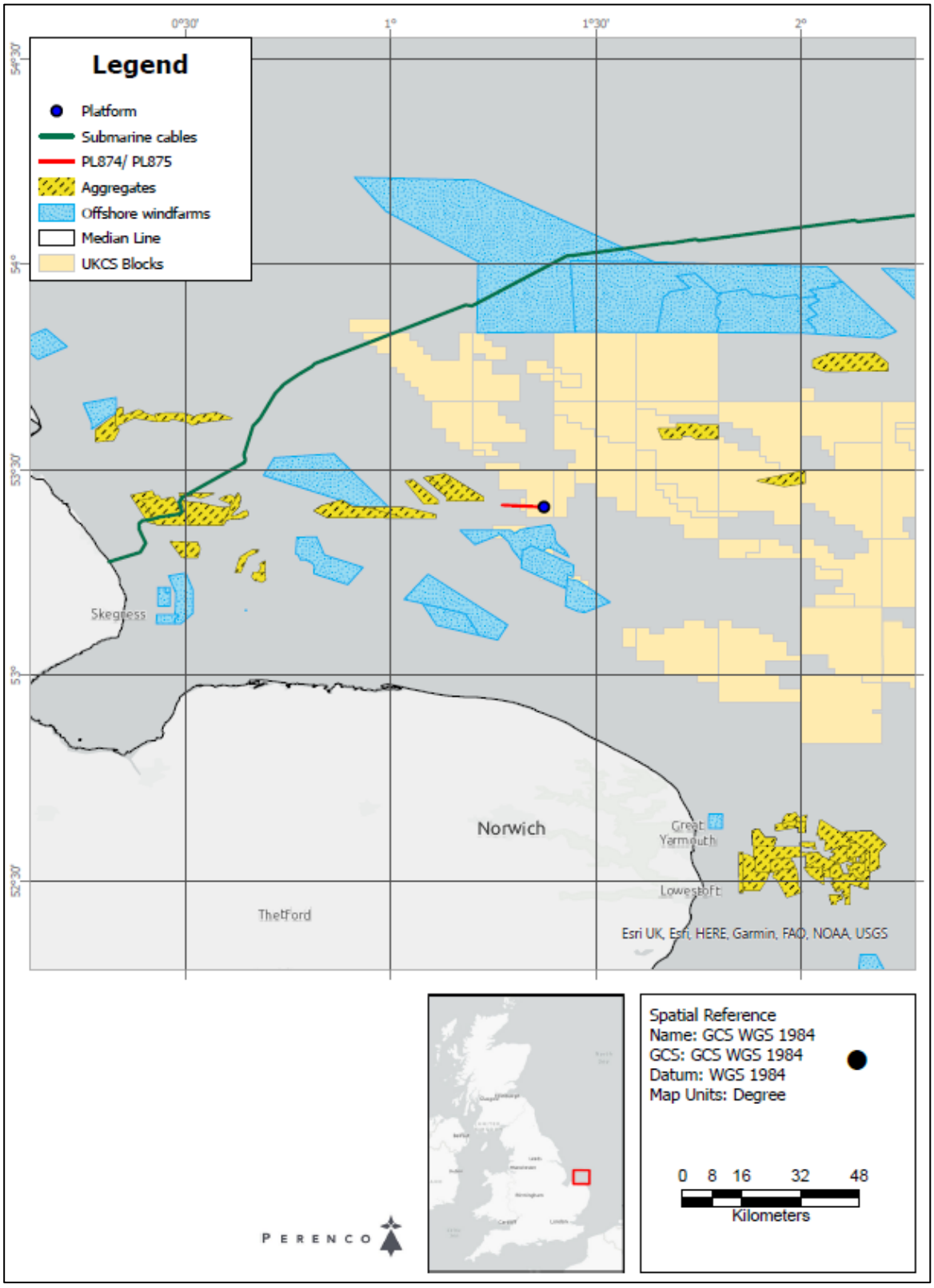


Figure 5-23: PL 874/ PL 875 in relation to surrounding aggregate, offshore renewables and cable activity.



