LOGGS Area Decommissioning

Environmental Appraisal to the LOGGS LDP2 – LDP5 Decommissioning Programmes

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Revision	Location of Change	Brief Description of Change
C2	Throughout	Response to OPRED comments
C3	Throughout	Responses to additional comments from OPRED
C4	Throughout	Response to OPRED comments
C5	Throughout	Further responses from stakeholders
C6	Throughout	Further responses from stakeholders
C8	Throughout	Addressing OPRED comments
C9	p1,4, Section 5.1.3; Section 5.3.6, p95	Evidence of OBM cuttings contamination, cumulative impacts of noise, plastics,
C10	Section 5.1.3	Evidence of OBM cuttings contamination
C11	P5-6, 32, 63, 66-73, 89, 133, 134,159	Addressing OPRED comments
C12	Throughout	Addressing OPRED comments
C13	Section 5.3.6	Addressing OPRED comments LDP2 & LDP4
C14	Section 6	Addressing OPRED comments addition of separate section for socio economic impacts

GLOSSARY OF TERMS

Abbreviations / Definitions

" – inch

% - percent

$\mu g.g^{-1}$ – microgram per gram

µm – micrometres

3PLE – 3 Layer Polyethylene

AIS – Automatic Identification System

AWV – Accommodation Works Vessel

BEIS – Department for Business, Energy and Industrial Strategy

CIP – Communication Interface Plan

cm – centimetre

CMS – Caister Murdoch System

CO_2 – Carbone Dioxide

db re 1 µPa @ 1 m – decibel relative to one micropascal at one metre

DECC – Department of Energy and Climate Change

Defra - Department for Environment, Food and Rural Affairs

DP – Dynamic Positioning

EIA – Environmental Impact Assessment

EMS – Environmental Management System

Exposure -Pipeline exposure occurs when the crown of the pipeline or umbilical can be seen. In this document, an exposure may be spanning or non-spanning.

EU – European Union

FBE – Fusion-bonded Epoxy

HRA – Habitats Regulations Assessment

HSC – High-Speed Crafts

HSE – The Health and Safety Executive

ICES – International Council for the Exploration of the Sea

JNCC – Joint Nature Conservation Committee

km^2 – kilometre squared

LAT – Lowest Astronomical Tide

LDP1 – LOGGS Decommissioning Programme 1

LDP2 – LDP5 – LOGGS Decommissioning Programme 2 to LOGGS Decommissioning Programme 5

LOGGS – Lincolnshire Offshore Gas Gathering System

m – metres

m^2 – metre squared

MAT – Master Application Template

MCZ – Marine Conservation Zone

MeOH – Methanol

MLWM – Mean Low Water Mark

MoD – Ministry of Defence

mm – millimetres

NNSSR SAC – North Norfolk Sandbanks and Saturn Reef SAC

NORM – Naturally Occurring Radioactive Material

OGUK – Oil and Gas UK

OPRED – Offshore Petroleum Regulator for Environment and Decommissioning

OSPAR – Oslo Paris Convention

PAH – Polycyclic Aromatic Hydrocarbon

PEXA – Practice and Exercise Area

Pipeline End - Point at which a pipeline is severed from infrastructure. This may be exposed or buried.

Ra – Radium

ROV – Remotely Operated Vehicle

SAC – Special Area of Conservation

SAT – Subsidiary Application Template

Saturn Unit - The Saturn Unit consists of natural gas accumulations Atlas, Hyperion and Rhea

SCANS – Small Cetacean Abundance in the North Sea

SCANS-III – Small Cetaceans in European Atlantic waters

SPAN - Sometimes referred to as a 'freespan'. Similar to an exposure except that the whole of the section of pipeline is visible above the seabed rather than just part of it. Once the height and length dimensions meet or exceed certain criteria the span becomes a reportable span.

SNS SAC – Southern North Sea SAC

SPA – Special Protection Area

SSIV – Subsea Isolation Valve

Surface laid Part of pipeline (or umbilical) that was not trenched when originally installed. At installation surface laid pipeline would typically be overlain by protection and stabilisation features such as mattresses in various forms and grout bags. Such features may also be overlain by deposited rock, but this is usually at locations where the pipeline is entering a trench. Pipelines are usually "surface laid" on the final approach to an installation or pipeline manifold, for example.

TGT – Theddlethorpe Gas Terminal

THC – Total Hydrocarbon Concentration

UK – United Kingdom

UKCS – United Kingdom Continental Shelf

US EPA – United States Environment Protection Agency

VDP1 – Viking Decommissioning Programme

Non-Technical Summary

Introduction and Background

Chrysaor Production (U.K.) Limited (Chrysaor) operates the Lincolnshire Offshore Gas Gathering System (LOGGS) and is 50% owner with BP, which owns the other 50%. The LOGGS complex is the hub facility receiving gas from the Chrysaor-operated V-fields, the Saturn unit and Jupiter, as well as a number of third-party fields. The LOGGS complex forwards this gas onto the Theddlethorpe Gas Terminal (TGT) in Lincolnshire, England, through a 36-inch trunk line (PL454).

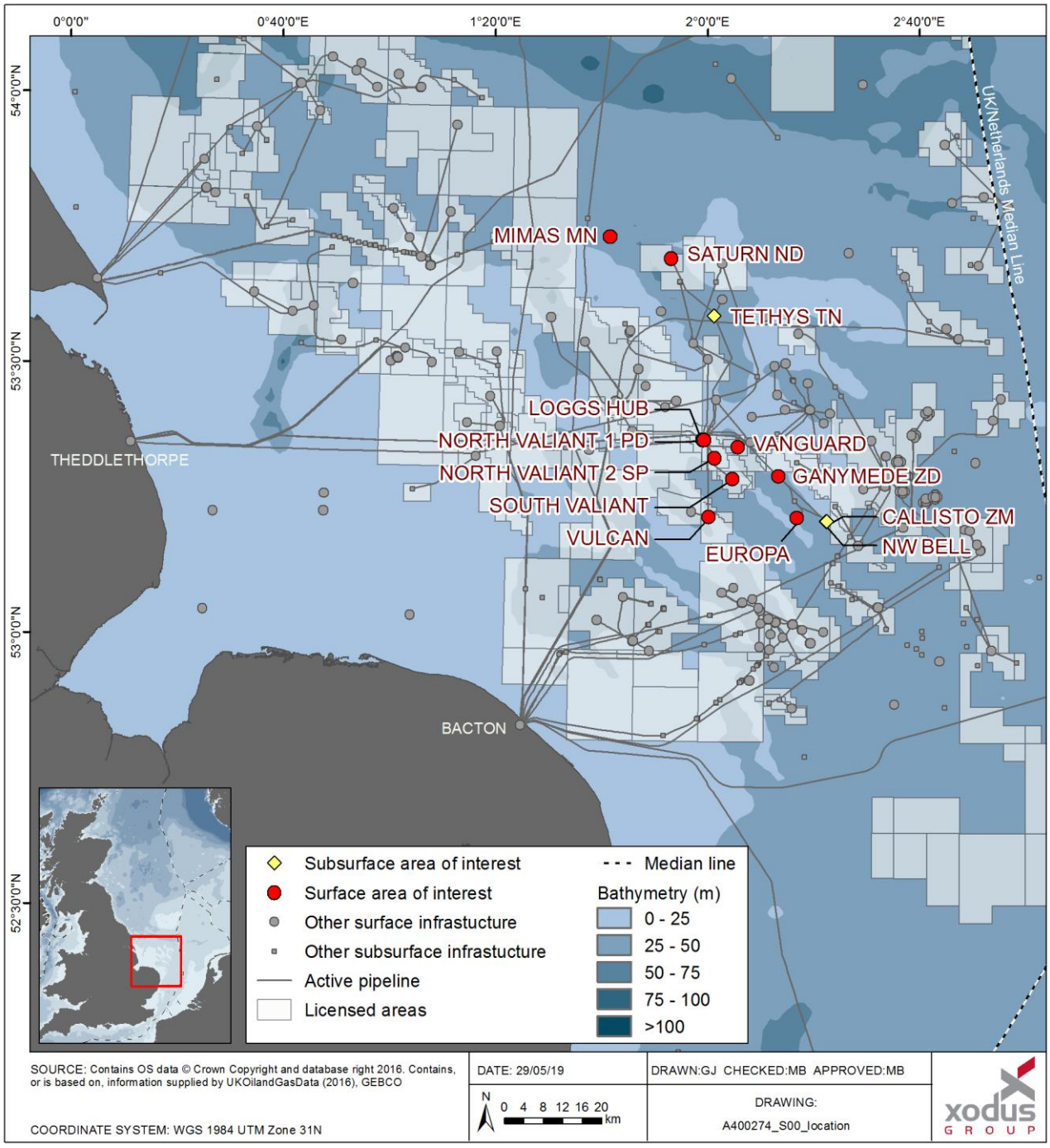
This non-technical summary outlines the findings of the Environmental Appraisal conducted by Chrysaor in support of the next phase of decommissioning activities following the already approved decommissioning programme for the first phase of LOGGS decommissioning (termed LDP1). This next phase of decommissioning activities will be supported by four decommissioning programmes, termed LDP2 – LDP5.

The LDP2 – LDP5 infrastructure is shown in Figure i. A summary of the main facilities and associated infrastructure is given in Table i.

Table i LDP2 – LDP5 area infrastructure

Five manned platforms (the LOGGS Hub complex)		
North Valiant 1 PD	LOGGS Hub PR	LOGGS Hub PC
LOGGS Hub PP	LOGGS Hub PA	
Nine satellite platforms		
Mimas MN	North Valiant 2 SP	Europa EZ
Saturn ND	South Valiant TD	Ganymede ZD
Tethys TN	Vulcan (1) RD	Vanguard QD
Twenty six pipelines (including a 36" gas export trunk line and 290 km of in-field pipelines)		
Nine subsea structures (including NW Bell ZX and Callisto ZM):		
Structure:	**Dimensions (m):**	
ZX North West Bell Manifold	2.38 x 2.38	
Callisto ZM Manifold	13.4 x 13.4	
Sinope Tee Structure	12 x 6	
Sinope Pigging Skid	10 x 7.5	
Tethys TN Tee Structure	13 x 6	
Tethys TN 10" (PL2334) valve skid	2.8 x 2	
Tethys TN 3" (PL2335) valve skid	1.5 x 0.5	
PL454 Tie-in Tee Structure	W x L x H 6 x 13 x 3.5	
PL454 Tie-in Tee Structure	W x L x H 6 x 13 x 3.5	
Fifty nine wells		

Figure i Infrastructure associated with LDP2 – LDP5 area



Regulatory Context

The Petroleum Act 1998 (as amended by the Energy Acts) governs the decommissioning of offshore oil and gas infrastructure, including pipelines, on the United Kingdom Continental Shelf (UKCS). The Act requires the operator of an offshore installation or pipeline to submit a draft Decommissioning Programme for statutory and public consultation, and to obtain approval of the Decommissioning Programme from the Offshore Petroleum Regulator for Environment and Decommissioning

(OPRED), part of the Department for Business, Energy and Industrial Strategy (BEIS), before initiating decommissioning work. The Decommissioning Programme outlines in detail the infrastructure being decommissioned and the method by which the decommissioning will take place.

Formal Environmental Impact Assessment (EIA) to support the Decommissioning Programme is not explicitly required under existing UK legislation. However, the primary guidance for offshore decommissioning that was updated and published by OPRED in 2018 detailed the need for an Environmental Appraisal to be submitted in support of the Decommissioning Programme. The latest guidance recognises that environmental deliverables to support Decommissioning Programmes were historically overly lengthy and did not focus in on the key issues, and now describes a more proportionate Environmental Appraisal process that culminates in a streamlined Environmental Appraisal Report which focuses on the screening out of non-significant impacts and detailed assessment of potential significant impacts.

OSPAR Decision 98/3 sets out the United Kingdom's international obligations on the decommissioning of offshore installation. The Decision prohibits the dumping and leaving wholly or partly in place of offshore installations and is in line with the UK's agreements made under the London Convention 1972, as amended 2006. Under Decision 98/3, the topsides of all installations must be returned to shore, and all installations with a jacket weight of less than 10,000 tonnes must be completely removed for re-use, recycling or disposal on land. Any piles securing the jacket to the seabed should be cut below the natural seabed level at a depth that will ensure they remain covered. The depth to which this is required will be dependent on prevailing seabed conditions and currents.

Decision 98/3 does not include the decommissioning of pipelines, and there are no international guidelines on the decommissioning of disused pipelines. However, the UK Petroleum Act and Pipeline Safety Regulations 1996 provide a framework for the safe decommissioning of disused pipelines. Due to the recognition that each pipeline may have its own specific characteristic and be situated in varying environmental conditions, the OPRED decommissioning guidelines require all feasible pipeline decommissioning options to be considered and a 'Comparative Assessment' made of the available options.

In terms of offshore activities in the southern North Sea, The East Inshore and East Offshore Marine Plans have been developed by the Department for Environment, Food and Rural Affairs (Defra) to help ensure sustainable development of the marine area. Although the Plans do not specifically address decommissioning of oil and gas, they do note the challenges that such activities can bring. As part of the LOGGS decommissioning, Chrysaor has considered the broader aims of the Plans and made a statement on alignment with the aims.

Scope and Schedule of the Decommissioning Programme (LDP2 – LDP5)

The proposed activities associated with the preparation and decommissioning of the infrastructure associated with these programmes include the following:

- Decommissioning of the wells in accordance with the well abandonment programme (covered in separate environmental assessments);
- Preparation, final cleaning and removal of mobile hydrocarbons, production chemicals and mobile solids from pipelines and topsides (gas methanol and corrosion inhibitors) and subsequent flooding of pipelines with seawater (covered in separate environmental assessments);
- Preparation of infrastructure for removal by specialist contractors to an approved onshore disposal facility;
- Leaving installations in cold suspension marked with appropriate navigational aids for up to four years;
- Removal of infrastructure by lifting vessel; and

- Dismantling and disposal of infrastructure which has been removed to an onshore reception facility.

The decommissioned infrastructure will be taken to an appropriate and permitted disposal yard located within the UK. The specific disposal yard is still to be determined.

A post-decommissioning monitoring programme covering any infrastructure decommissioned *in situ* will be agreed with OPRED.

Under the Petroleum Act 1998 OPRED's regulatory remit with regards to decommissioning of offshore oil and gas pipelines ends at the Low Water Mark. Regulatory locus beyond that, to the onshore end point, lies with the Town and Country Planning Act and Local Planning Authority. Where the pipelines beyond Low Water Mean are adequately buried, which they all are, the intention is to leave these *in-situ*.

Consideration of Alternatives and Selected Decommissioning Options

Options to re-use the LDP2 – LDP5 installations *in situ* for future hydrocarbon developments have been considered, but to date none have yielded a viable commercial opportunity. This has primarily been due to limited remaining hydrocarbon reserves and design life of the infrastructure. The decommissioning methods for the associated flushed and cleaned pipeline infrastructure were assessed against each other in a Comparative Assessment which looked at a number of full removal, partial removal and decommission *in situ* options. To facilitate the Comparative Assessment, the pipeline portfolio was split into groups of lines with similar characteristics. Please note that where a pipeline is referred to as 'trenched and buried,' this refers to natural burial by sediment. The emerging recommendation for each group was as follows:

- **Group 1: 36" Trenched and buried trunkline from LOGGS PP to MLWM**

The recommendation from the Comparative Assessment is to decommission the gas export pipeline *in situ* with minimum intervention. This would require disconnection and removal of the pipeline connected to the LOGGS PP platform and at the tee locations with local rock placement at the cut pipeline ends only. The remaining pipeline, left in its current state, would be marked on sea charts and notifications issued to fishermen / other users of the sea. The post decommissioning monitoring programme will be agreed with OPRED and will be in accordance with OPRED guidance in operation at that time.

This is the only type of pipeline where any detected span would not be subject to rock placement.

- **Group 2: NW Bell – Mattress Covered Short Umbilical & Associated Pipelines (PL1690, PL1691 and UM3)**

The recommendation from the Comparative Assessment is that both the full removal and the leave *in situ* options may be progressed. Chrysaor intends to fully remove these 80m lines by cut and lift. The lines will be cut into shorter sections using hydraulic shears. These short sections will be recovered to the deck of the vessel for transfer to shore.

- **Group 3a: Trenched Interfield Non-concrete Coated Piggyback Pipelines ≤ 16" (PL1694, PL1695, PL2234, PL2235, PL2236, PL2237)**

The recommendation from the Comparative Assessment is to decommission the lines *in situ* with minimum intervention. This comprises removal of the ends of the pipelines and placing spot rock cover at the cut ends only. The remaining pipeline, left in its current state, would be marked on sea charts and notifications issued to fishermen / other users of the sea. The post decommissioning

monitoring programme will be agreed with OPRED and will be in accordance with OPRED guidance in operation at that time. Note any exposed sections will be removed with the pipeline ends.

- **Group 3b: Trenched Interfield Non-concrete Coated Non-piggyback MeOH Pipeline ≤ 16" (PL455)**

The recommendation from the Comparative Assessment is that both the partial removal and the leave *in situ* options are equally preferred. This would require disconnection and removal of the pipeline connected to the LOGGS PP platform and at the tee locations with local rock placement at the cut pipeline ends in all cases. The individual exposures will be risk assessed to determine whether remediation is necessary to protect the safety of fishermen, with the outcome of this assessment influencing whether the exposures will be removed, rock covered or left *in situ*. For the purposes of the environmental assessment, owing to the environmental sensitivities and intent not to place rock over exposed pipeline sections, partial removal is assumed whereby the exposures will be removed and rock placed on cut pipeline ends.

The remaining pipeline, left in its current state, would be marked on sea charts and notifications issued to fishermen / other users of the sea. The post decommissioning monitoring programme will be agreed with OPRED and will be in accordance with OPRED guidance in operation at that time.

- **Group 3c: Trenched Interfield Concrete Coated Piggyback Pipelines ≤ 16" (PL456, PL457, PL460, PL461, PL470, PL471, PL191, PL192)**

The recommendation from the Comparative Assessment is that both the partial removal and the leave *in situ* options are equally preferred. This would comprise removal of the ends of the pipelines and placing spot rock cover at the cut ends in all cases. The individual exposures will be risk assessed to determine whether remediation is necessary to protect the safety of fishermen, with the outcome of this assessment influencing whether the exposures will be removed, rock covered or left *in situ*. For the purposes of the environmental assessment, owing to the environmental sensitivities and intent not to place rock over exposed pipeline sections, partial removal has been assessed as a worst case whereby the exposures will be removed and rock placed on cut pipeline ends.