6 Environmental Impacts Identification Summary

Table 6-1 provides details of the potential impacts associated with the preferred decommissioning option as identified in the Environmental Impacts Identification (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

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	MPAs	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
General																						
Physical presence	Use of survey vessels	*	*	*	*	*	*	*	*	*	*	A	A	A	*	*	*	*	*	*	*	*
	Removal of 500m exclusion zone	*	*	*	*	*	*	*	*	*	*	P	P	P	*	*	*	*	*	*	*	*
Seabed Disturbance	Overtrawl survey	A	A	*	*	*	A	A	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Noise emissions	Use of survey vessels.	*	*	*	*	*	*	A	*	A	*	*	*	*	*	*	*	*	*	*	*	*
	Use of survey equipment	*	*	*	*	*	*	A	*	A	*	*	*	*	*	*	*	*	*	*	*	*
Marine discharges	Vessel discharges (operational/domestic)	*	A	*	*	A	A	A	A	A	*	*	*	*	*	*	*	*	*	*	*	*
Atmospheric emissions	Use of survey vessels.	*	*	A	A	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Waste (Hazardous/non-hazardous)	Operational/domestic waste from survey vessel.	*	*	A	A	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	A
	Decommissioning waste	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Accidental Events	Vessel collision	*	A	A	A	A	A	A	A	A	*	A	A	A	*	*	*	*	*	*	*	*
Decommissioning pipelines and stabilisation materials in situ																						
Physical presence (infrastructure in situ)	Physical presence/absence of removal	*	*	*	*	*	P	P	*	P	*	*	A	*	*	*	*	*	*	*	*	*
Physical degradation (infrastructure)	Release of contaminants	A	A	*	*	A	A	A	*	*	*	*	A	*	*	*	*	*	*	*	*	*

Key:

	Potential for significant effects		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 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 [21; 7; 64; 30]. 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 [21], the Business, Energy and Industrial Strategy (BEIS) Guidance [13] and the relevant Department for Energy Security & Net Zero (DESNZ) Offshore SEA 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. 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.

In accordance with BEIS guidance [13], 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 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). 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.

Unplanned Events

In accordance with BEIS guidance [13], 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 to undertake (both onshore and offshore), these activities are required to be undertaken to meet decommissioning obligations for the infrastructure. The preferred option has been considered with a focus on minimising vessel time and therefore minimising any associated emissions. An assessment of air emissions associated with the preferred option is presented in Appendix 1. Although it should be noted that this assessment accounts for a single post decommissioning survey, these 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. Future legacy survey frequency will be determined and agreed with OPRED, however the resulting emissions from these surveys are determined to be negligible as they will be extremely small in the context of UKCS and global emissions.

Sensitivity: High

Magnitude: Negligible

Significance: Negligible

Best practices will be employed to minimise this environmental footprint. This includes optimal survey planning and procurement of vessels which operate effective environmental management systems minimising their emissions.

As a result, no further assessment is required.

7.2.2 Operational Discharges to Sea

Prior to decommissioning activities, pipework and subsea flowlines have been cleaned to an agreed standard with OPRED. Any potential residual volumes are expected to be minimal and have previously been considered under the individual permit consent applications for the decommissioning activities through the Portal Environmental Tracking System (PETS).

Sensitivity: Medium

Magnitude: Negligible

Significance: Negligible

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

Any residual hydrocarbons, if present within the pipelines, will continue to dissipate slowly. It should be noted that the pipelines have been cut and open to seawater since 2017.

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 option will be limited to surveys via the use of a single vessel per survey. It is not anticipated that the vessels would require a significant exclusion area to operate within, instead relying on standard maritime navigational rules. Typical surveys are expected to take approximately 7 days to complete including travel to and from port. The project area has a moderate amount of shipping activity within it which will not be significantly increased due to project activity.

Sensitivity: Medium

Magnitude: Negligible

Significance: Negligible

Vessel traffic will be managed by issuing of kingfisher notice to mariners and vessel operated Automated Identification Systems (AIS). There will be an overall positive benefit of opening up of 500m safety exclusion zone following seabed clearance at the former Guinevere platform location.

As a result, no further assessment is required.

7.2.4 Waste Generation

All waste generated from decommissioning activities, which will be limited to vessel generated waste, will be handled and recovered or disposed of in line with existing waste management legislation following the principles of the waste hierarchy. 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.

Only licensed contractors will be used for waste handling and treatment/disposal.

Sensitivity: Medium

Magnitude: Negligible

Significance: Negligible

As a result, no further assessment is required.

7.2.5 Noise Emissions

The only noise emissions associated with the preferred decommissioning option are those from operation of the survey vessel and geotechnical survey equipment. The operation of a single vessel within an area classed as having moderate shipping density is not expected to add any significant noise to the surrounding area.