However, the exposures are examined in more detail and none of them are considered as candidates for remediation at this stage. Since the CA recommends either in-situ or partial removal, the in-situ state has been chosen. The driver for this decision is that more information over a longer period of time needs to be gathered about the adjacent seabed in order to understand whether cut and lift of exposures would result in permanent burial and not induce scouring around adjacent cut ends, and therefore further exposures. Additionally these pipelines are already accessible for overtrawl outside of the 500m zones and the existing condition does not raise any significant safety concerns.

Should there be a need to removal a section of the pipeline, the remaining pipeline, left in its current state, would be marked on sea charts and notifications issued to fishermen / other users of the sea. The post decommissioning monitoring programme will be agreed with OPRED and will be in accordance with OPRED guidance in operation at that time.

- **Group 4: Trenched Interfield Concrete Coated Piggyback Pipelines > 16" (PL458, PL459, PL1093, PL1094, PL2107 and PL2108)**

The recommendation from the comparative assessment is that both the partial removal and the leave *in situ* options are equally preferable. This would comprise removal of the ends of the pipelines and placing spot rock cover at the cut ends in all cases. The individual exposures will be risk assessed to determine whether remediation is necessary to protect the safety of fishermen, with the outcome of this assessment influencing whether the exposures will be removed, rock covered or left *in situ*.

For the purposes of the environmental assessment, owing to the environmental sensitivities and intent not to place rock over exposed pipeline sections, partial removal has been assessed as a worst case, whereby the exposures will be removed and rock placed on cut pipeline ends.

However, the exposures are examined in more detail and none of them are considered as candidates for remediation at this stage. Since the CA recommends either in-situ or partial removal, the in-situ state has been chosen. The driver for this decision is that more information over a longer period of time needs to be gathered about the adjacent seabed in order to understand whether cut and lift of exposures would result in permanent burial and not induce scouring around adjacent cut ends, and therefore further exposures. Additionally these pipelines are already accessible for overtrawl outside of the 500m zones and the existing condition does not raise any significant safety concerns.

Should there be a need to removal a section of the pipeline. The remaining pipeline, left in its current state, would be marked on sea charts and notifications issued to fishermen / other users of the sea. The post decommissioning monitoring programme will be agreed with OPRED and will be in accordance with OPRED guidance in operation at that time.

- **Group 7: Trenched and Buried Umbilical (UM2)**

The recommendation from the comparative assessment is that both the partial removal and the leave *in situ* options are equally preferable. This would comprise removal of the ends of the pipelines and placing spot rock cover at the cut ends in all cases. The single 11 m exposure will be risk assessed to determine whether remediation is necessary, with the outcome of this assessment influencing whether the exposure will be removed, rock covered or left *in situ*. For the purposes of the environmental assessment, owing to the environmental sensitivities and intent not to place rock over exposed pipeline sections, partial removal is assumed whereby the exposure will be removed and rock placed on cut pipeline ends.

The remaining pipeline, left in its current state, would be marked on sea charts and notifications issued to fishermen / other users of the sea. The post decommissioning monitoring programme will be agreed with OPRED and will be in accordance with OPRED guidance in operation at that time.

The following options were excluded from the evaluation phase for all the pipeline groupings:

- Accelerated decomposition was screened out of all options as the concept is un-proven and the impact of potential chemical agents into the marine environment is not understood and cannot be quantified.
- Burial of exposed ends and pipeline sections is not considered a permanent solution for the pipelines in this location due to the dynamic seabed movement, rendering a burial solution vulnerable to unburial over time.
- Rock cover over the full pipeline length is not considered a feasible solution as large magnitude rock cover is considered detrimental to the free movement of sand in the protected area.
- Reburial of the full pipeline length is not considered a permanent solution due to the dynamic seabed movement, rendering a burial solution vulnerable to unburial over time.

Trench and re-burial was discounted because there is no information that is known of these pipelines to suggest that sufficient burial will result in no subsequent exposure in this area where dynamic seabed conditions persist (shallow water, strong tidal influence with mega-ripple sediment features).

There is a lot of uncertainty associated with the chance of success in the achievement of burial of pipeline ends and exposures in this dynamic seabed environment. As the assets were trenched and buried in construction phase, it is unlikely that re-burial will achieve permanent burial of exposures. Despite advances in pipelaying techniques since the time of installation, the methods used for the burial of these types of pipelines within the dynamic area have not changed significantly to increase the level of assurance that the pipelines will remain buried. Furthermore, in this locality the dynamic seabed is the dominant factor that influences pipeline exposure (with the exception of the 36” trunkline which was trenched and left to backfill naturally, also contributing to the exposures present).

The analysis of the pipeline depth of cover survey information does not appear to correlate between installation burial depth and areas of exposure. This is evident in the LOGGS area where surficial soils are generally hard and sandy but of varying depths overlaying clay. If reburial were to be attempted, the localised variability of the soil and seabed profile contributes to the uncertainty of success of permanent burial.

The burial under natural sediment of pipeline ends has also been discounted for the same reasons as this option will require an unknown length and depth of pipeline trenching and excavation back to

sufficient depth to ensure some degree of success. Furthermore, trenching and burial will result in widespread, short term disturbance of the seabed within the marine protected area with limited long term success.

Due to the dynamic seabed environment, rock remediation on pipeline ends is expected to provide the safest profile for other users of the sea. Burial is not considered a permanent solution in the dynamic seabed conditions exposing other users of the sea to potential snag hazards should unburial of ends occur.

Rock cover over the full pipeline length was excluded from the evaluation phase for all the pipeline groupings. The key reason for discounting this option was the impact of permanent habitat loss associated with the deposit of hard substrate within the marine protected area. The placement of rock material is still considered feasible in other options selected for further consideration on the basis that the options provide a high certainty of long term success whilst the impact of habitat loss through the deposit of hard substrate is localised in comparison. Whilst rock deposits provide long term success, the potential for rock influenced scour adjacent to the deposits has been considered in the comparative assessment of the feasible options.

Proposed Schedule

Chrysaor anticipates executing the LDP2 – LDP5 activities between 2018 and 2025; an indicative schedule is provided in Figure ii. However, the specific timing is still to be agreed with OPRED and the Health and Safety Executive. All relevant permits and consents will be submitted, and approval sought, prior to activities commencing.

Table i Indicative decommissioning schedule

Environmental Sensitivities

Key environmental sensitivities are described in Table ii. In particular, any habitats listed in Annex I or species listed in Annex II of the Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora, known as Habitats Directive, have been listed below. Areas where species or habitats listed in Annex I or Annex II of the Habitats Directive are known to occur are protected through the Natura 2000 network which includes Special Areas of Conservation (SACs).

Table ii Environmental sensitivities

Environmental Receptor	Description
Conservation Interests	
Protected Habitats	
Annex I habitat 'sandbanks slightly covered by seawater all the time' was present within the LOGGS Hub, Mimas MN and Ganymede ZD survey areas during the habitat assessment and pre-decommissioning survey across the LOGGS gas fields conducted in 2015.	
No evidence of any threatened and/or declining species and habitats on the OSPAR List of Threatened and/or Declining Habitats and Species.	
Coastal and offshore Annex II species most likely to be present in the project area	
Environmental Receptor	**Description**
Harbour porpoise	Harbour porpoise are frequently found throughout UK waters. They usually occur in groups of one to three individuals in shallow waters, although they have been sighted in larger groups and in deep water. While the species is highly mobile, harbour porpoise populations persist in the summer and winter months within the Southern North Sea SAC (JNCC, 2019a). Harbour porpoise have been reported to occur from February through to May and again from August to October (ConocoPhillips, 2015). Trend analysis of harbour porpoise estimates in the North Sea shows no support for a change in abundance between 1994 and 2016, and the species range appears to have expanded (Hammond *et al.*, 2017).
Grey seal Harbour seal	As the project area is located approximately 56 km offshore, these species may be encountered in the vicinity from time to time, but the project area is not of specific importance for these species. The presence of grey seals in the project area is between 0 – 5.0 individual per 25 km^2 and /harbour seals are between 0-50.0 High numbers of grey seals are found around the mouth of the Humber and close to the Donna Nook National Nature Reserve. Grey seal density diminished with distance offshore. High concentrations of harbour seals have been found in the Wash National Nature Reserve and are also likely to be found further offshore.
Conservation Sites	
Special Areas of Conservation (SACs)	The decommissioning area is located with the North Norfolk Sandbank and Saturn Reef SAC. This site is designated for Annex I habitat reefs and sandbanks which are slightly covered by water all of the time. A small section of the export pipeline runs through Inner Dowsing, Race Bank and North Ridge SAC (note no decommissioning activities will occur at this site). This site is also designated for Annex I habitat reefs and sandbanks which are slightly covered by water all of the time. The decommissioning area is also located within the Southern North Sea SAC which is designated for Annex II species harbour porpoise. The area covered by

Environmental Receptor	Description
	the decommissioning project largely overlaps with that of the North Norfolk Sandbanks and Saturn Reef SAC. The Humber Estuary SAC is located 6.5 km north of the decommissioning area. it is designated due to the presence of the Annex I habitat estuaries and mudflats and sandflats not covered by seawater at low tide. The Wash and North Norfolk Coast SAC is located 27 km south of the LOGGS to Theddlethorpe Gas Terminal pipeline. The site is designated for Annex I habitat sandbanks which are slightly covered by water all of the time, mudflats and sandflats not covered by seawater at low tide, large shallow inlets and bays, reefs, Salicornia and other annuals colonising mud and sand, Atlantic salt meadows and Mediterranean and thermos-Atlantic halophilous scrubs, and Annex II species harbour seal.
Special Protection Areas (SPAs)	The LOGGS to MLWM pipeline crosses the Humber Estuary SPA and Greater Wash SPA. The Humber Estuary is used regularly by at least 1% of the 12 Annex I bird species found in Great Britain: including bittern; hen harrier; marsh harrier and avocet. The site also qualifies as it is regularly used by 1% or more of the biogeographical populations of a number of bird species including shelduck, dunlin, bar-tailed godwit, black tailed godwit, golden plover, little tern, redshank and ruff. In addition, the site also qualifies as it is used regularly by over 20,000 waterbirds in any season (Natural England, 2007). The Greater Wash SPA provides areas of importance for over-wintering for the red-throated diver *Gavia stellata*, little gull *Hydrocoloeus minutus* and common scoter *Melanitta nigra*. In addition the site aims to protect ideal coastal feeding waters used by breeding populations of common tern *Sterna hirundo*, sandwich tern *Thalasseus sandvicensis* and little tern *Sternula albifrons*.
Nature Conservation Marine Protection Area (MPAs)	Holderness offshore MCZ is located approximately 24 km north of the LOGGS to Theddlethorpe Gas Terminal pipeline. The site is designated for OSPAR list of threaten and/or endangered ocean quahog (*Arctica islandica)* and due to the presence of habitats such as subtidal sand, subtidal coarse sediment and subtidal mixed sediment (Defra, 2019). The Cromer Shoal Chalk beds MCZ is located 47 km to the decommissioning area. the site is designated for habitat features including high energy circalittoral rock, high energy infralittoral rock, moderate energy circalittoral rock, moderate energy infralittoral rock, North Norfolk coast (subtidal) peat and clay exposures, subtidal coarse sediment, subtidal mixed sediments and subtidal sand.
Benthic Environment	
Bathymetry	The LOGGS area ranges in depths from approximately 15 m to 36 m.
Seabed sediments	Sediments in the decommissioning area are comprised of fine to coarse sands, often silty and with variable amounts of shell fragments and occasional pebbles and cobbles. The highly dynamic marine environment restricts the silt and clay content to less than 15%.

Environmental Receptor	Description
	The seabed habitat when classified using the EUNIS code it A5.2: "Sublittoral, clean medium to fine or non-cohesive slightly muddy sands on open coasts, offshore or in estuaries and marine inlets".
Benthic fauna	Benthic fauna identified during seabed surveys are typical for this area of the SNS. The shallow-water infaunal assemblage is typically characterised by taxa including polychaetes, bivalve molluscs and amphipods and crustaceans. *Sabellaria spinulosa* were identified in several historical survey reports within and adjacent to the SNS Phase 1 area. Surveys have observed some patchy fragmented areas of *Sabellaria spinulosa,* however these patches would not be classified as 'reef' under the JNCC *Sabellaria spinulosa* reef definition guidance.
Fish – spawning and nursery grounds	
Spawning grounds	The project area is located within the spawning grounds of cod (January to April, [peak spawning February to March]), lemon sole (April to September), Norway lobster* (January 20 December [peak spawning April to June]), plaice (December to March [peak spawning January to February]), sandeels (November to February), sole (December and March to May [peak spawning in April], sprat (May to August [peak spawning May to June]), thornback ray (February to September [peak spawning April to August]) and whiting (February to June). Within the decommissioning area is an area of high intensity spawning for plaice. *At the north eastern edge of the NNSSR SAC Norway lobster are also present, this overlaps with the area of activity (JNCC, 2010c).
Nursery grounds	The following species have nursery grounds in the vicinity of the project: anglerfish, cod, herring, lemon sole, plaice, sandeel, sprat, mackerel, spurdog, herring, Norway lobster, sole, tope, thornback ray and whiting. Within the decommissioning area is an area of high intensity nursery grounds for cod, herring and whiting.

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Anglerfish	N	N	N	N	N	N	N	N	N	N	N	N
Cod	SN	S*N	S*N	SN	SN	N	N	N	N	N	N	N
Herring	N	N	N	N	N	N	N	N	N	N	N	N
Lemon sole	N	N	N	SN	SN	SN	SN	SN	SN	N	N	N
Mackerel	N	N	N	N	N	N	N	N	N	N	N	N
Norway lobster	SN	SN	SN	S*N	S*N	S*N	SN	SN	SN	SN	SN	SN
Plaice	S*N	S*N	SN	N	N	N	N	N	N	N	N	SN
Sandeels	SN	SN	N	N	N	N	N	N	N	N	SN	SN
Sole	N	N	SN	S*N	SN	N	N	N	N	N	N	SN
Sprat	N	N	N	N	S*N	S*N	SN	SN	N	N	N	N
Spurdog	N	N	N	N	N	N	N	N	N	N	N	N
Tope	N	N	N	N	N	N	N	N	N	N	N	N
Thornback ray	N	SN	SN	S*N	S*N	S*N	S*N	S*N	SN	N	N	N
Whiting	N	SN	SN	SN	SN	SN	N	N	N	N	N	N

S = Spawning, N = Nursery, SN = Spawning and Nursery; * = peak spawning; Species = High nursery intensity as per Ellis *et al*, 2012; Species = High intensity spawning as per Ellis *et al* (2012); Species = High concentration spawning as per Coull *et al.*, 1998;

Seabirds
The most common species of seabird found in these areas of the SNS include fulmar, gannet, guillemot, kittiwake, razorbill, puffin and little auk, as well as numerous species of gull, tern and skua.

Environmental Receptor	Description
Through the Seabird Monitoring Programme, the JNCC prepare trends in abundance, productivity, demographic parameters and diet of breeding seabirds. This data provides at-a-glance UK population trends as a percentage of change in breeding numbers from the complete censuses (JNCC, 2016). From the years 1998-2015, the following population trends for species known to use the field area have been recorded: black-legged kittiwake (-44%), northern fulmar (-31%), guillemot (+5%), razorbill (+32%), and northern gannet (+34%). In the decommissioning area the sensitivity of seabirds to oil pollution, reflected by the Seabird Oil Sensitivity Index, is low between July and September, with the exception of Block 49/17 in July. Between November and March, the Seabird Oil Sensitivity Index is very high to extremely high. There is no data for April to June for many of the blocks, and again for October and November.	

Seabed Oil Sensitivity Index

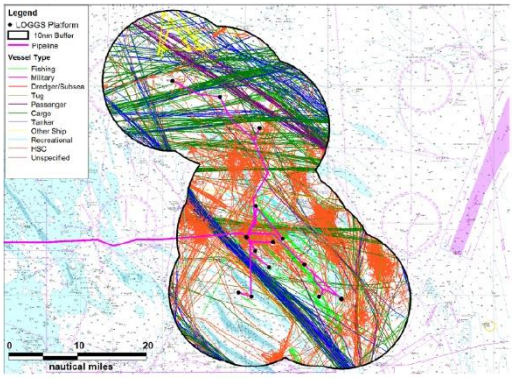
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
48/20	1*	1	1*	N	3*	5*	5*	5	5*	N	1*	1
49/16	2*	2	2*	N	N	5*	5*	5	5*	N	2*	1*
49/17	N	**1***	2*	N	N	2*	2	5	5	5*	N	1*
49/21	1*	1	2	2*	N	N	5*	5	5*	N	1*	1
Key	1 = Extremely high		2 = Very high		3 = High		4 = Medium		5 = Low		N = No data	
	* in light of coverage gaps, an indirect assessment of SOSI has been made											

Socioeconomic Sensitivities

Key socioeconomic sensitivities are described in Table iii.

Table iii societal sensitivities

Socio-economic receptor	Description
Commercial fishing	
The main species targeted are shellfish, with demersal species dominate catch in some areas. The highest number of effort days takes place in the summer months (July-September), but fishing activity is low to moderate at the pipeline ends in comparison to other regions of the North Sea, expect at the Europa platform where fishing intensity is higher. Along the pipelines within the LDP2 to LDP5 areas, fishing intensity is low to moderate, expect along a section of the pipelines between Vanguard and Vulcan (LDP4) where intensity is high.	
Other Users	

Shipping activity	The North Sea contains some of the world's busiest shipping routes, with significant traffic generated by vessels trading between ports at either side of the North Sea and the Baltic. North Sea oil and gas fields also generate moderate vessel traffic in the form of support vessels. Shipping activity is very low to high in the area. A review of Automatic Identification System data from 2016 allowed the identification of shipping routes within the Project area, including merchant vessels over 300 tonnes and fishing vessels of 15 m length and over. This allowed identifying the main vessel types passing through the Project area, which are cargos, High-Speed Crafts, tankers, passengers and fishing vessels.	 *AIS data from a four-week period in 2016 within 10 nm of the LOGGS platforms (Anatec, 2017).*
Oil and Gas	The nearest non-Chrysaor field is the Leman Field and its 33 platforms, located approximately 4 km to the south.	
Telecomms.	The Tampnet Telecommunications cable passes 28 km east of the LOGGS Hub.	
Military activities	A Ministry of Defence area combat training zone is partially located within the decommissioning area.	
Renewables	The nearest windfarms are Hornsea zone and East Anglia zone located approximately 35 km N and SE, respectively, from Viking and LOGGS facilities, and the Dudgeon windfarm site which is located approximately 36 km W.	
Wrecks	No designated historical wreck recorded in the area; however, there are nine non-designated wrecks, and seven of these are classified as dangerous.	

Impact Assessment

An initial screening of the impacts and receptors was undertaken as part of the impact identification workshop. This workshop identified the key environmental sensitivities, discussed the sources of potential impact and identified those sources which required further assessment. Table IV summaries the identification workshop and provides justification statements as to inclusion in further assessment within the Environmental Appraisal.

Table IV Summary of the identification workshop, with justification for the inclusion and exclusion of impact sources

Impact	Further assessment?	Rationale
Gaseous emissions to atmosphere and energy use.	No	Emissions regulated under the European Union Emissions Trading Scheme (EU ETS) and Industrial Emissions Directive (IED) will cease as the combustion plants become inoperable. During the pipeline flush and clean campaign there will be venting of natural gas. The worst case scenario for the mass of natural gas vented during these operations was:

Impact	Further assessment?	Rationale
		• LDP2 - 2.64 tonnes; • LDP3 - 14.0 tonnes; • LDP4 - 1.92 tonnes; and • LDP5 - 49.31 tonnes. These levels are all below the annual vent consents for each of the field areas. Therefore venting of the gas does not pose a significant risk to the environment. The estimated CO_2 emissions to be generated by the selected decommissioning options is 19,019 te, this equates to 0.13% of the total UKCS CO_2e emissions in 2018 (14,630,000 te; OGUK, 2019). See Appendix 1 for further details. Recycling, transportation of waste onshore and also the accountability for any material decommissioned *in situ* (deemed to be lost to society) has been accounted for in the calculation of energy spent and CO_2 emissions generated within the accompanying Comparative Assessment. Considering the above, atmospheric emissions and energy use are not assessed further herein.
Physical presence of vessels and rigs in relation to other sea users (including commercial shipping)	No	The presence of vessels for decommissioning activities will be relatively short term in the context of the life of the LOGGS fields. Activity will occur using similar vessels to those currently deployed for oil and gas across the southern North Sea. Vessels will also generally be in use around existing infrastructure and will not occupy 'new' areas. Chrysaor have commissioned a Navigational Risk Assessment (NRA) which covers the wider LOGGS area and includes Vessel Traffic Surveys (Anatec, 2017) and consultation of the results with relevant stakeholders. With standard mitigation measures such as Notice to Mariners, the presence of a 500 m safety exclusion zone around the platform, the short term nature of these operations and use of navigation aids and safety standby vessels, this risk is not expected to be significant. Other sea users will be excluded from the 500 m safety zone during active operations. The 500 m safety zones will remain until such time the installations are fully removed. Thereafter applied safety zones will remain until such time debris clearance and seabed remediation has been completed.

Impact	Further assessment?	Rationale
		Navaids will be included on the installation and HLV. The HLV will also have an accompanying Communication Interface Plan in place. Other sea users at sea and in port will be notified in advance of activities occurring and the movements of the vessels associated with decommissioning work, meaning those stakeholders will have time to make any necessary alternative arrangements for the limited period of operations. The nearshore activities associated with this project are very likely to be limited in duration (limited to passing vessels). Considering the above, temporary presence of vessels is not assessed further herein.
Physical presence of infrastructure decommissioned *in situ* in relation to other sea users, both in terms of possible exclusion and risk of snagging	Yes – Section 0	The preferred option from the Comparative Assessment is to decommission pipelines/umbilicals *in situ*. Protection/support material (mattresses and grout bags) will be recovered when they must be moved to access infrastructure underneath. Post decommissioning, non-intrusive surveys will be used where possible. No overtrawl activities will be undertaken along pipeline corridors or within sites designated to protect seabed features or supporting habitats in line with conservation objectives for these sites. Consideration has been given as a worse case for the potential overtrawl of the 500 m safety zone around the Saturn platform location, however this is highly unlikely as non-intrusive surveys will be used in the first instance. The Saturn platform is not located in any designated sites. Post removal of the pipeline ends there are two areas of spanning (PL454 - 14.97 m and PL456 - 17.97 m), these areas are potentially characteristic of spans meeting FishSafe reporting requirements and will be monitored during post decommissioning for evidence of change in state. The total seabed footprint including decommissioning operations and overtrawl survey is estimated as 0.8278 km^2, 0.0339 km^2 of which will be within the North Norfolk Sandbanks and Saturn Reef SAC, which represent 0.0009% of the total SAC area. For the Southern North Sea SAC the area impacted is 0.0289 km^2 representing only 0.000078% of the total SAC area. On this basis, further assessment has been undertaken. There is an approximate footprint of 0.39 km^2 associated with the pipeline located within the Inner Dowsing, Race Bank and North Ridge SAC. However,

Impact	Further assessment?	Rationale
		there is not anticipated to be any impacts other than the physical presence of the pipeline and there are no reportable spanning events along this section of pipeline.
Discharges from infrastructure during decommissioning activities. Routine vessel discharges (e.g. grey water, blackwater, ballast) Chemical, hydrocarbon and naturally occurring radioactive material (NORM) discharges	No	Discharges from vessels are regulated activities that are managed on an ongoing basis. Discharges from infrastructure occurring during decommissioning activities will be assessed in more detail as part of the environmental permitting process (e.g. through Master Application Templates/Subsidiary Application Templates). Controls will be in place, as relevant, through the Offshore Chemical Regulations and the Oil Pollution Prevention and Control regulations. Pipelines have been flushed to achieve a hydrocarbon concentration in flush fluids of less than 30 mg/l. Pipeline contents including flushing chemicals have been disposed of downhole on the LOGGS Complex, a strategy designed to eliminate discharges to the marine environment. Chrysaor reviewed various techniques for the effective flushing of the subsea pipelines including turbulent flushing and the use of pigging trains. It was concluded that the most effective method, of flushing the subsea pipelines was to utilise a pigging train arrangement comprising of varying cleaning solvents and gels separated by high density foam or gel pigs. The objective being to displace pipeline contents, remove mobile hydrocarbons whilst leaving *in situ* scale deposits. Considering the above, discharges to sea during decommissioning activities are not assessed further herein.
Long term release of cuttings swarf/plastics or metals left *in situ.* Chemical, hydrocarbon and naturally occurring radioactive material (NORM) discharges	Yes – Section 5.1	The preferred options from the Comparative Assessment includes the decommissioning of pipelines/umbilicals *in situ*. Protection/support material (mattresses and grout bags) will be recovered when they must be moved to access infrastructure underneath. Given the location within the North Norfolk Sandbanks and Saturn Reef SAC, and the Southern North Sea SAC, the potential impact of long term release from infrastructure decommissioned *in situ* on the receiving environment requires investigation. On this basis, further assessment has been undertaken. Although there are sections of the export pipeline which transit the Greater Wash and Humber Estuary SPAs,

Impact	Further assessment?	Rationale
		any deposition of degradation products is expected to be highly localised to the pipeline and of such low concentration/ volumes as to pose no significant risk to the qualifying features.
Underwater noise emissions from vessels and cutting operations	Yes – Section 5.2	The location of project activities within the Southern North Sea SAC, designated for harbour porpoise, makes this a key sensitivity. There is potential for localised injury and disturbance to marine mammals and fish through noise from cutting operations and vessels across the project area, although this is expected to be low. However, given activity is taking place within the SAC further assessment has been undertaken.
Onshore dismantling yard activities including airborne noise, odour, light, dust and aesthetics	No	All onshore decontamination, dismantlement and disposal facilities at which decommissioned material will be handled currently manage potential environmental impacts as part of their existing site management plans. There is anticipated to be no change in potential for impact as a result of any of the material proposed for recovery. Based on Chrysaor's contracting strategy, multiple disposal facilities are likely. Whilst the yards are yet to be selected, they will be in the UK. Chrysaor's procedures require suitably approved facilities. The approval process comprises site visits, review of permits and consideration of how the facility's construction and design has been developed to minimise impact. Chrysaor understands that dismantling sites will also require consents and approvals from onshore regulators such as the Environment Agency, who apply conditions relating to mitigation, management and details of who are responsible for the provision of permits for such work. Considering the above, onshore interactions are not assessed further herein.
Waste: Resource use - Use of landfill space	Yes – Section 5.3	Waste management is a key interest in decommissioning activities. On this basis, further assessment has been undertaken.
Waste: including non-hazardous, hazardous, radioactive and marine growth	Yes – Section 5.3	Waste management is a key interest in decommissioning activities. On this basis, further assessment has been undertaken.

Impact	Further assessment?	Rationale
Employment	No	The variable potential for impact from project activities was not identified as a differentiator in the Comparative Assessment. Whilst it is recognised that there could be a negative effect resulting from cessation of production, there will be a countering benefit in the additional work required to affect the decommissioning activities. It is expected that the key socio-economic effect would occur through potential interaction with fisheries (assessed in 4.6). Considering the above, changes in employment (positive or negative) are not assessed further herein.
Unplanned events, including chemical/hydrocarbon release and dropped objects	No	Well plugging and abandonment is outside of the scope of this specific impact assessment, since it not dependent on approval of the Decommissioning Programme. The possibility of a well blowout therefore does not require consideration in this assessment (it is assessed as part of separate well intervention and marine licence applications). All lift operations will happen within platform safety zones or at the dockside therefore there is minimal risk from dropped objects on live 3rd party infrastructure from these activities. During transport the infrastructure will either be transported on deck with suitable sea fastening or held 'in the hook' securely for transport as per safe vessel operating procedures. As a result, there will be minimal risk from significant dropped objects during transport. Should such an event occur, the likely destination ports would mean transport over gas or condensate lines only which would result in a low risk hydrocarbon release which could be managed by offshore spill procedures with minimal environmental impact. Pipelines and umbilicals have been flushed and cleaned prior to the decommissioning activities described herein being carried out. Release of a hydrocarbon and chemical inventory is therefore also out of scope of this assessment. Chrysaor expect that the heavy lift vessel will have an accompanying Communication Interface Plan (CIP) and oil spill modelling included in the relevant OPEP. As the methodology for platform removal to shore has not been defined, there exists the possibility that jackets and/or topsides could be transported by a vessel using a crane. Where these would be suspended over the

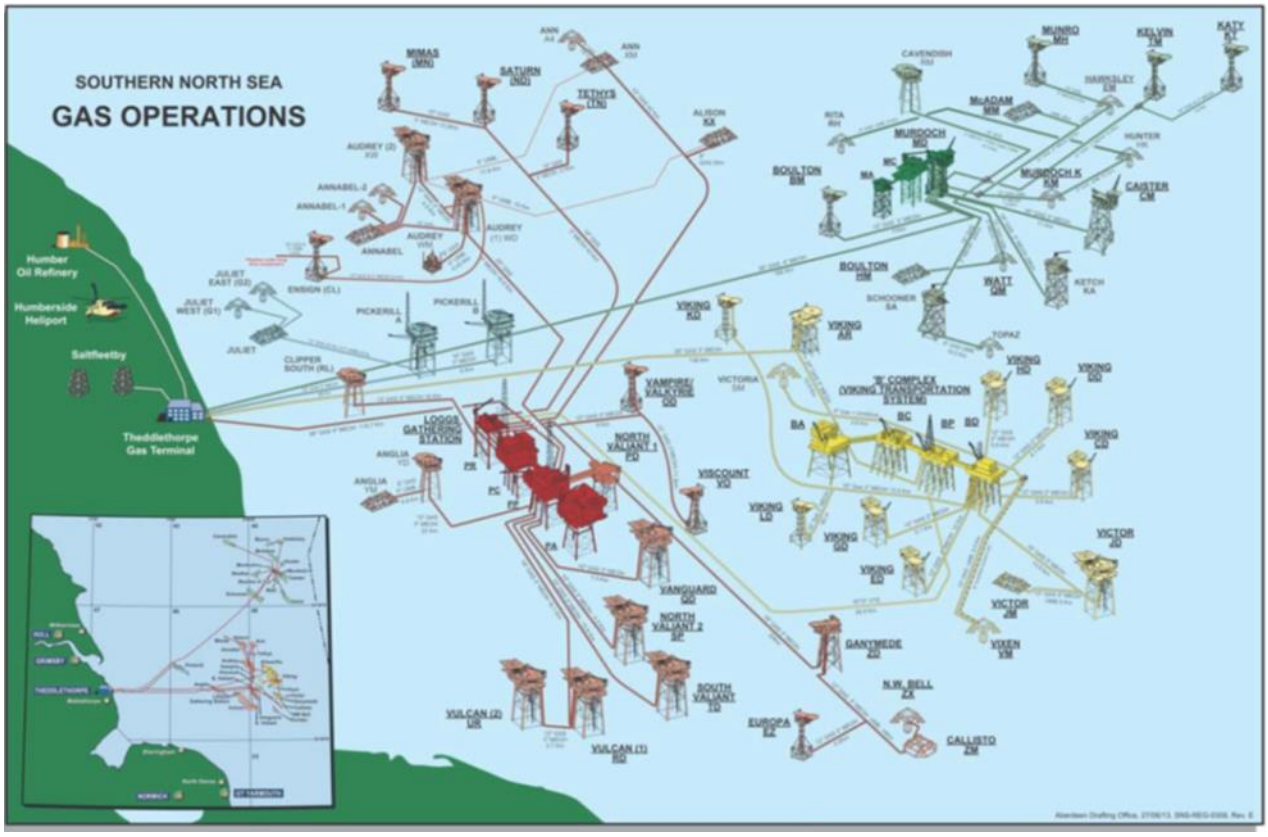
Impact	Further assessment?	Rationale
		side of the vessel for the transfer, the possibility of dropping onto a live pipeline cannot be ruled out. However, dropped object procedures are industry standard and there is only a very remote probability of any interaction with any live infrastructure, when planning for such transport efforts will be made to minimise the transit over live infrastructure. Considering the above, accidental events are not assessed further herein.

1.0 Introduction

1.1 Background

Chrysaor Production (U.K.) Limited (Chrysaor) operates three main gas areas in the southern North Sea, called Viking, the Lincolnshire Offshore Gas Gathering System (LOGGS) and the Caister Murdoch System (CMS). These areas are shown alongside Chrysaor's other southern North Sea infrastructure in Figure 1-1.

Figure 1-1 Chrysaor southern North Sea assets



Chrysaor is making progress through a ten-year decommissioning project covering these facilities, a project which began with well plugging and abandonment activities in 2014. For the purposes of planning the decommissioning activities, Chrysaor has divided the facilities associated with the Viking, LOGGS and CMS assets into a number of smaller areas to align with co-venture groups as follows:

- Four Decommissioning Programme submissions are required for the Viking area:
    - VDP1a: Viking GD, HD, DD, CD, ED installations (approved by OPRED in 2016);
    - VDP1b: Viking GD, HD, DD, CD, ED associated pipelines (approved by OPRED in 2017);

  - VDP2: Remaining Viking area installations and associated pipelines (approved by OPRED Feb 2019);
  - VDP3: Victor area installations and associated pipelines (Approved by OPRED Feb 2019); and
  - All Viking area assets are currently in cold suspension with all platform Wells abandoned. Eight Viking platforms are scheduled to be fully removed in the 2019 programme (Viking CD, DD, GD, HD, ED, KD, LD and Victor JD).

- Five Decommissioning Programme submissions are required for the LOGGS area:
  - LDP1: Vulcan UR, Vampire OD, Viscount VO installations and associated pipelines (approved by OPRED in 2017);
  - LDP2: Saturn area installations and associated pipelines (to be submitted for approval in 2021);
  - LDP3: Jupiter area installations and associated pipelines (Approved);
  - LDP4: North Valiant SP, South Valiant TD, Vanguard QD and Vulcan RD installations and associated pipelines (to be submitted for approval in 2020);
  - LDP5: LOGGS Complex and North Valiant PD installations and associated pipelines (to be submitted for approval in 2020); and
  - LOGGS area assets are sequentially being transitioned to cold suspension with the Ensco 92 mobile drilling-rig undertaking well plug and abandonment and the Seajacks Leviathan accommodation work vessel (AWV) currently completing final clean and disconnect scopes. One platform is scheduled to be removed in 2019 (Vulcan UR).
- Further Decommissioning Programme submissions will be required for the CMS area:
  - Currently, a minimum of three Decommissioning Programme submissions are planned, with the first (concerning Caister platform removal) approved in March 2020 and the remainder to follow thereafter.

This Environmental Appraisal supports the decommissioning activities associated with LOGGS Decommissioning Programmes 2 – 5 (LDP2 – LDP5), for which further information is given in the following sections.

1.2 Overview of the LOGGS Area

The LOGGS complex started operating in 1988 and received natural gas from the V-fields, the Saturn Unit and Jupiter, as well as third-party fields. The gas was forwarded from the LOGGS PP platform in the LOGGS Hub Figure 1-1 to the Theddlethorpe Gas Terminal (TGT) in Lincolnshire, England, through a 36" trunk line (called PL454). Chrysaor is the Operator of the LOGGS Area with a 50% share, along with BP which owns the other 50%.

The focus of this Environmental Appraisal Report is the decommissioning activities associated with the facilities within the LDP2 – LDP5 divisions; these facilities are shown in the context of the southern North Sea in Figure 1-2. Further information on the main facilities and infrastructure associated with LDP2 – LDP5 is then given in Table 1-1 to Table 1-4 and Figure 1-3 to Figure 1-6.

Overall, LDP2 – LDP5 includes five manned platforms (forming the LOGGS Hub complex), nine satellite platforms, a total of 26 pipelines (including a 36" gas export trunk line and 290 km of in-field pipelines), nine subsea structures (including NW Bell ZX and Callisto ZM), stabilisation material (including mattresses and grout bags) and 59 wells.