The monitoring of infrastructure left in situ may require the use of geotechnical survey equipment such as Multi Beam Echo Sound or Sub Bottom Profiler survey. An assessment of any potential impacts from the use of this equipment will be made in individual survey applications via the PETS portal system.

Sensitivity: Medium

Magnitude: Minor

Significance: Minor

Surveys will be scheduled and planned efficiently to minimise vessel operation time. 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 Seabed Disturbance

The only source of potential impact from the selected decommissioning option is from the completion of overtrawl surveys. Overtrawl surveys, or other alternative methods of seabed verification are an important element of the decommissioning process to ensure that no snagging hazards are present before the removal of exclusion zones or approval to leave pipeline and other materials in situ.

Following approval of the Guinevere DP, it will be necessary to confirm that no snagging hazards are present across the length of the pipelines and within the Guinevere 500m exclusion zone. A clear seabed will be validated by an independent verification survey of the pipeline corridors. The aim of this clean seabed verification is to ensure the seabed is left in a safe condition for future fishing effort, in line with the current decommissioning guidance [13].

The main impacts from the completion of overtrawl surveys will be physical damage to the seabed in the survey area.

Typically, overtrawl surveys are targeted trawls whereby bottom trawl gear is towed across the target area to determine if any snagging hazards are present. The targeted nature of these surveys will limit damage to the seabed to specific areas around the pipeline route.

Specific survey methods will be discussed and agreed with OPRED prior to commencement. Where possible to do so preference will be given to non-intrusive survey methods such as Side Scan Sonar and Remotely Operated Vehicle surveys to determine a clear seabed. Where these are deemed inconclusive targeted overtrawling may be undertaken to ensure no residual risk of snagging remains post-decommissioning. Should overtrawling be required, it will be conducted by fishing vessel(s) using trawl gear that is appropriate for the area.

Surveys shall be conducted, and any debris identified shall be recovered and recycled / disposed of accordingly.

Due to the limited nature of the activity, both spatially and temporally, any effects from physical damage to the seabed and the resulting settlement of suspended sediments would be small in nature and duration.

Sensitivity: Medium

Magnitude: Moderate

Significance: Minor

As a result, no further assessment is required.

7.3 Assessment of Potentially Significant Impacts

7.3.1 Infrastructure Left in Situ

Source of Potential Impacts

The decommissioning of the Guinevere pipelines has the potential to impact on other users of the offshore environment through the physical presence of subsea infrastructure decommissioned in situ which may pose a potential snagging risk for commercial fisheries. The long-term presence of materials left in situ has the potential to interfere with other sea users, for subsea infrastructure this is particularly applicable to bottom trawl (Demersal) fishing. In addition to the pipelines themselves, other materials left in situ such as rock placement, concrete mattresses and grout bags all have the potential to add to this snagging risk.

In addition to the above, the decommissioning of the Guinevere pipelines in situ has to potential to impact on the environment through the degradation and mobilisation of materials left in situ, including plastics used for pipeline coating.

Effects on Sensitive Receptors

Physical Presence of Infrastructure

Annual fishing effort in the area surrounding the Guinevere Pipelines (ICES rectangle 35F1) is on average 726 days [42] with an approximate value below £0.1 million [40]. This annual mean is consistent with large areas of the SNS. Monthly fishing effort is generally low but is highest between March and July. The most frequently used gear type is static gears, particularly traps which target shellfish species. 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 and value (over 95% for both). The most frequently caught species include the Norway lobster (Nephrops norvegicus), crabs, lobsters and scallops [41].

Pipeline surveys completed along the pipeline route in 2017 confirmed both PL 874 and PL 875 are buried with an average depth of 0.7m across the entire length with no exposures. Additional surveys completed in 2022 confirmed that the pipeline remains buried with no exposures or freespans. Due to the time period between these surveys it is reasonably assumed that the pipelines are stable and will remain buried at a suitable depth in their current location.

The four concrete mattresses present in the Guinevere 500m exclusion zone are fully covered by a berm that was designed with a 1:3 slope to make it overtrawlable, which prevents snagging.