Figure 1-2 Infrastructure associated with the LDP 2-5

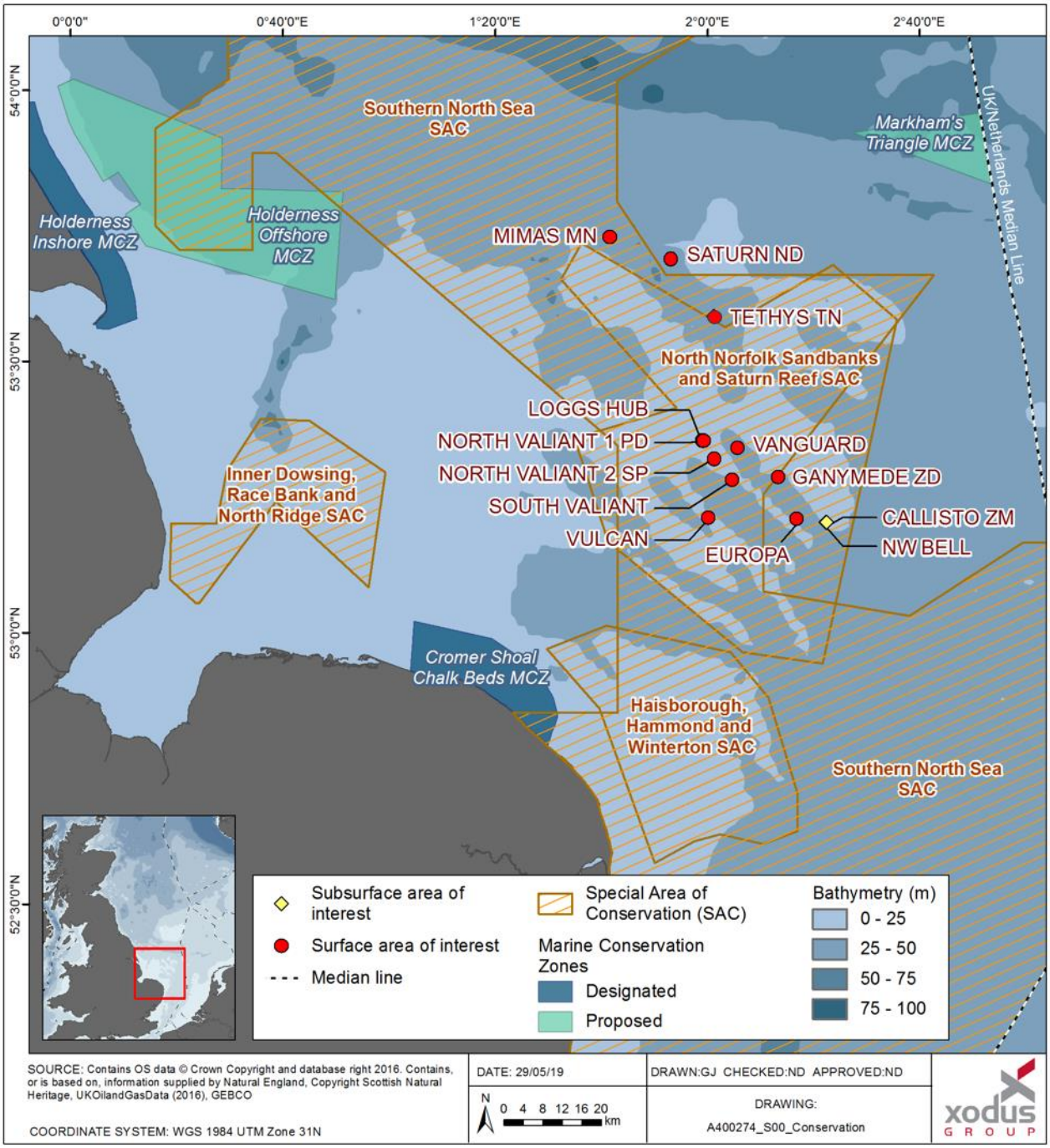


Table 1-1 Description of LDP2 infrastructure

Installation	Description	Associated pipelines
LDP2		
Tethys TN	SLP SeaPony design, fixed steel wellhead platform	PL2234 PL2235 PL2237 PL2236 PL2107 PL2108
Mimas MN	SLP SeaPony design, fixed steel wellhead platform	
Saturn ND	SLP SeaPony design, fixed steel wellhead platform	

Figure 1-3 Overview of LDP2 infrastructure

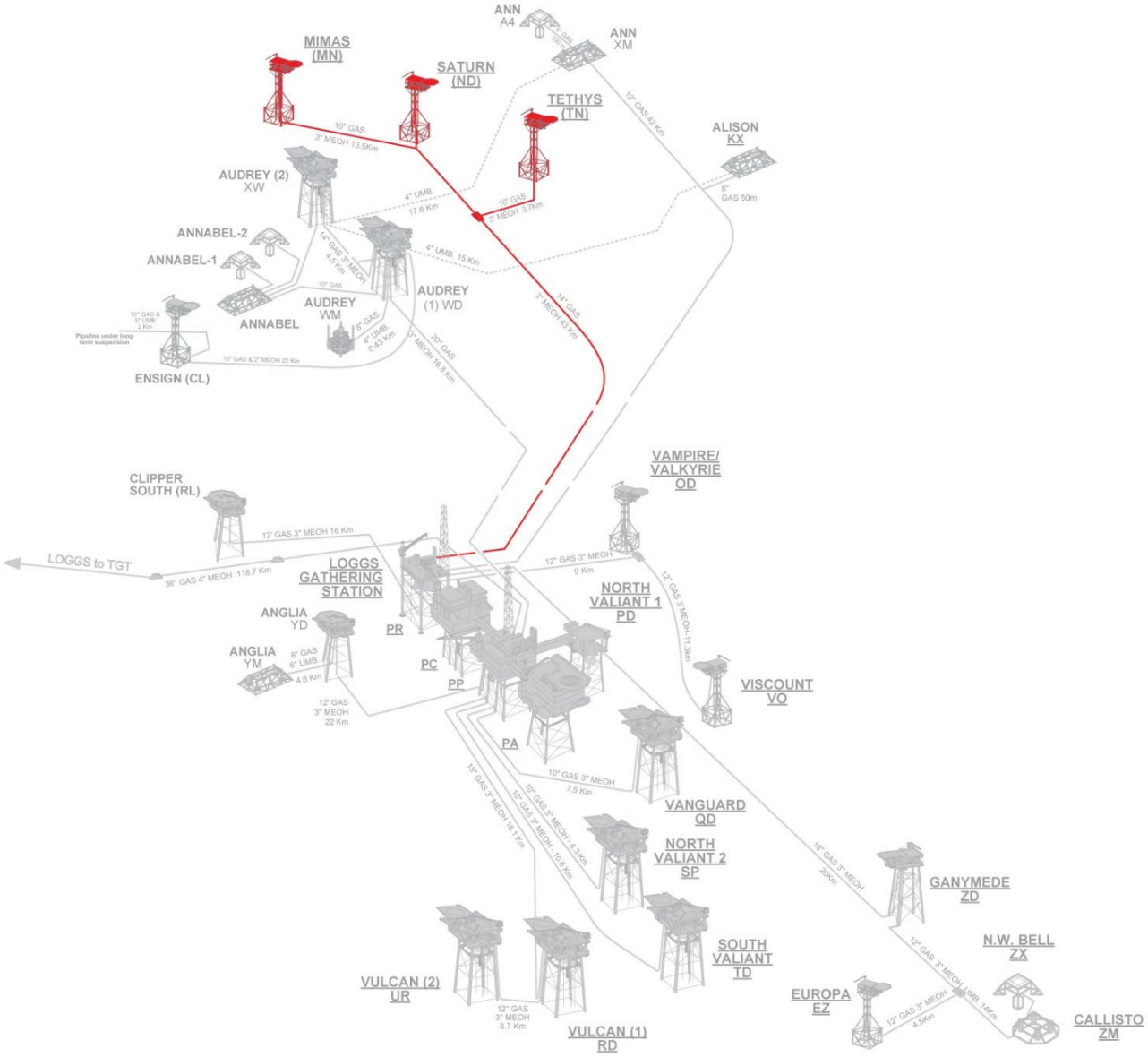


Table 1-2 Description of LDP3 infrastructure

Installation	Description	Associated pipelines
LDP3		
Ganymede ZD	Four-legged, fixed steel platform	PL1093 PL1094 PL1694 PL1695 PL1690 PL1691 UM3 PL1091 PL1092 UM2
Europa EZ	Four-legged Vierendeel tower, fixed steel platform	
NW Bell ZX	Wellhead and a manifold located under a wellhead protective structure	
Callisto ZM	Wellhead and a manifold located under a wellhead protective structure	

Figure 1-4 Overview of LDP3 infrastructure

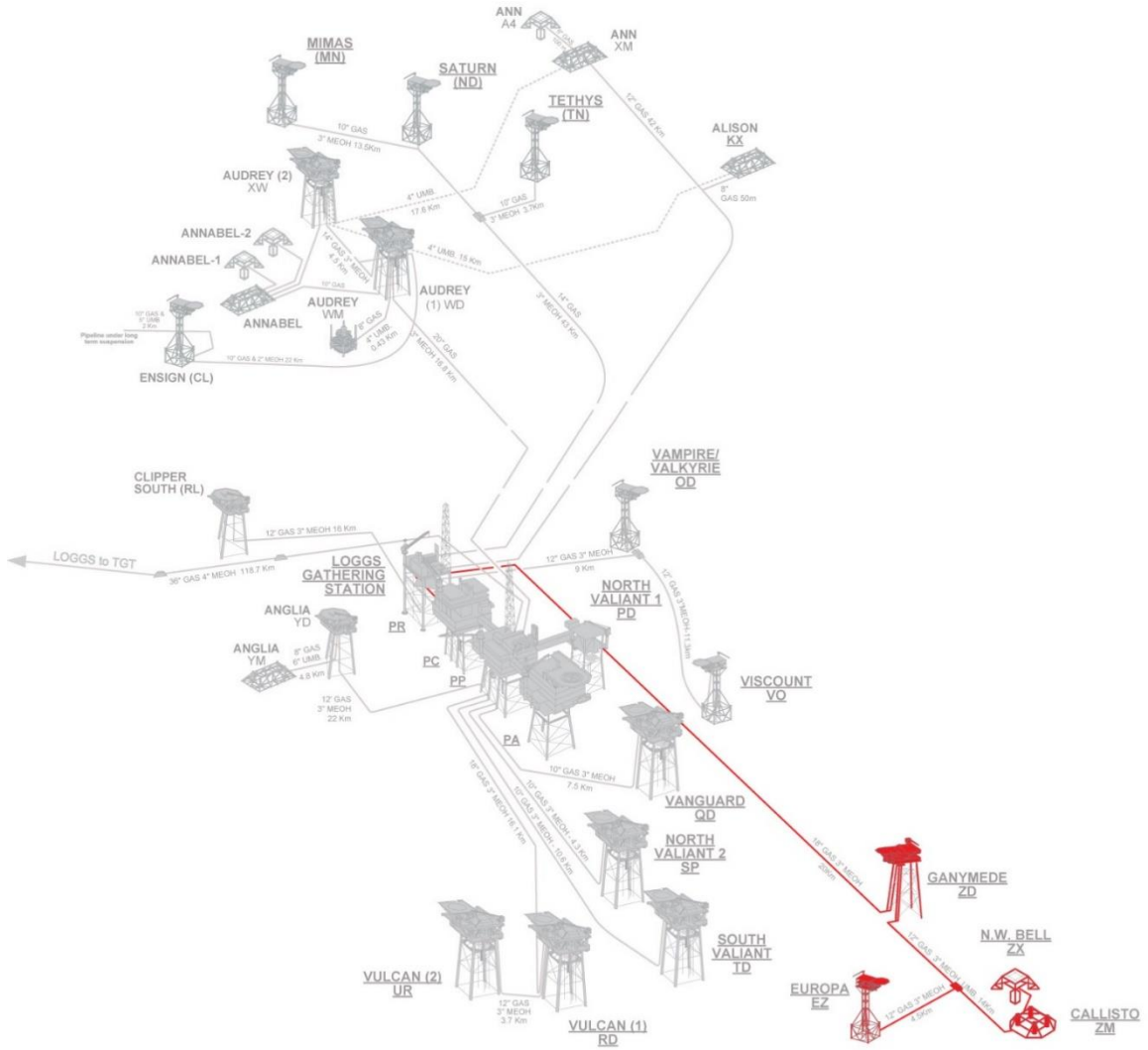


Table 1-3 Description of LDP4 infrastructure

Installation	Description	Associated pipelines
LDP4		
South Valiant TD	Four-legged, fixed steel platform	PL460 PL461 PL470 PL471 PL456 PL457 PL458 PL459
North Valiant 2 SP	Four-legged, fixed steel platform	
Vanguard QD	Four-legged, fixed steel platform	
Vulcan (1) RD	Four-legged, fixed steel platform	

Figure 1-5 Overview of LDP4 infrastructure

Table 1-4 Description of LDP5 infrastructure

Installation	Description	Associated pipelines
LDP5		
LOGGS Hub PR	Four-legged, manned fixed steel platform	PL454 PL455
LOGGS Hub PC	Eight-legged, manned fixed steel platform	
LOGGS Hub PP	Eight-legged, manned fixed steel platform	
LOGGS Hub PA	Four-legged, manned fixed steel platform	
North Valiant 1 PD	Four-legged, manned fixed steel platform	

Figure 1-6 Overview of LDP5 infrastructure

1.3 Regulatory Context

The Petroleum Act 1998 (as amended by the Energy Act 2008) governs the decommissioning of offshore oil and gas infrastructure, including pipelines, on the United Kingdom Continental Shelf (UKCS). The responsibility for ensuring compliance with the Petroleum Act 1998 rests with Department of Business, Energy and Industrial Strategy (BEIS), formerly the Department for Energy and Climate Change (DECC) and is managed through its regulatory body the Offshore Petroleum Regulator for Environment and Decommissioning (OPRED). OPRED is also the Competent Authority on decommissioning in the UK for OSPAR purposes and relevant legislation. The Petroleum Act requires the operator of an offshore installation or pipeline to submit a draft Decommissioning Programme for statutory and public consultation, and to obtain approval of the Decommissioning Programme from the OPRED, part of BEIS, before initiating decommissioning work. The Decommissioning Programme outlines in detail the infrastructure being decommissioned and the method by which the decommissioning will take place. Well plug and abandonment is determined under a different process to the Decommissioning Programme, called the Well Operations Notification System.

Formal Environmental Impact Assessment (EIA) to support the Decommissioning Programme is not explicitly required under existing UK legislation. However, the primary guidance for offshore decommissioning that was updated and published by OPRED in 2018, detailed the need for an Environmental Appraisal to be submitted in support of the Decommissioning Programme. The new guidance recognises that environmental deliverables to support Decommissioning Programmes were overly lengthy and did not focus in on the key issues, and now describes a more proportionate Environmental Appraisal process that culminates in a streamlined Environmental Appraisal Report which focuses on screening out of non-significant impacts and presents a detailed assessment of potentially significant impacts.

In terms of activities in the southern North Sea, The East Inshore and East Offshore Marine Plans have been developed by the Department for Environment, Food and Rural Affairs to help ensure sustainable development of the marine area. Although the Plans do not specifically address decommissioning of oil and gas, they do note the challenges that such activities can introduce. As part of the conclusions to this assessment (Section 7.0), Chrysaor has considered the broader aims of the Plans and made a statement on alignment with the aims.

CLEAR SEABED VERIFICATION POLICY – UPDATE OCTOBER 2020 - Readers to note that OPRED's updated clear seabed verification policy now requires that non-intrusive survey methods be used where there are environmental sensitivities - this will include the 500m zones covered by this document. Appropriate methodology for clear seabed verification will be agreed with OPRED.

Where there are references to overtrawl/trawl sweeps within this document these should be read as understanding that non-intrusive means of clear seabed verification will now be required where there are environmental sensitivities.

1.4 Learning from Southern North Sea decommissioning

The LDP2 – LDP5 decommissioning activities are the second major set of decommissioning works within Chrysaor's wider decommissioning plans for the southern North Sea. The activities proposed herein, and the assessment that has been undertaken, have incorporated learnings from Chrysaor's other southern North Sea decommissioning activities and from wider decommissioning activities in the North Sea. Following initial decommissioning activities approved under VDP1 and VDP2, Chrysaor has conducted further design work, including micro-siting of the AWV on the basis of further review of the site-specific survey data to minimise the need for additional stabilisation material at

these locations. This has significantly reduced the quantity of rock required for stabilisation of the AWV, and therefore the potential environmental impact. Chrysaor will continue to investigate the possibility of streamlining operations to further reduce potential environmental impact as planning for the decommissioning activities progresses.

1.5 Scope of the Environmental Appraisal

This Environmental Appraisal Report sets out to describe, in a proportionate manner, the potential environmental impacts of the proposed activities associated with LDP2 – LDP5 and to demonstrate the extent to which these can be mitigated and controlled to an acceptable level. This is achieved in the following sections, which cover:

- The process by which Chrysaor has arrived at the selected decommissioning strategy (Section 2.0);
- A description of the proposed decommissioning activities (Section 2.0);
- A review of the potential impacts from the proposed decommissioning activities and justification for the assessments that support this Environmental Appraisal (Section 3.0);
- A summary of the baseline sensitivities relevant to the assessments that support this Environmental Appraisal (Section 4.0);
- Assessment of key issues (Section 5.0); and
- Conclusions (Section 7.0).

This Environmental Appraisal Report has been prepared in line with Chrysaor's environmental assessment philosophy and has given due consideration to the regulatory guidelines (OPRED, 2019a) and to Decom North Sea's Environmental Appraisal Guidelines for Offshore Oil and Gas Decommissioning (Decom North Sea, 2017).

2.0 Project Description

2.1 Consideration of alternatives and selected approach

2.1.1 Decision-making context

Platforms

As a Contracting Party of the Convention for the Protection of the Marine Environment of the North-East Atlantic ('OSPAR'), the UK has agreed to implement OSPAR Decision 98/3, which prohibits leaving offshore installations wholly or partly in place. The legal requirement for Operators to comply with the OSPAR Convention is affected through the Petroleum Act 1998 (as amended by the Energy Act 2008), the Guidance Notes for which outline the expectations of the UK regulator in terms of complying with the relevant OSPAR decisions. OSPAR Decision 98/3 states that the topsides of all installations should be returned to shore and that all jackets with a weight of less than 10,000 tonnes are completely removed for reuse, recycling or final disposal on land. This applies to the LOGGS Hub as each of the 14 platforms weigh less than 10,000 tonnes.

Subsea infrastructure

The latest guidance (OPRED, 2019a) states that subsea installations (e.g. drilling templates, wellheads and their protective structures, production manifolds and risers) must, where practicable, be completely removed for reuse or recycling or final disposal on land. Any piles used to secure such structures in place should be cut below natural seabed level at such a depth to ensure that any remains are unlikely to become uncovered. Should an Operator wish to make an application to leave in place a subsea installation because of the difficulty of removing it, justification in terms of the environmental, technical or safety reasons would be required. With regards to pipelines (including flowlines and umbilicals), these should be considered on a case-by-case basis. The guidance does provide general advice regarding removal for two categories of pipelines:

- For small diameter pipelines (including flexible flowlines and umbilicals) which are neither trenched nor buried, the guidance states that they should normally be entirely removed; and

- For pipelines covered with rock protection, the guidance states that these are expected to remain in place unless there are special circumstances warranting removal.

The guidance also highlights instances where pipelines could be decommissioned *in situ*. For example, pipelines that are adequately buried or trenched or which are expected to self-bury. Where an Operator is considering decommissioning pipelines *in situ*, the decision-making process must be informed by 'Comparative Assessment' of the feasible decommissioning options. This Comparative Assessment takes account of safety, environmental, technical, societal and economic factors to arrive at a preferred decommissioning solution.

Finally, the guidance states that mattresses and grout bags installed to protect pipelines should be removed for disposal onshore, if their condition allows. If the condition of the mattresses or grout bags is such that they cannot be removed safely or efficiently, any proposal to leave them in place must be supported by an appropriate Comparative Assessment of the options.

2.1.2 Alternative to decommissioning

Options to re-use the LDP2 – LDP5 infrastructure *in situ* for future hydrocarbon developments have been considered, but to date none have yielded a viable commercial opportunity. Reasons for this include the absence of remaining hydrocarbon reserves in the vicinity of the infrastructure, and the limited remaining design life of the LDP2 – LDP5 infrastructure. It is considered unlikely that any opportunity to re-use the LDP2 – LDP5 infrastructure will be feasible and, as such, there is no reason to delay decommissioning of the infrastructure in a way that is safe and environmentally and socio-economically acceptable (and the 'do nothing' approach to the infrastructure is thus rejected).

2.1.3 Subsea Comparative Assessment

In line with the latest guidelines on decommissioning (OPRED, 2019a), Chrysaor committed to fully removing a number of subsea structures from the LDP2 – LDP5 area (including two manifolds and pipeline tee structures). For the remaining infrastructure (listed below), Chrysaor has undertaken a Comparative Assessment (CA) in order to arrive at an optimal decommissioning method. The CA, conducted in line with the OPRED (2018) and OGUK (2015a) guidance, is described fully in the LDP2 – LDP5 Subsea Infrastructure Decommissioning Comparative Assessment Report (Xodus Group, 2019). A summary of the infrastructure for which a CA of options was made and the selected option (based on consideration of safety, environmental, technical, societal and economic factors) is given in Table 2-1. The CA used a non-weighted process to eliminate any subjectivity. Actual environmental data was considered when comparing options including seabed disturbance, habitat loss and underwater noise in line with the conservation objectives and sensitivities of protected sites in the vicinity.

Table 2-1 Options preferred for subsea decommissioning

Group no.	Pipeline infrastructure description	Options preferred for subsea decommissioning
1.	36" Trunkline (PL454)	1a Leave the trunkline *in situ* with minimum intervention
2.	NW Bell – Mattress Covered Short Umbilical & Associated Pipeline (PL1690, PL1691 and UM3)	6 Full removal by cut and lift
3a.	Trenched Interfield Non-concrete Coated Piggyback Pipelines ≤ 16" (PL1694, PL1695, PL2234, PL2235, PL2236, PL2237)	1a Leave *in situ* with minimum intervention
3b.	Trenched Interfield Non-concrete Coated Non-piggyback MeOH Pipeline ≤ 16" (PL455)	4 Partial removal, 1a and 2a leave *in situ* (all three options equally preferred)
3c.	Trenched Interfield Concrete Coated Piggyback Pipelines ≤ 16"	4 Partial removal, 1a and 2a leave *in situ* (all three options equally preferred)
4	Trenched Interfield Concrete Coated Piggyback Pipelines > 16"	4 Partial removal, 1a and 2a leave *in situ* (all three options equally preferred)
7	Trenched and Buried Umbilical	4 Partial removal, 1a and 2a leave *in situ* (all three options equally preferred)

2.2 Proposed schedule

Chrysaor anticipates executing the LDP2 – LDP5 activities between 2017 and 2025; an indicative schedule for the work is shown in Figure 2-1. However, the specific timing of decommissioning activities will be agreed with OPRED and with the Health and Safety Executive (HSE) and applications for all relevant permits and consents will be submitted and approval sought prior to activities taking place.

Figure 2-1 Indicative decommissioning schedule

The following sections provide a high-level description of the activities required to execute the decommissioning schedule; full detail can be found in the Decommissioning Programmes for LOGGS 2 – 5.

2.3 Decommissioning activities

2.3.1 Preparation for decommissioning

Well plug and abandonment

Note: well plug and abandonment is not within the scope of this environmental appraisal, and it has been or will be assessed as part of well intervention and marine licence applications. A description is included here to describe the activities leading up to the point that the decommissioning activities that are assessed here begin.

The 59 wells associated with LDP2 – LDP5 will be plugged and abandoned prior to any of the platform and subsea decommissioning activities progressing. This means that each well will be systematically and permanently closed in accordance with well abandonment best practice (e.g. OGUK Guidelines Well Decommissioning Guidelines - issue 6 June 2018).

Flushing and cleaning operations

Note: these flushing and cleaning operations are not within the scope of this environmental appraisal, and they have been assessed as part of ongoing operations of the facilities. A description is included here to describe the activities which have occurred leading up to the point that the decommissioning activities that are assessed here begin.

Pipelines

Chrysaor has flushed all the infield production pipelines with seawater, followed by plugs of gel or foam called 'pigs' propelled through the lines. This activity was designed to remove mobile hydrocarbons and achieve a cleanliness of less than 30mg/l oil in pipeline flush fluids. Chemical pipelines were subjected to a turbulent seawater flush to displace all contents. The pipeline contents and flush fluids were transferred from the platform into the North Valiant PD well 05/03, such that there was no overboard discharge from the pipeline flushing and cleaning operations. The pipelines have been left flooded with raw seawater.

Platforms

Following isolation from the wells, gas (nitrogen) is passed through the platform processing systems to ensure that minimal hydrocarbons remained in the system prior to the final cleaning and disconnect. During the final cleaning and disconnect activities, all the processing systems on the platform are progressively depressurised, purged with gas (nitrogen) and rendered safe for removal operations. All process chemicals and hydrocarbons contained within pipelines were disposed of downhole into North Valiant PD well 05/03. All bulk chemicals surplus to requirement were backloaded onshore for disposal. The pipework and tanks will be visually inspected where possible and may be further treated should any sources of potential spills of oils and other fluids be identified.

2.3.2 Platform decommissioning

Cold suspension

There are fourteen platforms within the LDP2 – LDP5 area, each comprising a topside and a jacket structure. Specialist engineering contractors will prepare the infrastructure for removal. For the nine satellite platforms, topsides may or may not require removal prior to the jackets being removed, whilst for the five manned platforms the topsides will require removal separately from the removal of the jacket.

Once hydrocarbon free, isolated from hydrocarbon sources and without a routine power source (all diesel fuel will have been drained and backloaded to shore), the platforms will enter a phase called 'cold suspension'. During this time, the platforms will be equipped with solar powered aids to navigation and an automatic identification system (AIS) to mark the structures until such time as they are fully removed. During cold suspension, it is assumed that:

- The assets will be marked accordingly in line with the Consent to Locate. Dispensation from the Standard Marking Schedule is to be requested owing to the solar powered aids to navigation consisting of primary lights and foghorn, without subsidiary lighting. The solar powered aids to navigation have been designed to ensure availability of the system remains 99.82% for five years reliability. A contingency plan has been prepared in the event of a failure with the executive action being dependent on the remaining duration of the period of cold suspension; and

- No further activities are to be undertaken at the assets during cold suspension ahead of the removals phase apart from subsea surveys; and

- No personnel will re-board the topsides during cold suspension, until the removals phase. The platform removal techniques planned will be similar for all platform types.

Each jacket is secured to the seabed by piles. All piles securing the jackets will be cut below the natural seabed level at a depth that will ensure they remain covered. The depth of cutting is dependent upon the prevailing seabed conditions and currents. Chrysaor is estimating this to be in the region of 3.0 m below the natural seabed level.

Topside removal

Chrysaor will remove the topsides using the single lift method. A heavy lift vessel capable of lifting the entire topsides in one lift will be used. The topsides will be prepared for this by a combination of making sure modules are secured for transport and structural strengthening of the topsides if needed. The topsides will then be transported to the designated disposal yard by heavy lift vessel or cargo barge where they will be transferred to the quayside for dismantling.

Jacket removal

The removal process for of each of the fourteen jackets is expected to be:

- Cutting of the lines that connect the platform to the subsea infrastructure (called risers);
- Cutting of the piles that secure the jacket to the seabed; and
- Removal of each platform jacket by heavy lift vessel (including risers).

2.3.3 Subsea infrastructure

Overview

A subsea contractor will sequentially mobilise a fleet comprising vessels with a range of crane capabilities for lifting objects of different sizes and weights off the seabed, vessels that can support underwater operations including remotely operated vehicle (ROV) deployment, diving, cutting, trench ploughing and backfilling, excavation and rock placement, survey vessels and guard vessels. The vessels will deploy ROVs (or divers when necessary) to disconnect the subsea installations and tie-in spools and to cut the spools and ends of flowlines. The vessels' cranes will lift the subsea structures to the vessel. A full inventory of subsea infrastructure to be decommissioned is provided in the LOGGS 2 – 5 Comparative Assessment Report (Xodus Group, 2019).

Pipelines and umbilicals

Pipelines and umbilicals will be physically disconnected subsea from all subsea and surface structures and any mattresses and grout bags that cover the disconnection points will be recovered back to the vessel. The following terminology of exposures and spans will be used. When pipelines are installed, great care is taken to ensure they are as safe as possible to other seabed users. However, due to an uneven seabed, tidal currents or scouring, some pipelines may develop spans. A span on a pipeline is where the seabed sediments have been eroded, or scoured away and the pipeline is no longer supported on the seabed, all spans are a type of exposure. Exposures can occur when seabed sediments have been eroded but not all exposures are spans.

Following this, the lines will be prepared for decommissioning as below:

- Group 1: 36" Trenched and buried trunkline from LOGGS PP to MLWM

The recommendation from the Comparative Assessment is to decommission the gas export pipeline *in situ* with minimum intervention. This would require disconnection and removal of the pipeline connected to the LOGGS PP platform and at the tee locations with local rock placement at the cut pipeline ends only. The remaining pipeline, left in its current state, would be marked on sea charts and notifications issued to fishermen / other users of the sea. The post decommissioning monitoring programme will be agreed with OPRED and will be in accordance with OPRED guidance in operation at that time.

- Group 2: NW Bell – Mattress Covered Short Umbilical & Associated Pipelines (PL1690, PL1691 and UM3)

The recommendation from the Comparative Assessment is that both the full removal and the leave *in situ* options may be progressed. Chrysaor intends to fully remove these 80m lines by cut and lift. The lines will be cut into shorter sections using hydraulic shears. These short sections will be recovered to the deck of the vessel for transfer to shore.

- Group 3a: Trenched Interfield Non-concrete Coated Piggyback Pipelines ≤ 16” (PL1694, PL1695, PL2234, PL2235, PL2236, PL2237)

The recommendation from the Comparative Assessment is to decommission the lines *in situ* with minimum intervention. This comprises removal of the ends of the pipelines and placing spot rock cover at the cut ends only. The remaining pipeline, left in its current state, would be marked on sea charts and notifications issued to fishermen / other users of the sea. The post decommissioning monitoring programme will be agreed with OPRED and will be in accordance with OPRED guidance in operation at that time.

- Group 3b: Trenched Interfield Non-concrete Coated Non-piggyback MeOH Pipeline ≤ 16” (PL455)

The recommendation from the Comparative Assessment is that both the partial removal and the leave *in situ* options are equally preferred. This would require disconnection and removal of the pipeline connected to the LOGGS PP platform and at the tee locations with local rock placement at the cut pipeline ends in all cases. The individual exposures will be risk assessed to determine whether remediation is necessary to protect the safety of fishermen, with the outcome of this assessment influencing whether the exposures will be removed, rock covered or left *in situ*. For the purposes of the environmental assessment, owing to the environmental sensitivities and intent not to place rock over exposed pipeline sections, partial removal is assumed whereby the exposures will be removed and rock placed on cut pipeline ends.

The remaining pipeline, left in its current state, would be marked on sea charts and notifications issued to fishermen / other users of the sea. The post decommissioning monitoring programme will be agreed with OPRED and will be in accordance with OPRED guidance in operation at that time.

- Group 3c: Trenched Interfield Concrete Coated Piggyback Pipelines ≤ 16” (PL456, PL457, PL460, PL461, PL470, PL471, PL1091, PL1092)

The recommendation from the Comparative Assessment is that both the partial removal and the leave *in situ* options are equally preferred. This would comprise removal of the ends of the pipelines and placing spot rock cover at the cut ends in all cases. The individual exposures will be risk

assessed to determine whether remediation is necessary to protect the safety of fishermen, with the outcome of this assessment influencing whether the exposures will be removed, rock covered or left *in situ*. For the purposes of the environmental assessment, owing to the environmental sensitivities and intent not to place rock over exposed pipeline sections, partial removal is assumed whereby the exposures will be removed and rock placed on cut pipeline ends.

The remaining pipeline, left in its current state, would be marked on sea charts and notifications issued to fishermen / other users of the sea. The post decommissioning monitoring programme will be agreed with OPRED and will be in accordance with OPRED guidance in operation at that time.

- Group 4: Trenched Interfield Concrete Coated Piggyback Pipelines > 16" (PL458, PL459, PL1093, PL1094, PL2107 and PL2108)

The recommendation from the comparative assessment is that both the partial removal and the leave *in situ* options are equally preferable. This would comprise removal of the ends of the pipelines and placing spot rock cover at the cut ends in all cases. The individual exposures will be risk assessed to determine whether remediation is necessary to protect the safety of fishermen, with the outcome of this assessment influencing whether the exposures will be removed, rock covered or left *in situ*. For the purposes of the environmental assessment, owing to the environmental sensitivities and intent not to place rock over exposed pipeline sections, partial removal is assumed whereby the exposures will be removed and rock placed on cut pipeline ends.

The remaining pipeline, left in its current state, would be marked on sea charts and notifications issued to fishermen / other users of the sea. The post decommissioning monitoring programme will be agreed with OPRED and will be in accordance with OPRED guidance in operation at that time.

- Group 7: Trenched and Buried Umbilical (UM2)

The recommendation from the comparative assessment is that both the partial removal and the leave *in situ* options are equally preferable. This would comprise removal of the ends of the pipelines and placing spot rock cover at the cut ends in all cases. The single 11 m exposure will be risk assessed to determine whether remediation is necessary, with the outcome of this assessment influencing whether the exposure will be removed, rock covered or left *in situ*. For the purposes of the environmental assessment, owing to the environmental sensitivities and intent not to place rock over exposed pipeline sections, partial removal is assumed whereby the exposure will be removed and rock placed on cut pipeline ends.

The remaining pipeline, left in its current state, would be marked on sea charts and notifications issued to fishermen / other users of the sea. The post decommissioning monitoring programme will

Subsea infrastructure

Subsea infrastructure, including wellhead protection structures, manifolds and tees will be disconnected by either ROV or divers, fully removed and recovered to a vessel for transfer onshore for recycling or disposal.

Protection and support materials

Mattresses and grout bags that do not need to be moved to gain access to underlying infrastructure will be decommissioned *in situ*.

2.4 Post-decommissioning

Following decommissioning activities, a seabed clearance survey will identify any debris on the seabed within a 500 m radius of each platform and within the corridor of any pipelines and umbilicals decommissioned *in situ*. An ROV support vessel may be deployed to recover large items of debris whilst chain mats are likely to be deployed to clear smaller items of debris outwith any designated sites. Where environmental sensitives dictate (within designated sites) an alternative method maybe selected to demonstrate that the remaining infrastructure does not present a risk to other users of the sea. No overtrawling will be undertaken within any designated site. Any significant oil and gas related seabed debris will be recovered for onshore recycling and disposal. Subject to verification of clear seabed and a statement of clearance to OPRED and to acceptance of the LOGGS Decommissioning Programmes LDP 2 – LDP5 Decommissioning Close-out Report by OPRED, all existing safety zones around platforms and subsea infrastructure will be removed.

A post-decommissioning monitoring programme covering the pipelines and associated stabilisation features remaining *in situ* is to be agreed with OPRED. The proposed approach includes the following:

- An initial baseline survey covering the full length of each pipeline;
- Followed by a risk assessment for each pipeline (and associated stabilisation materials) which will inform the minimum agreed extent and frequency of future surveying. This will take account of pipeline burial, exposure and spanning derived from the initial baseline survey, historical survey information and fisheries impact assessment;
- A report of each required survey will be prepared which will include analysis of the findings, the impact of the risk-based assessment and identification of the proposed timing of the next survey. This is for discussion and agreement with OPRED;
- Provision will be included for remediation where such a requirement is identified. Appropriate remediation will be discussed and agreed with OPRED;
- Where remediation has been undertaken, a follow up survey of the remediated area will be required;
- In the event of a reported snagging incident on any section of pipeline, the requirement of any additional survey and/or remediation will be discussed and agreed with OPRED;
- Monitoring will be become reactive following completion of the agreed survey programme and OPRED agreement; and
- Pipeline information will be recorded on navigation charts and FishSAFE.

3.0 EA METHODOLOGY

3.1 Identification of environmental issues

An Environmental Appraisal in support of a Decommissioning Programme should be focused on the key issues related to the specific activities proposed; the impact assessment write-up should be proportionate to the scale of the project and to the environmental sensitivities of the project area. This does not mean, however, that the impact assessment process should be any less robust than for a statutory EIA or consider any fewer impact mechanisms. To this end, Chrysaor undertook an impact identification workshop early in the EIA. This workshop identified the key environmental sensitivities, discussed the sources of potential impact and identified those sources which required further assessment. The decision on which issues required further assessment was based on the specific proposed activities and environmental sensitivities, a review of industry experience of decommissioning impact assessment and on an assessment of wider stakeholder interest (informed in part by the stakeholder engagement described in Section 3.2). Table 3-1 summarises the identification workshop, providing justification for the inclusion and exclusion of impact mechanisms.

Table 3-1 Summary of the identification workshop, with justification for the inclusion and exclusion of impact sources

Impact	Further assessment?	Rationale
Gaseous emissions to atmosphere and energy use.	No	Emissions regulated under the European Union Emissions Trading Scheme (EU ETS) and Industrial Emissions Directive (IED) will cease as the combustion plants become inoperable. During the pipeline flush and clean campaign there will be venting of natural gas. The worst case scenario for the mass of natural gas vented during these operations was: • LDP2 - 2.64 tonnes; • LDP3 - 14.0 tonnes; • LDP4 - 1.92 tonnes; and • LDP5 - 49.31 tonnes. These levels are all below the annual vent consents for each of the field areas. Therefore venting of the gas does not pose a significant risk to the environment. The estimated CO_2 emissions to be generated by the selected decommissioning options is 19,019 te, this equates to 0.13% of the total UKCS CO_2e emissions in 2018 (14,630,000 te; OGUK, 2019). See Appendix 1 for further details. Recycling, transportation of waste onshore and also the accountability for any material decommissioned *in situ* (deemed to be lost to society) has been accounted for in the calculation of energy spent and CO_2 emissions generated within the accompanying Comparative Assessment.