PUK will commit to a series of post decommissioning legacy surveys to confirm that the pipeline remains buried and does not pose a risk to other sea users. The frequency of such surveys will be agreed with OPRED as part of the decommissioning close out reporting arrangements, although it is anticipated that this will be based on a risk-based approach. During the period over which monitoring is required, the burial status of the infrastructure decommissioned in situ would be reviewed and any necessary remedial action undertaken to ensure it does not pose a risk to other sea users. However, the pipeline is not expected to become exposed in the future due to either being covered by rock placement or being sufficiently buried and negatively buoyant outside of rock placement areas.

Should any of the pipelines become exposed in the future this could result in the loss of benthic habitat over the pipeline. This impact, however, would be anticipated to be limited to the seabed surface immediately around the pipeline itself (8” pipeline and 3” piggybacked MEG line) representing a small area. Should rock placement be required to remediate any such exposures there is the potential for a greater impact area where rock berms, designed to provide a berm with an overtrawlable gradient, are used resulting in a loss of soft benthic substrate. It is not possible to definitively assess this impact at this time, however, any such requirement for future rock placement will be fully assessed and agreed with OPRED if required.

Figure 7-1: Historical rock placement on PL 874/PL 875 within the Guinevere 500m exclusion zone.

Degradation of Materials

The degradation of materials left in situ has the potential to impact on the environment depending on the chemical nature of the materials involved and the degradation process it undergoes. Any degradation of the pipelines left in situ will be a gradual process cause by the corrosion of the pipelines steel structure and eventual collapse under their own weight. During this process, degradation products derived from the exterior and interior of the pipe will breakdown and potentially become bioavailable to benthic fauna in the immediate vicinity.

The primary degradation products will originate from the following pipeline components:

- Steel;
- Sacrificial anodes;
- FBE coating.

Note: The pipelines have previously been flushed clean and left open to sea since 2017.

Both PL 874 and PL 875 are coated with a 0.55mm layer of FBE which is not considered to be directly toxic in the marine environment. However, as no micro-organisms have evolved to utilise the chemically resistant polymer chains as a carbon source, these plastics can be expected to persist in the environment for centuries [52]. Microplastics in general in the marine environmental have been identified as a major contaminant of concern where ingested by zooplankton [3]. Due to their small size, microplastics are potentially bioavailable, via ingestion, to a wide range of organisms as they overlap with the size range of their prey. Ingestion of microplastics has been reported in several marine species over a broad range of taxa including cetaceans, seabirds, molluscs, echinoderms, zooplankton and corals [3], where it has been reported to cause several detrimental effects including physical injury and reduced feeding behaviour with the knock on effects for growth and reproduction.

For ingestion to occur however, any plastic in the marine environment would need to incur a level of degradation. For FBE, degradation may occur as a result of mechanical disturbance and/or chemical and biological processes, particularly exposure to ultraviolet radiation [4].

As both pipelines are buried below the seabed in a stable condition, it is not expected that they would be subject to mechanical or chemical degradation and there are no known biological species capable of biologically breaking down FBE material. As such the degradation and subsequent release of microplastic materials into the surrounding sediment or water column is not expected, preventing the ingestion of microplastics by marine fauna and mobilisation into the food chain.

Due to the highly localised nature of any potential degradation products being released over an extended period, it is highly unlikely that these products will be detectable above current background conditions in the area.

Cumulative and Transboundary Impacts

The Guinevere field is located approximately 45km from the UK coastline and 107km from the UK/Netherlands median line. As such the majority of fishing activity in the areas is by UK based vessels and the proportion of foreign fishing vessels is relatively low, although fishing in the area by EU vessels is permitted under the Trade and Cooperation Agreement agreed between the UK government and the EU post Brexit. The lack of snagging hazards along the pipeline route, which will be confirmed by a clear seabed certificate, will prevent impacts on fishing vessels from both the UK and EU.

As stated above, due to the pipelines being fully buried and stable below the seabed, it is not anticipated that any degradation materials would present any significant impacts either cumulatively or transboundary in nature.

Mitigation Measures

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

- The Guinevere Pipelines are currently shown on Admiralty Charts, the FishSafe system and the NSTA Infrastructure data systems (NSTA Open Data).

- Overtrawl surveys will be undertaken to confirm lack of snagging hazards and obtain clear seabed verification. This will ensure there is no residual risk to other sea users. Non-intrusive verification techniques will be considered in the first instance, but if deemed necessary, seabed clearance may require conventional overtrawl survey methods. Any snagging hazard identified will be reviewed and discussed with OPRED on the appropriate method of remediation.
- PUK will commit to a series of post decommissioning legacy surveys to confirm that the pipeline remains buried and does not pose a risk to other sea users. The frequency of such surveys will be agreed with OPRED as part of the decommissioning close out reporting arrangements, although it is anticipated that this will be based on a risk-based approach. During the period over which monitoring is required, the burial status of the infrastructure decommissioned in situ would be reviewed and any necessary remedial action undertaken to ensure it does not pose a risk to other sea users.