Impact	Further assessment?	Rationale
		Considering the above, atmospheric emissions and energy use are not assessed further herein.
Physical presence of vessels and rigs in relation to other sea users (including commercial shipping)	No	The presence of vessels for decommissioning activities will be relatively short term in the context of the life of the LOGGS fields. Activity will occur using similar vessels to those currently deployed for oil and gas across the Southern North Sea. Vessels will also generally be in use around existing infrastructure and will not occupy 'new' areas. Chrysaor have commissioned a Navigational Risk Assessment (NRA) which covers the wider LOGGS area (Anatec, 2017). With standard mitigation measures such as Notice to Mariners, the presence of a 500 m safety exclusion zone around the platform, the short term nature of these operations and use of navigation aids and safety standby vessels, this risk is not expected to be significant. Other sea users will be excluded from the 500 m safety zone during active operations. The 500 m safety zones will remain until such time the installations are fully removed. Thereafter applied safety zones will remain until such time debris clearance and seabed remediation has been completed. Navaids will be included on the installation and HLV. The HLV will also have an accompanying Communication Interface Plan in place. Other sea users at sea and in port will be notified in advance of activities occurring and the movements of the vessels associated with decommissioning work, meaning those stakeholders will have time to make any necessary alternative arrangements for the limited period of operations. The nearshore activities associated with this project are very likely to be limited in duration (limited to passing vessels). Considering the above, temporary presence of vessels is not assessed further herein.
Physical presence of infrastructure decommissioned *in situ* in relation to other sea users, both in terms of possible	Yes – Section 0	The preferred option from the Comparative Assessment is to decommission pipelines/umbilicals *in situ*. Protection/support material (mattresses and grout bags) will be recovered when they must be moved to access infrastructure underneath. Post decommissioning, non-intrusive surveys will be used where possible. No overtrawl activities will be undertaken along pipeline corridors or within sites

Impact	Further assessment?	Rationale
exclusion and risk of snagging		designated to protect seabed features or supporting habitats in line with conservation objectives for these sites. Consideration has been given as a worse case for the potential overtrawl of the 500 m safety zone around the Saturn platform location, however this is highly unlikely as non-intrusive surveys will be used in the first instance. The Saturn platform is not located in any designated sites. Post removal of the pipeline ends there are two areas of spanning (PL454 - 14.97 m and PL456 - 17.97 m), these areas are potentially characteristic of spans meeting FishSafe reporting requirements and will be monitored during post decommissioning for evidence of change in state. The total seabed footprint including decommissioning operations and overtrawl survey is estimated as 0.8278 km^2, 0.0339 km^2 of which will be within the North Norfolk Sandbanks and Saturn Reef SAC, which represent 0.00045% of the total SAC area. For the Southern North Sea SAC the area impacted is 0.0289 km^2 representing only 0.000078% of the total SAC area. On this basis, further assessment has been undertaken. There is an approximate footprint of 0.39 km^2 associated with the pipeline located within the Inner Dowsing, Race Bank and North Ridge SAC. However, there is not anticipated to be any impacts other than the physical presence of the pipeline and there are no reportable spanning events along this section of pipeline.
Discharges from infrastructure during decommissioning activities. Routine vessel discharges (e.g. grey water, blackwater, ballast) Chemical, hydrocarbon and naturally occurring radioactive material (NORM) discharges	No	Discharges from vessels are regulated activities that are managed on an ongoing basis. Discharges from infrastructure occurring during decommissioning activities will be assessed in more detail as part of the environmental permitting process (e.g. through Master Application Templates/Subsidiary Application Templates). Controls will be in place, as relevant, through the Offshore Chemical Regulations and the Oil Pollution Prevention and Control regulations. Pipelines have been flushed to achieve a hydrocarbon concentration in flush fluids of less than 30 mg/l. Pipeline contents including flushing chemicals have been disposed of downhole on the LOGGS Complex, a strategy designed to eliminate discharges to the marine environment.

Impact	Further assessment?	Rationale
		Chrysaor reviewed various techniques for the effective flushing of the subsea pipelines including turbulent flushing and the use of pigging trains. It was concluded that the most effective method, of flushing the subsea pipelines was to utilise a pigging train arrangement comprising of varying cleaning solvents and gels separated by high density foam or gel pigs. The objective being to displace pipeline contents, remove mobile hydrocarbons whilst leaving *in situ* scale deposits. Considering the above, discharges to sea during decommissioning activities are not assessed further herein.
Long term release of cuttings swarf/plastics or metals left *in situ.* Chemical, hydrocarbon and naturally occurring radioactive material (NORM) discharges	Yes – Section 5.1	The preferred options from the Comparative Assessment includes the decommissioning of pipelines/umbilicals *in situ*. Protection/support material (mattresses and grout bags) will be recovered when they must be moved to access infrastructure underneath. Given the location within the NNSSR SAC, and the SNS SAC, the potential impact of long term release from infrastructure decommissioned *in situ* on the receiving environment requires investigation. On this basis, further assessment has been undertaken. Although there are sections of the export pipeline which transit the Greater Wash and Humber Estuary SPAs, any deposition of degradation products is expected to be highly localised to the pipeline and of such low concentration/ volumes as to pose no significant risk to the qualifying features.
Underwater noise emissions from vessels and cutting operations	Yes – Section 5.2	The location of project activities within the SNS SAC, designated for harbour porpoise, makes this a key sensitivity. There is potential for localised injury and disturbance to marine mammals and fish through noise from cutting operations and vessels across the project area, although this is expected to be low. However, given activity is taking place within the SAC further assessment has been undertaken.
Onshore dismantling yard activities including airborne noise, odour, light, dust and aesthetics	No	All onshore decontamination, dismantlement and disposal facilities at which decommissioned material will be handled currently manage potential environmental impacts as part of their existing site management plans. There is anticipated to be no

Impact	Further assessment?	Rationale
		change in potential for impact as a result of any of the material proposed for recovery. Based on Chrysaor's contracting strategy, multiple disposal facilities are likely. Whilst the yards are yet to be selected, they will be in the UK. Chrysaor's procedures require suitably approved facilities. The approval process comprises site visits, review of permits and consideration of how the facility's construction and design has been developed to minimise impact. Chrysaor understands that dismantling sites will also require consents and approvals from onshore regulators such as the Environment Agency, who apply conditions relating to mitigation, management and details of who are responsible for the provision of permits for such work. Considering the above, onshore interactions are not assessed further herein.
Waste: Resource use - Use of landfill space	Yes – Section 5.3	Waste management is a key interest in decommissioning activities. On this basis, further assessment has been undertaken.
Waste: including non-hazardous, hazardous, radioactive and marine growth	Yes – Section 5.3	Waste management is a key interest in decommissioning activities. On this basis, further assessment has been undertaken.
Employment	No	The variable potential for impact from project activities was not identified as a differentiator in the Comparative Assessment. Whilst it is recognised that there could be a negative effect resulting from cessation of production, there will be a countering benefit in the additional work required to affect the decommissioning activities. It is expected that the key socio-economic effect would occur through potential interaction with fisheries (assessed in Section 4.6). Considering the above, changes in employment (positive or negative) are not assessed further herein.
Unplanned events, including chemical/hydrocarbon release and dropped objects	No	Well plugging and abandonment is outside of the scope of this specific impact assessment, since it not dependent on approval of the Decommissioning Programme. The possibility of a well blowout therefore does not require consideration in this assessment (it is

Impact	Further assessment?	Rationale
		assessed as part of separate well intervention and marine licence applications). All lift operations will happen within platform safety zones or at the dockside therefore there is minimal risk from dropped objects on live 3rd party infrastructure from these activities. During transport the infrastructure will either be transported on deck with suitable sea fastening or held 'in the hook' securely for transport as per safe vessel operating procedures. As a result, there will be minimal risk from significant dropped objects during transport. Should such an event occur, the likely destination ports would mean transport over gas or condensate lines only which would result in a low risk hydrocarbon release which could be managed by offshore spill procedures with minimal environmental impact. Pipelines and umbilicals have been flushed and cleaned prior to the decommissioning activities described herein being carried out. Release of a hydrocarbon and chemical inventory is therefore also out of scope of this assessment. Chrysaor expect that the heavy lift vessel will have an accompanying Communication Interface Plan (CIP) and oil spill modelling included in the relevant OPEP. As the methodology for platform removal to shore has not been defined, there exists the possibility that jackets and/or topsides could be transported by a vessel using a crane. Where these would be suspended over the side of the vessel for the transfer, the possibility of dropping onto a live pipeline cannot be ruled out. However, dropped object procedures are industry standard and there is only a very remote probability of any interaction with any live infrastructure, when planning for such transport efforts will be made to minimise the transit over live infrastructure. Considering the above, accidental events are not assessed further herein.

3.2 Stakeholder engagement

Throughout the SNS decommissioning planning, Chrysaor has continually engaged a range of stakeholders; Chrysaor recognises the importance of active and appropriate engagement, to ensure that all stakeholder concerns are addressed through the planning and execution stages of

decommissioning. Specifically, Chrysaor has involved stakeholders, including OPRED, NFFO, SFF, the OGA and JNCC, within the Comparative Assessment and within the Environmental Appraisal process. With respect to the Comparative Assessment, stakeholders have received relevant briefing material and participated in regular update meetings. With respect to the Environmental Appraisal, stakeholders have received a briefing letter outlining the proposed SNS decommissioning activities, and OPRED have been engaged in informal discussion on the content of the Environmental Appraisal. With respect to the Environmental Appraisal, key concerns raised included:

- Cumulative impact – considering Chrysaor's SNS decommissioning activities will extend over a ten year period and result in some infrastructure decommissioned *in situ*, stakeholders expressed concern over the potential cumulative impact. In particular, potential impacts on the seabed were highlighted. Chrysaor has considered this within the Environmental Appraisal, and each impact assessment presented in Section 5 includes consideration of cumulative impact; and

- Protected sites – the decommissioning activities will take place within or close to a number of sites designated for protection of various environmental sensitivities. Considering the temporal scale and the nature of the proposed activities, along with the other potential activities occurring within the protected sites, stakeholders raised concern around the potential impact on the integrity of the protected sites. Consideration of these sites has been an integral part of the Environmental Appraisal process, and each of the impact assessments presented in Section 5.0 includes a specific assessment of protected sites (Note: protected sites are dealt with within specific impact assessments rather than a standalone protected sites section – this is because each impact assessment requires a specific consideration of whether there could be significant negative interaction with protected sites before a conclusion can be made).

3.3 Environmental significance

For the sources of impact that were assessed further in the EIA, it is important that a conclusion is reached regarding whether the impact is likely to result in a substantive change to environmental and societal conditions. In the EIA, there are many ways this can be done; a common approach is to define 'significance', and this approach is taken here. However, it is equally appropriate to employ some other method; the key is that the methods used for identifying and assessing significance are transparent and verifiable. The methodology for assigning significance to the impacts assessed further in Section 5.0 is described as follows. The significance of the environmental and societal impact was assessed according to pre-defined criteria, which Chrysaor has used on the EIA that supported the two Viking and LOGGS Decommissioning Programmes that have so far been approved by OPRED. The first step is to assign a consequence of environmental and societal impact, based on the criteria presented in Table 3-2. These criteria recognise the likely effectiveness of planned mitigation measures to minimise or eliminate potential impact; as such, they represent an impact where mitigation has been taken into account. Next, a prediction of likelihood is assigned as per Table 3-3; this indicates the frequency of the impact mechanism occurring during the project activities (as opposed to the likelihood of a subsequent impact occurring). The consequence and likelihood criteria are then combined as per Table 3-4 to give an overall risk score. This risk score is compared against the criteria presented in Table 3-5 to give a conclusion regarding significance. This assessment will identify measures to remove, reduce or manage any negative effects to a point where the resulting residual significance is at an acceptable level. Any residual impacts which cannot

feasibly be mitigated and are still deemed significant following this assessment are assessed in terms of their significance.

Table 3-2 Definition of consequences

Category	Socio-cultural economic impact	Biodiversity impact	Environmental impact remediation cost
5	- Permanent loss of access or use of area with permanent reduction in associated community; - Major economic impact to surrounding community; Irrevocable loss of culture resources; - Irrevocable loss of culture resources; - Scale typically widespread (national or greater level).	**Very High:** - Catastrophic loss of natural resources or biodiversity typically over a widespread area, with permanent or long-term consequences; and/or - Irrevocable loss of regionally unique habitat, legally designated conservation site or intact ecosystems; - No mitigation possible	<$10,000,000
4	- Permanent partial restriction on access or use, or total restriction >10 years in duration; - Temporary reduction in quality of life >10 years durations; -Harm to cultural resources requiring major mitigation;	**High:** - Persistent environmental degradation within and beyond the project area, typically with prospects of short-to-medium term recovery if the cause of the impact is removed or by natural abatement process and/or; - Extensive disturbance / permanent loss of unique habitat or legally designated	$1,000,000 to $10,000,000

	-Scale typically regional to national level.	conservation site or intact ecosystems within area of study; - Mitigation only possible through prolonged and resource intensive effort (>50 years).	
3	- Temporary restriction <10 years in duration with a moderate reduction in usage levels or quality of life; - Harm to cultural resources recoverable through moderate mitigation efforts; - Scale typically local to regional level.	**Medium:** - Persistent environmental degradation within and close to the project area, localised within defined areas, typically with prospects of rapid recovery if cause of the impact is removed or by natural abatement processes and/or; - Widespread / persistent disturbance or permanent loss of unique habitat or legally designated conservation site or intact ecosystems within area of study; - Moderate mitigation efforts required (>1 to 50 years).	$100,000 to $10,000,000
2	- Best restriction <5 years in duration with a minor reduction in usage levels or quality of life; - Minor harm to cultural resources that is recoverable through minor mitigation efforts; - Scale typically localised.	**Low:** - Temporary environmental degradation, typically within and close to project area, with good prospects of short-term recovery; and/or - Localised disturbance or permanent loss of unique habitat or legally designated	$10,000 to $100,000

		conservation site or intact ecosystems within area of study; - Minor mitigation efforts required (<1 year).	
1	- Restrictions on access without loss of resources; Temporary but fully reversible impacts on quality of life; - Minor impact on cultural resources; - Typically transient and highly localised.	**Negligible:** - Highly transitory or highly localised environmental degradation typically contained within the project area and noticeable/measurable against background only within or in very close proximity to the project area; and/or - Naturally and completely reversible.	$0 to $10,000

Table 3-3 Definition of likelihood

Likelihood (most likely down to least likely)			
Category	**One-word descriptor**	**Description**	**Quantitative range per year**
5	**Frequent**	- Likely to occur several times a year; - Very high likelihood or level of uncertainty	$<10^{-1}$
4	**Probable**	- Expected to occur at least once in 10 years; - High likelihood or level of uncertainty	10^{-3} to 10^{-1}
3	**Rare**	- Occurrence considered rare; - Moderate likelihood or level of uncertainty.	10^{-4} to 10^{-3}
2	**Remote**	- Not expected nor anticipated to occur; - Low likelihood or level of uncertainty.	10^{-6} to 10^{-4}
1	**Improbable**	- Virtually impossible and unrealistic; - Very low likelihood or level of uncertainty	$<10^{-6}$

Table 3-4 Risk matrix

Risk matrix						
Likelihood	5	II 5	II 10	III 15	IV 20	IV 25
	4	I 4	II 8	III 12	III 16	IV 20
	3	I 3	II 6	II 9	III 12	III 15
	2	I 2	I 4	II 6	II 8	II 10
	1	I 1	I 2	I 3	I 4	II 5
		1	2	3	4	5
		Consequence Category*				

Note: * Biodiversity and/or socioeconomic considerations take precedence: for all other factors, the worst case score is assumed from the severity descriptions

Table 3-5 Definition of significance

Score	Risk category	Significance
IV: 17-25	**High Risk.** Manage risk utilising prevention and/or mitigation **with highest priority**. Promote issues to appropriate management level with commensurate risk assessment detail.	**Significant**
III: 12-16	**Significant Risk.** Manage risk utilising prevention and/or mitigation **with priority**. Promote issue to appropriate management level with commensurate risk assessment detail.	**Significant**
II: 5-10	**Medium Risk** with controls verified. No mitigation required where controls can be verified as functional.	**Not significant**
I: 1-4	**Low Risk.** No mitigation required.	**Not significant**

3.4 Cumulative impact assessment

Although the scope of this impact assessment is restricted to the decommissioning of the LDP2 – LDP5 facilities as outlined in Section 2.0, it is recognised that the decommissioning workscope is one part of the Chrysaor's wider Southern North Sea Decommissioning Project and the possibility of cumulative impact with other elements of the project exists. The activities will also occur in the context of other oil and gas and non-oil and gas activities, with which there is the potential to interact. To this end, the impact assessments presented in the following sections specifically consider the potential for cumulative impact within the definition of significance.

3.5 Transboundary impact assessment

For most potential impacts from decommissioning, the likelihood of transboundary impact is low. However, where impacts on mobile receptors such as marine mammals are of concern, the likelihood of impact is higher. The impact assessments presented in the following sections have identified the potential for transboundary impacts and the potential for transboundary impact is considered within the definition of significance.

3.6 Habitats Regulations Assessment and Marine Conservation Zone (MCZ) Assessment

Under Article 6.3 of the Habitats Directive, it is the responsibility of the Competent Authority to make an Appropriate Assessment of the implications of a plan, programme or in this case project, alone or in combination, on a Natura site (SAC or Special Protection Area; SPA) in view of the site's conservation objectives and the overall integrity of the site. As part of the approvals process for VDP1 and LDP1, in its role as Competent Authority, OPRED undertook an HRA with respect to the potential impact on the North Norfolk Sandbanks and Saturn Reef SAC (NNSSR SAC) and on the Southern North Sea SAC (SNS SAC). The HRA considered the activities associated with the VDP1 and LDP1 programme of activities (BEIS, 2017) and a look ahead consideration of Chrysaor's forthcoming decommissioning activities, including those proposed for LDP2 – LDP5 (i.e. those activities assessed herein). BEIS (2017) concluded that, based on the best available information on current and likely forthcoming activities, it was "satisfied that the planned decommissioning activities will not have an adverse effect upon the integrity" of either of the sites. In addition, LDP2 - LDP5 infrastructure is located within the Inner Dowsing, Race Bank and North Ridge SAC, Greater Wash SPA and Humber Estuary SPA, however as there no direct decommissioning operations being undertaken in these sites to any significant level consideration has been given with regards to these and negligible effects degradation of these *in situ* pipelines over time.