Residual Impact

Considering the above assessment and mitigations is has been determined that the decommissioning of the Guinevere pipelines and stabilisation materials in situ is unlikely to pose a significant hazard to other sea users by way of a snagging hazard, or the environment by way of the degradation of materials.

8 Assessment Conclusions

Following detailed review of the proposed decommissioning option, the environmental sensitivities present in the area and potential impacts on other sea users and the environment it has been determined that the decommissioning of the Guinevere Pipelines and stabilisation materials in situ will not present any significant impacts.

The majority of impacts associated with the decommissioning option were well understood and managed through the implementation of established mitigation measures. The only impacts with potential to be significant were those associated with the leaving of infrastructure in situ including snagging hazards for other sea users, particularly fisherman and the environmental impacts from the degradation of materials. However, following further assessment these were also determined not to be significant following the implementation of stated mitigation measures. Overall, the decommissioning option presented within this report is determined as having a negligible impact.

In addition, the 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 Guinevere 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 Guinevere pipelines decommissioning operations.

9.1 Introduction

PUK hold ISO 14001 standard certification. Additionally, PUK operate under a Safety and 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 and Safety Executive (HSE) issues within the business. This EMS 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 Environmental Management Systems 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 Guinevere 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 EMS remains an effective tool to control the environmental impacts of operations, and to re-configure the EMS 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. Aires, C., Gonzaelz-Irusta, J.M. and Watret, R. (2014). Updating fisheries sensitivity maps in British waters. Scottish marine and freshwater science report. Vol 5 No 10.
2. DESNZ (2022) UK Offshore Energy Strategic Environmental Assessment OESEA4 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1061670/OESEA4_Environmental_Report.pdf [Accessed March 2023].
3. Botterell, Z., Beaumont, N., Dorrington, T., Steinke, M., Thompson, R., Lindeque, P. (2019) Bioavailability and effects of microplastics on marine zooplankton: A review. Environmental Pollution Vol 245.
4. Cetiner, M., Singh, P., Abes, J., Gilroy-Scott, A. (2000). UV Degradation of Fusion Bonded Epoxy Coating in Stockpiled Pipes. Conference: 2000 3rd International Pipeline Conference. DOI: 10.1115/IPC2000-181
5. 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.
6. Coull, K.A., Johnstone, R., and S.I. Rogers. (1998). Fisheries Sensitivity Maps in British Waters. Published and distributed by UKOOA Ltd.
7. 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.
8. Collins, M.B., Shimwell, S.J., Gao, S., Powell, H., Hewitson, C. & Taylor, J.A. (1995) Water and sediment movement in the vicinity of linear sandbanks: the Norfolk Banks, southern North Sea. Marine Geology 123: 125-142.
9. 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.
10. Crown Estate (2021) The Crown Estate Offshore Activity Map. https://opendata-thecrownestate.opendata.arcgis.com/ [Accessed March 2023].
11. Dann, R., van het Groenewoud, H., de Jong, S.A. and Mulder, M., 1992. Physico-chemical and biological features of a drilling site in the North Sea, 1 year after discharges of oil contaminated drill cuttings. Mar. Ecol Prog. Ser., 91: 37-45.
12. DESNZ (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 April 2023].
13. BEIS Guidance notes (2018) - Decommissioning of Offshore Oil and Gas Installations and Pipelines.
14. Directive 2011/92/EU of the European Parliament and of the Council
15. Dobson, M. and Frid, C. (1998). Ecology of aquatic systems, Addison Wesley Longman Ltd.