In anticipation of OPRED updating the HRA based on the current knowledge of proposed activities (although it is noted it will be for OPRED to determine whether or not this is required), the assumptions regarding potential impacts on the seabed and on harbour porpoise (the two key features of interest in the HRA) have been reviewed. Any changes to those assumptions, or any additional information that is felt to assist OPRED in determining the need for, and subsequently carrying out (if required), an update of the HRA is provide within the relevant impact sections. In a similar process of assessing impact on protected sites, there is also a requirement under the Marine and Coastal Access Act for the Competent Authority to consider the potential for the proposed activities to impact upon MCZs. As with SACs and SPAs, OPRED is the Competent Authority for determination of likely significant effect on MCZ's with respect to oil and gas development. Where relevant, the impact assessments presented below provide information on the potential for the proposed activities to affect the protected features of MCZs, or to affect ecological or geomorphological processes on which the MCZs are dependent.

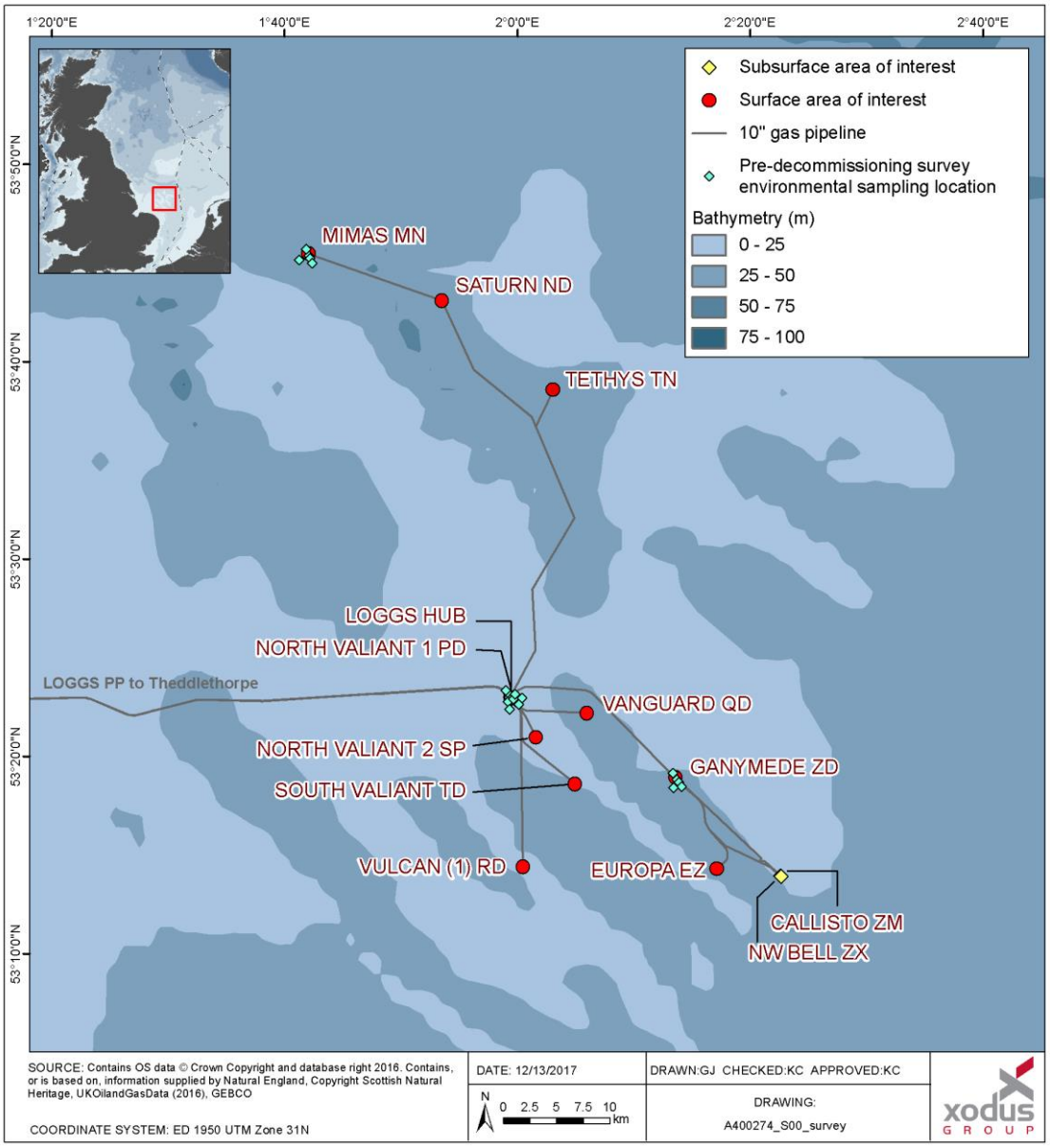
4.0 Environmental Baseline

4.1 Seabed conditions

The North Sea is a large shallow sea with a surface area of around 750,000 km^2. The southern North Sea is particularly shallow, with water depths of approximately 50 m or less (DECC, 2009). Benthic sediments in the southern North Sea consist largely of sand or muddy sand, with significant areas of coarse sediment, the latter mostly closer to shore (DECC, 2016; JNCC, 2010a). Seabed features in the southern North Sea include active sandbanks and sand waves which are maintained by the tidal and current regimes. An example is the North Norfolk sandbanks which is an active sandbank system thought to be progressively elongating in a north-easterly direction, maintained and developed by sediment transported offshore (JNCC, 2019b). Another example is the less active Dogger Bank which is characterised by a large sublittoral sandbank formed by glacial processes before being submerged through sea level rise (DECC, 2016).

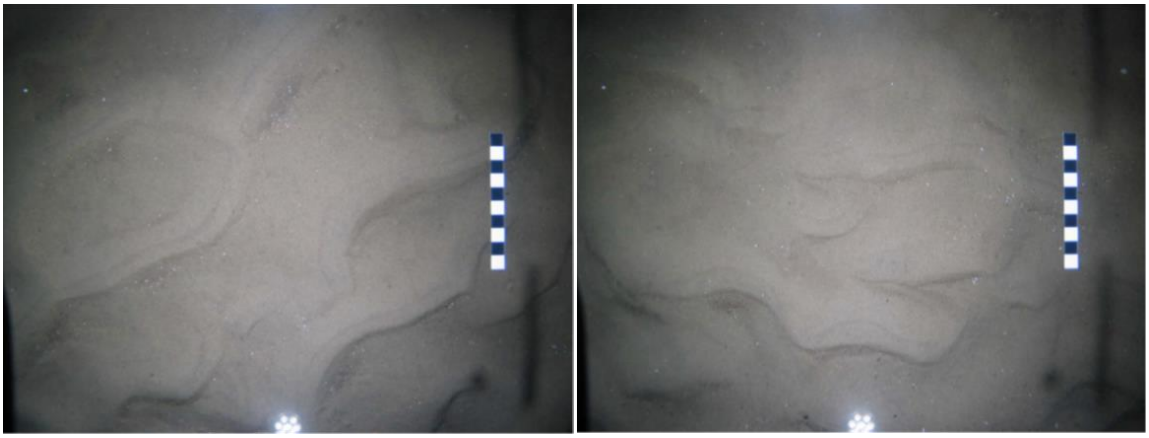
In August 2015, Gardline Environmental Limited completed a habitat assessment and pre-decommissioning survey across the offshore LOGGS gas fields, comprising the LOGGS Hub, Mimas MN, Ganymede ZD, South Valiant TD and Europa EZ platforms (Gardline, 2015a, 2015b). The surveys gathered geophysical data to characterise the local physical environment around each platform. Still images and environmental samples were obtained at LOGGS Hub, Mimas MN and Ganymede ZD platforms to identify seabed features and classify the benthic communities. The locations of the environmental sampling are shown in Figure 4-1.

Figure 4-1 Location of environmental sampling in the LOGGS offshore area



Bathymetry across the survey area ranged between 12.5 m relative to Lowest Astronomical Tide (LAT) at the LOGGS Hub and 40.1 m LAT at Europa EZ, in the southernmost part of the LOGGS area (Gardline, 2015b). The seabed was relatively flat across the survey area, with some specific seabed features noted for each of the five gas fields. At the LOGGS Hub, occasional boulders/debris up to 1.7 m high were observed. At Mimas, in the north of the LOGGS area, north-west to south-east orientated bands of coarser sediments with mega-rippled sand in-between and frequent boulders/debris up to 1.7 m high were identified. At Ganymede, north-east to south-west orientated sand mega-ripples were observed throughout the area, with occasional boulders/debris up to 1.1 m high. At South Valiant, north-east to south-west orientated mega-rippled sands were found, with occasional boulders/debris up to 1.2 m high. A 6.7 m high gravel dump was identified to the south-east of the South Valiant platform. At Europa, north-east to south-west orientated mega-ripples sands were found across the surveyed area, with a boulder reaching 0.5 m high. An example of mega-rippled sand observed during the survey campaign is shown in Figure 4-2.

Figure 4-2 Example of mega-rippled sand observed at the majority of survey stations (Gardline, 2015b) (scale bar shown represents 10 cm in the field of view)



The seabed across the survey area was predominantly composed of sand with shells and shell fragments, with some gravel and cobbles seen at Mimas MN some shell hash seen at Ganymede ZD. Sediments were generally well sorted and uniform, dominated by fine and medium sand, and negligible (<2%) gravel (>2 mm) and fines (<63 µm).

Total hydrocarbon concentration (THC) across the survey area was generally low and below the threshold of 50 $\mu g.g^{-1}$ for significant environmental impact, consistent with 95% of survey stations further than 5 km from the infrastructure in the southern North Sea (UKOOA, 2001). Polycyclic aromatic hydrocarbon (PAH) distribution indicated mixed petrogenic and biogenic sources across the survey area. Concentration of lower weight PAHs were above the effect range low at two stations at the LOGGS Hub, which might be associated with toxicity in sediments. All PAHs were below their effect threshold defined by the United States Environment Protection Agency (US EPA) and are unlikely to have an ecotoxicological effect on benthic fauna. At Mimas MN and Ganymede ZD, higher hydrocarbon concentrations were recorded at stations with higher proportion of fines.

4.2 Benthos

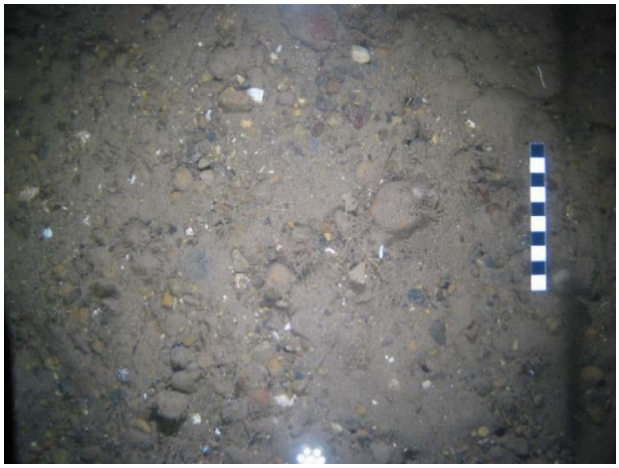
The biota living near, on or in the seabed is collectively termed benthos; the term infauna refers to those species living predominantly within the sediment, whilst the term epifauna refers to those species living predominantly on or just above the sediment. The type, diversity and biomass of the benthos is dependent on a number of factors including substrata (e.g. sediment, rock), water depth, salinity, the local hydrodynamics and degree of organic enrichment.

The infaunal community identified across the survey area (extent shown in Figure 4-1; Gardline, 2015a) differed at the three main survey locations. Whilst sampling around the LOGGS Hub showed an infaunal community that was generally dominated by crustacea (often *Monopseudocuma gilsoni)*, the infaunal community at Mimas MN was dominated more by polychaete worms including *Nephtys cirrosa*, *Ophelia borealis* and *Nephtys* juveniles. These species are typical of the sandy sediments of southern North Sea. Sampling around Ganymede ZD showed a community that was dominated more equally by polychaetes, crustaceans, molluscs and echinoderms.

Whilst epifauna were generally sparse across the survey area due to the lack of hard substrata, polychaete worms, hermit crabs, fish including sand eels and flatfish, starfish including the common starfish *Asterias rubens* and the sea star *Astropecten irregularis,* and the soft coral dead mans' fingers *Alcyonium digitatum* were all observed within the LOGGS Hub. At Mimas MN, similar epifaunal species were observed with additional records of bivalve molluscs, the dahlia anemone

Urticina felina, hydroids, bryozoans (such as Flustridae) and sponges. The greater abundance and diversity of epifauna at Mimas MN may be a result of the presence of cobbles, shells and shell fragments found amongst the medium to coarse sandy sediments which offer habitat diversity and points for attachment. Examples of some of the epifauna recorded during the survey work are shown in Figure 4-3.

Figure 4-3 Examples of benthic fauna recorded during survey work (Gardline, 2015a) (scale bar shown represents 10 cm in the field of view)



Station MN_05: Sand with gravel and shell fragments, showing bryozoa (Flustridae), hydroids and starfish

Station LOGG_06: Rippled sand with shell fragments/hash, showing the common starfish *A. rubens*

In terms of habitat classification, most stations within the LOGGS Hub, Mimas MN and Ganymede ZD survey areas were categorised as 'infralittoral fine sand', which corresponds to clean sands occurring in shallow water (generally shallower than 20 m), either on open coast or in tideswept channels of marine inlets (Gardline, 2015a). This is consistent with the protected Annex I habitat 'sandbanks slightly covered by seawater all the time'. Sediments at one station in the Mimas survey area contained more gravel and were categorised as circalittoral mixed sediment (Gardline, 2015a).

In terms of protected species and habitats recorded during the survey, bathymetry, seabed imagery and particle size analysis results are consistent with the definition of the Annex I habitats 'sandbanks slightly covered by water all the time' (Gardline, 2015b). A small fragment of tube structure recovered in a sieve during sampling at the Ganymede ZD location was considered to have possibly been made by the Ross worm *Sabellaria spinulosa* aggregations of such tubes can sometimes create reef structures which are of conservation concern. However, no *S. spinulosa* were evident either as individuals or as tube aggregations from the survey, and none of the geophysical data suggested the presence of such structures. Seabed imagery did not provide any evidence of any threatened and/or declining species and habitats on the OSPAR (2008) list or any species on the International Union for Conservation of Nature Global Red List of threatened species (Gardline, 2015b).

4.3 Seabirds

Much of the North Sea and its surrounding coastline is an internationally important breeding and feeding habitat for seabirds. The western flank of the Dogger Bank supports high densities of seabirds, with notable colonies on the east coast located at Flamborough Head and Bempton Cliffs, including for kittiwake *Rissa tridactyla*, gannet *Morus bassanus*, guillemot *Uria aalge*, razorbill *Alca*

torda and fulmar *Fulmarus glacialis* (DECC, 2016). Seabirds are not normally affected by routine offshore oil and gas operations. In the unlikely event of an oil release, however, birds are vulnerable to oiling from surface pollution, which could cause direct toxicity through ingestion, and hypothermia as a result the birds' inability to waterproof their feathers. Birds are most vulnerable in the moulting season when they become flightless and spend a large amount of time on the water surface.

After the breeding season ends in June, large numbers of moulting auks (common guillemot and razorbill) disperse from their coastal colonies and into the offshore waters from July onwards. At this time these high numbers of birds are particularly vulnerable to oil pollution. In addition to auks, great black-backed gull and fulmar are present in sizable numbers during the post breeding season (DECC, 2016).

The Joint Nature Conservation Committee (JNCC) has released the latest analysed trends in abundance, productivity, demographic parameters and diet of breeding seabirds, from the Seabird Monitoring Programme (JNCC, 2016). This data provides at-a-glance UK population trends as a % of change in breeding numbers from complete censuses. From the years 1998-2015, the following population trends for species known to use the field area have been recorded: northern fulmars (-31%), black legged kittiwakes (-44%) and common guillemots (+5%). Breeding seabird numbers of some species have shown a long-term decline, most probably as a result of a shortage of key prey species such as sandeels associated with changes in oceanographic conditions (Baxter *et al*., 2011: DECC, 2016).

According to the seabird density maps provided in Kober *et al.* (2010), the following species have been recorded within the area, throughout the year; northern fulmar *Fulmarus glacialis* (all year), sooty shearwater *Puffinus griseus* (July-November), Manx shearwater *Puffinus puffinus* (May-September), northern gannet *Morus bassanus* (all year), pomarine skua *Stercorarius pomarinus* (all year), Artic skua *Stercorarius parasiticus* (all year), great skua *Stercorarius skua* (May- August), black-legged kittiwake *Rissa tridactyla* (all year), little gull *Larus minutes* (August- November), great black-backed gull *Larus marinus* (all year), common gull *Larus canus* (all year), lesser black-backed gull *Larus fuscus* (May- August), herring gull *Larus argentatus* (September- March), Sandwich tern *Sterna sandvicensis* (May- August), common tern *Sterna hirundo* (May- September), common guillemot *Uria aalge* (all year), razorbill *Alca torda* (all year), little auk *Alle alle* (November- March) and Atlantic puffin *Fratercula artica* (all year).

The Seabird Oil Sensitivity Index (SOSI) (Webb *et al*., 2016) identifies sea areas where seabirds are likely to be most sensitive to oil pollution. It is an updated version of the Oil Vulnerability Index (JNCC, 1999) as it uses survey data collected between 1995 and 2015 and includes an improved method to calculate a single measure of seabird sensitivity to oil pollution. The survey area covers the UKCS and beyond. Seabird data was collected using boat-based, visual aerial, and digital video aerial survey techniques. This data was combined with individual species sensitivity index values and summed at each location to create a single measure of seabird sensitivity to oil pollution (Webb *et al*., 2016). Block/month combinations that were not provided with data have been populated with the SOSI using the indirect assessment method provided by JNCC (Webb *et al*., 2016). Seabird sensitivity in the region ranges from extremely high (over winter and in July) to low (through spring, early summer and autumn) (MMO, 2018).

Chrysaor has separately prepared a birds Addendum to support this EA application. This provides and overview of the studies and survey effort that has occurred to demonstrate that seabirds have not found to be nesting on the infrastructure to be decommissioned. Additional ornithological surveys are to be planned to ensure that adequate survey coverage is provided prior to installations being removed.