16. 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 April 2023].
17. EMODnet, 2016. EUSEAMAP Seabed habitats project. European marine observation and data network (EMODnet). http://www.emodnet-seabedhabitats.eu [Accessed April 2023].
18. Energinet (Viking Link (2017) Volume 2: UK Offshore Environmental Statement
19. Eno NClare, Clark RA, Sanderson WG, Joint Nature Conservation Committee (Great Britain) (1997) Non-native marine species in British waters : a review and directory. Joint Nature Conservation Committee.
20. ERM (Environmental Resources Management Ltd), 2012. Marine Aggregate Regional Environmental Assessment (MAREA) of the Humber and Outer Wash Region. A report prepared for the Humber Aggregate Dredging Association (HADA).
21. 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.
22. Gubbay S (2007) Defining and managing Sabellaria spinulosa reefs: Report of an inter-agency 1-2 May, 2007.
23. Guinevere Pre-Decommissioning Environmental Survey 2017-001_Vol6_rev01
24. Guinevere Pre-Decommissioning Environmental Survey 2017-001_Vol5_rev00
25. Guinevere Post-Decommissioning survey 2022.
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. Howarth, M.J. & Huthnance, J.M. (1984) Tidal and residual currents around a Norfolk sandbank. Estuarine and Coastal Shelf Science 19: 105-117.
28. Hydrographer of the Navy (2008). Admiralty chart 2182A, Edition 8.
29. IAMMWG (2015). Management units for cetaceans in UK waters. JNCC REPORT NO. 547.
30. IEMA (2016). Environmental Impact Assessment Guide to: Delivering Quality Development, July 2016. Institute of Environmental Management and Assessment.
31. IUCN (2021) The IUCN Red List of Threatened Species. [Online] Available from: http://www.iucnredlist.org/ [Accessed April 2023].
32. JNCC (2018). Contributing to a Marine Protected Area Network. Available from: http://jncc.defra.gov.uk/page-4549 [Accessed April 2023].

33. JNCC (2019). EUNIS Combined Map: full-coverage EUNIS level 3 layer integrating maps from surveys and broad-scale models (Open Data). Available at https://hub.jncc.gov.uk/assets/2048c042-5d68-46c6-8021-31d177b00ac4 [Accessed April 2023].
34. Kis Orca. https://kis-orca.org/map/ [Accessed March 2023].
35. 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.
36. Kunzlik, P.A. (1988) The Basking Shark. Scottish Fisheries Information Pamphle Number 14, 1988.
37. 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.
38. 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.
39. Marine Management Organisation (2014) Marine Plan areas in England https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/325688/marine_plan_areas.pdf [Accessed March 2023].
40. Marine Management Organisation UK Sea fisheries Statistics 2019 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/920679/UK_Sea_Fisheries_Statistics_2019_-_access_checked-002.pdf [Accessed April 2023].
41. Marine Scotland (2021a) National Marine Plan Interactive. [Online] Available from: https://marinescotland.atkinsgeospatial.com/nmpi/ [Accessed November 2021].
42. Marine Scotland (2021b) Fishing Effort, Quantity and Value of Landings by ICES Rectangle. Available from: www.scotland.gov.uk/Topics/Statistics/Browse/Agriculture-Fisheries/RectangleData [Accessed November 2021].
43. 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 April 2023].
44. MMO (2014). East Inshore and East Offshore Marine Plans. London: Department for Environment, Food and Rural Affairs (DEFRA). Available from: https://www.gov.uk/government/publications/east-inshore-and-east-offshore-marine-plans [Accessed April 2023].
45. MMO (2019). Receiver of wreck: protected wrecks https://www.gov.uk/government/publications/receiver-of-wreck-protected-wrecks [Accessed April 2023].

46. 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.)
47. North Sea Transition Authority https://www.arcgis.com/apps/webappviewer/index.html?id=f4b1ea5802944a55aa4a9df0184205a5 [Accessed March 2023].
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 March 2023].
50. NSTA (2019) 32nd Licencing Round – Other Regulatory issues (July 2019). https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/815762/Other_Regulatory_Issues_-_July_2019.pdf [Accessed March 2023].
51. NSTA (2020). Interactive mapper. Available at https://www.ogauthority.co.uk/data-centre/interactive-maps-and-tools/ [Accessed April 2020].
52. OEUK (2013). Long term Degradation of Offshore Structures and Pipelines Decommissioned and left in situ, Oil and Gas UK. February 2013.
53. Oil and Gas UK (2015). Guidelines for Comparative Assessment in Decommissioning Programmes.
54. OSPAR Commission (2014) List of Threatened and/or Declining Species & Habitats. [Online] Available from: http://www.ospar.org/work-areas/bdc/species-habitats/list-of-threatened-declining-specieshabitats [Accessed April 2023].
55. 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.
56. Post Decommissioning MBES and Environmental survey results report NSO-PJ00292-RR-DC-SUR-003
57. PWA 11/W/92
58. 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).
59. 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).
60. 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.

61. 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 April 2023).
62. Seiter K, Hensen C, Schröter J, Zabel M (2004) Organic carbon content in surface sediments - Defining regional provinces. Deep Sea Res 1 Oceanogr Res Pap.
63. 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.
64. 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.
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. UK Digital Marine Atlas Project 1998
67. UKOOA, 2001. An analysis of U.K Offshore Oil & gas Environmental Surveys 1975-95, pp. 141.
68. 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 North-East Atlantic. Journal of Applied Ecology, 57: pp.253-269.
69. 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 April 2023].
70. 200605-S-REP-0004 Guinevere Pipelines and Stabilisation Materials Decommissioning CA report
71. 200605-S-REP-0003 Guinevere EA scoping

Appendix 1 – Air Emissions Assessment

The following assumptions were used in this assessment:

- Emission factors (EF) for offshore vessel use have been taken from the EEMS Atmospheric Emissions calculations (OEUK & DESNZ) - default EF for diesel consumption plant operations engines.
- 100% combustion efficiency.
- Sulphur content of fuel gas is 6.4 part per million weight.
- EF for onshore transport taken from DEFRA, (2020) - Delivery vehicles, All diesel Heavy Good Vehicles (HGV), 100% laden.
- EF for onshore waste treatment taken from DEFRA, (2020) - commercial and industrial waste disposal.
- Diesel specific gravity: 0.88 (Average).
- Fuel consumption based on a typical expected size vessel: $5m^3$/24hrs (Quayside), $20m^3$/24hrs (Transit), $15m^3$ (DP/On location).
- HGV limited to 17.6te carrying capacity (Environment agency, 2010).
- Distance between waste processing facility and landfill – 25km (Turner et al, 2015).
- Distance for inter-facility transports for recycling – 250km (Turner et al, 2015).
- Onshore treatment days account for waste processing, recycling, and disposal (including fugitive emissions).
- 95% recycling of pipeline waste.
- Vessel days taken from Schedule, costings and durations for Guin CA issued to Petrofac 03/03/23.
- Waste figures taken from CAL-001 Waste Assessment.

Appendix 2 - Option 4a: Leave In Situ

Table 1: Offshore Vessel Days and Fuel Consumption

	Total number	Diesel consumption /24hrs (m^3)	Total Diesel consumption (m^3)	Total diesel (te)
Vessel offshore days (Transit)	3	20.000	60.000	52.800
Vessel Offshore days (Onsite)	2	15.000	30.000	26.400
Vessel days (Quayside)	2	5.000	10.000	8.800
Total	7	40	100	88

Table 2: Offshore Emissions

Emission gas	EF	Total volume (te)
Carbon dioxide (CO_2)	3.200	281.6
Nitrogen oxides (NO_x)	0.059	5.2
Nitrous Oxide (N_2O)	0.000	0.02
Sulphur dioxide (SO_2)	0.004	0.35
Carbon monoxide (CO)	0.016	1.38
Methane (CH_4)	0.000	0.02
Volatile Organic Compounds (VOC)	0.002	0.18

Table 3: Onshore Transport

	Total (te)	Total (km)
Waste transport to landfill	0.070	25.0
Waste transport to Incineration	0.091	25.0

Table 4: Onshore Transport Emissions

Emission Gas	EF	Total Volume (te)
CO_2	1.016	0.0
NO_x	ND	ND
N_2O	0.013	0.0
SO_2	ND	ND
CO	ND	ND
CH_4	0.000	0.0
VOC	ND	ND

Table 5: Waste Treatment Emissions

Emission Gas	EF Reference	EF	Total volume (te)
CO_2e Vessel waste Non hazardous	(Household residual waste - Landfill)	446.204	0.031
CO_2e Vessel waste hazardous	(Household residual waste - combustion)	21.280	0.002
CO_2e Pipeline	(non-hazardous animal and vegetation waste- landfill)	587.326	0.000
CO_2e Pipeline	(Recycling)	0.000	0.000

Table 6: Option 4a Total Emissions

Emission Gas	Total Volume (te)
CO_2*	281.659
NO_x	5.227
N_2O	0.020
SO_2	0.352
CO	1.382
CH_4	0.016
VOC	0.176

***** All the CO_2e emissions from the waste treatment (Table 5) are considered as CO_2 emissions on this table