Table 4.1 Seabird vulnerability to surface pollution in the vicinity of LOGGS (Webb, et al., 2016)

Quad / Block	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
48/3	N	5*	5	5*	3*	3	1	4	1	1*	1*	1
48/4	N	5*	5	5*	4*	4	1	4	1	1*	1*	1
48/5	N	1*	5	5*	5*	5	1	5	1	1*	1*	1
49/1	1*	5*	5	5*	N	1*	1	4	5	5*	1*	1
48/8	1*	1	1*	N	3*	3	1	3	2	2*	1*	1
48/9	N	1*	N	N	4*	4	1	4	3	3*	1*	1
48/10	1*	1*	N	N	5*	5	1	4	4*	N	1*	1
49/6	1*	1*	N	N	N	1*	1	5	5*	N	1*	1
49/7	1*	1*	N	N	5*	5	1	5	5	N	1*	1
48/13	1	2	3	3*	3	5	5	3	3	1*	1	2
48/14	1	2	3	3*	3	5	2	3	5	1*	1	2
48/15	1*	1	1*	N	3*	5*	4*	4	4*	N	1*	1*
49/11	1*	1	1*	N	N	1*	1	5	5*	N	N	1*
49/12	N	1*	N	N	5*	5	1	5	5	5*	N	1*
48/20	1*	1	1*	N	3*	5*	5*	5	5*	N	1*	1
49/16	2*	2	2*	N	N	5*	5*	5	5*	N	N	1*
49/17	N	1*	2*	N	N	2*	2	5	5	5*	N	1*
49/18	5*	N	2*	N	5*	5	2	5	5	5*	5*	5
48/25	1*	1	1	1*	4*	5*	4*	4	4*	2*	2	2
49/21	1*	1	2	2*	N	N	5*	5	5*	N	1*	1
49/22	N	3*	3	3*	N	5*	5*	5	3	3*	1*	1
49/23	3*	4*	4	4*	5*	5	5*	5	5	5*	3*	3
48/30	1*	1	3	3*	N	5*	5	4	5	3*	3	2
49/26	1*	1	4	4*	N	N	5*	5	5	3*	3	2
49/27	1*	4*	4	4*	N	5*	5*	5	5*	N	1*	1
49/28	1*	4*	4	4*	N	5*	5*	5	5*	N	1*	1
Key	1 = Extremely high		2 = Very high		3 = High		4 = Medium		5 = Low		N = No data	
* in light of coverage gaps, an indirect assessment of SOSI has been made												

4.4 Marine mammals

4.4.1 Cetaceans

The Atlas of Cetacean Distribution in North-West European Waters compiles the distribution of cetacean species in UK waters (Reid *et al.*, 2003). This atlas is based on three sources of cetacean sightings data: JNCC Seabirds at Sea Team, SeaWatch Foundation and data from the first survey of a series called Small Cetacean Abundance in the North Sea. A total of 19 species of cetacean have been recorded in UK waters (Reid *et al*., 2003). Cetaceans regularly recorded in the North Sea include the harbour porpoise *Phocoena*, bottlenose dolphin *Tursiops truncatus*, minke whale

Balaenoptera acutorostrata, killer whale *Orcinus orca*, Atlantic white-sided dolphin *Lagenorhynchus acutus* and white-beaked dolphin *Lagenorhynchus albirostris*. Rarer species that are occasionally observed in the North Sea include fin whale *Balaenoptera physalus*, long-finned pilot whale *Globicephala melas*, Risso's dolphin *Grampus griseus* and the short beaked common dolphin *Delphinus delphis* (NMPi, 2019, Reid *et al*., 2003). However, harbour porpoise white-beaked dolphin are the only cetaceans considered as regular visitors in the southern North Sea throughout most of the year, and minke whale *Balaenoptera acutorostrata* as a frequent seasonal visitor (DECC, 2016).

Harbour porpoises are frequently seen across much of the North Sea for much of the year (Reid *et al*., 2003). The predicted density of harbour porpoises in the vicinity of the Project area from recent Small Cetaceans in European Atlantic waters (SCANS-III) surveys is high compared to the rest of the UK waters, with an estimate of around 0.8 – 0.9 animals per km^2 (Hammond *et al*., 2017). Harbour porpoise abundance estimates in the North Sea have remained stable between 1994 and 2016, and the species range appears to have expanded (Hammond *et al.*, 2017).

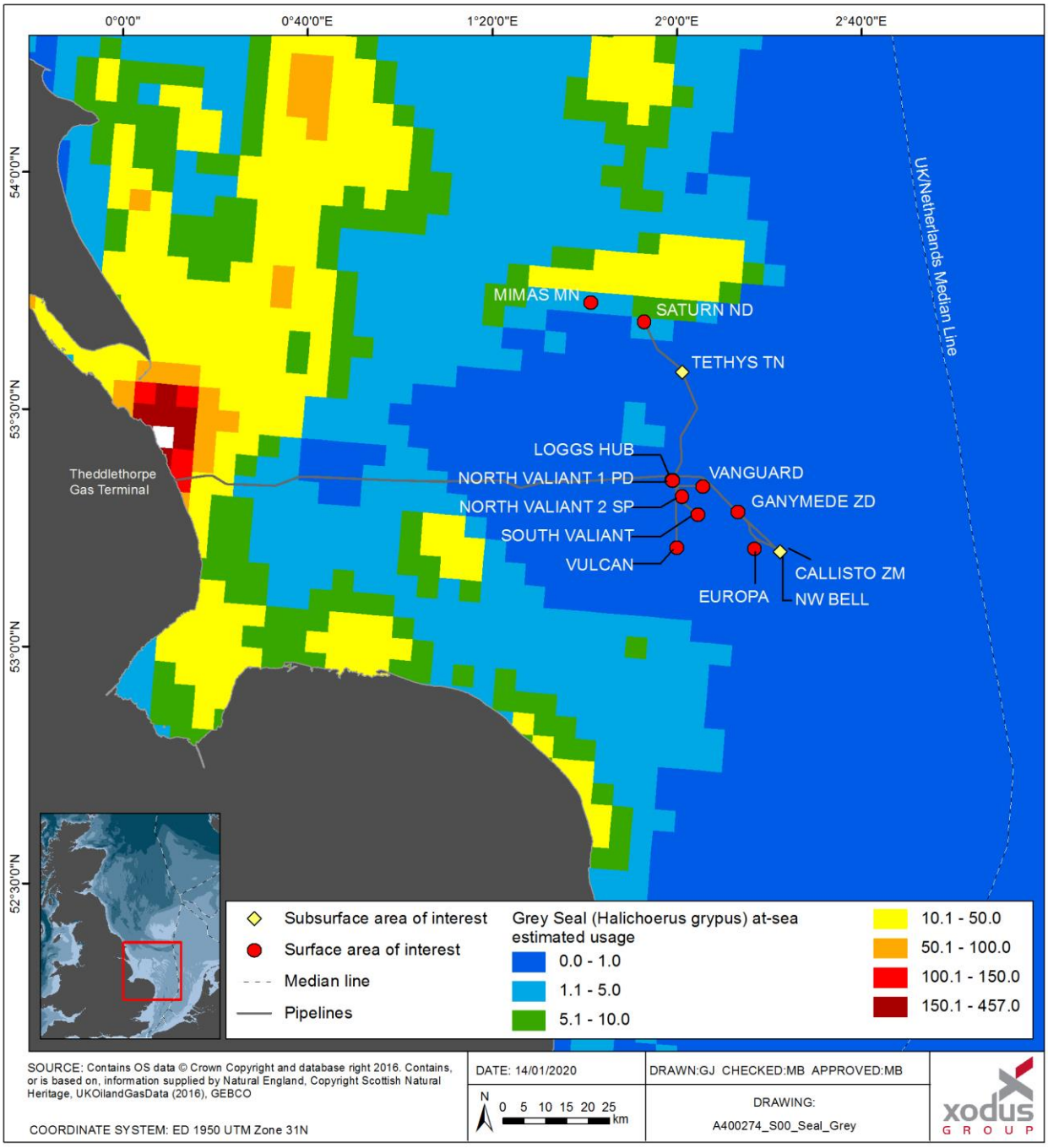
White-beaked dolphins are frequently seen in the central and northern North Sea all year-round in nearshore waters, with peak sightings between June and October. They have been recorded in the shallower waters of the North Norfolk Sandbanks and within the Dogger Bank and adjacent areas in small numbers (DECC, 2016, Reid *et al*., 2003). The results of the SCANS-III surveys found that trend analysis of white-beaked dolphin estimates in the North Sea gives no indication of changes in abundance since 1994 (Hammond *et al.*, 2017).

Minke whales are well distributed in the northern and central North Sea, but occasional sightings have been recorded in the southern half of the North Sea southwards of Flamborough Head and off the north Humberside coast mainly from July to October (DECC, 2016). To the north-west of the Project area, on the slopes of the Dogger Bank and in adjacent areas, relatively high densities of minke whales have been reported in spring and summer. Given the lack of sightings in the southern half of the North Sea, minke whales are thought to enter the North Sea from the north (DECC, 2016). 2016 abundance estimates for the species were slightly lower than in previous years but still within range of past data therefore there is no support for changes in abundance since 1989 (Hammond *et al.*, 2017).

4.4.2 Pinnipeds

About 38% of the world population of grey seal *Halichoerus grypus* occur in the UK, with 88% of the UK population breeding in Scotland. There are several breeding colonies along the English coast. Breeding takes place in the autumn with mean birth date in eastern England being November-December (DECC, 2016). Most of the grey seal population will be on land from October to December during the breeding season, and in February and March during the annual moult, therefore densities at sea are likely to be lower at these times of the year. Grey seal density varies across the LD2P2 – LDP5 area, ranging between 0 and 5 animals per 25 km^2 (Jones *et al*., 2015; Figure 4-4).

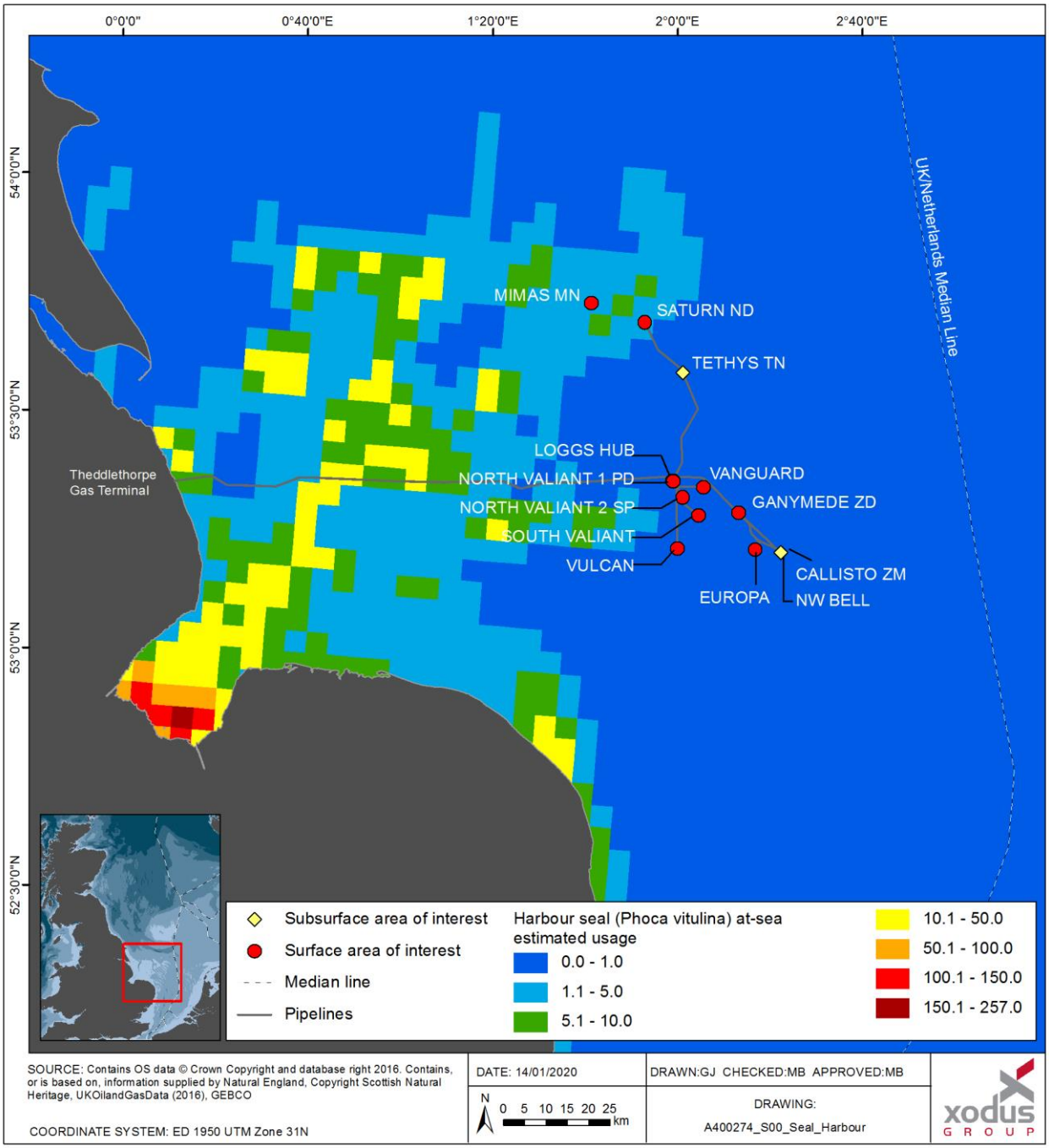
Figure 4-4 Grey seal density in the vicinity of the LDP2 – LDP5 infrastructure



Harbour seals *Phoca vitulina* are widespread in the Northern Hemisphere. Harbour seals generally haul out on tidally exposed areas of rock, sandbanks or mud. Pupping season is between June and July, and the moult occurs in August and September, therefore from June to September harbour seals are on shore more often than at other times of the year. Harbour seals use The Wash and North Norfolk Coast SAC for breeding and hauling-out. They also use the Wash Approach recommended MCZ and the Holderness Offshore recommended MCZs as feeding grounds, which

are in the vicinity of the LOGGS to MLWM pipeline. Harbour seal density varies across the LDP2 – LDP5 area, ranging between 0 and 50 animals per 25 km^2 (Jones *et al.*, 2015; Figure 4-5).

Figure 4-5 Harbour seal density in the vicinity of the LDP2 – LDP5 infrastructure



4.5 Sites of conservation importance

4.5.1 Overview of relevant sites

Sites of conservation importance located in the vicinity of the LDP2 – LDP5 infrastructure are shown in Figure 4-6 and . Sites for which potential interaction has been identified are described in Table 4.2.

Figure 4-6 Offshore sites of conservation importance in the vicinity of the LDP2 – LDP5 infrastructure

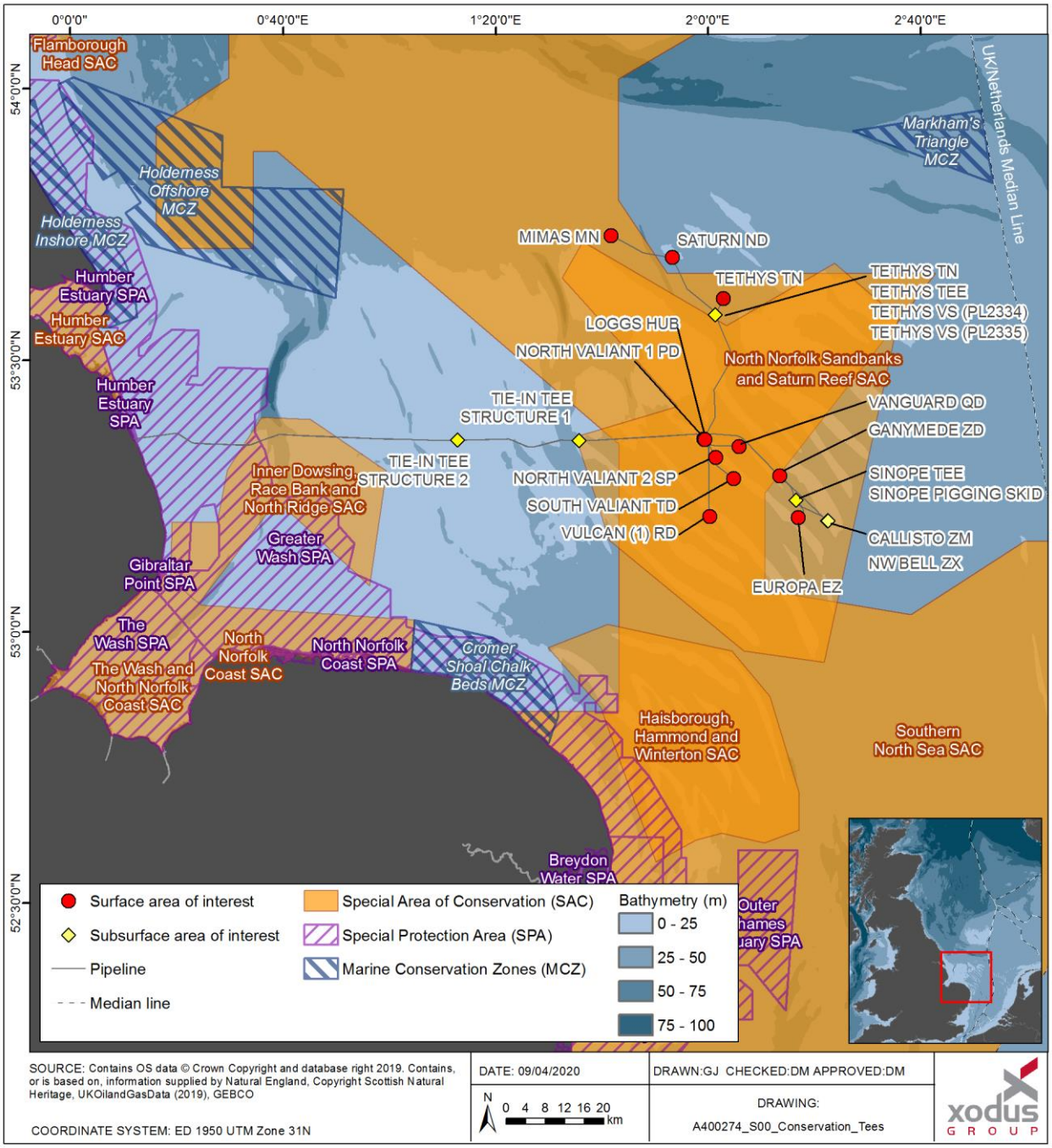


Figure 4-7 Landfall approach of LOGGS (LDP5 infrastructure)

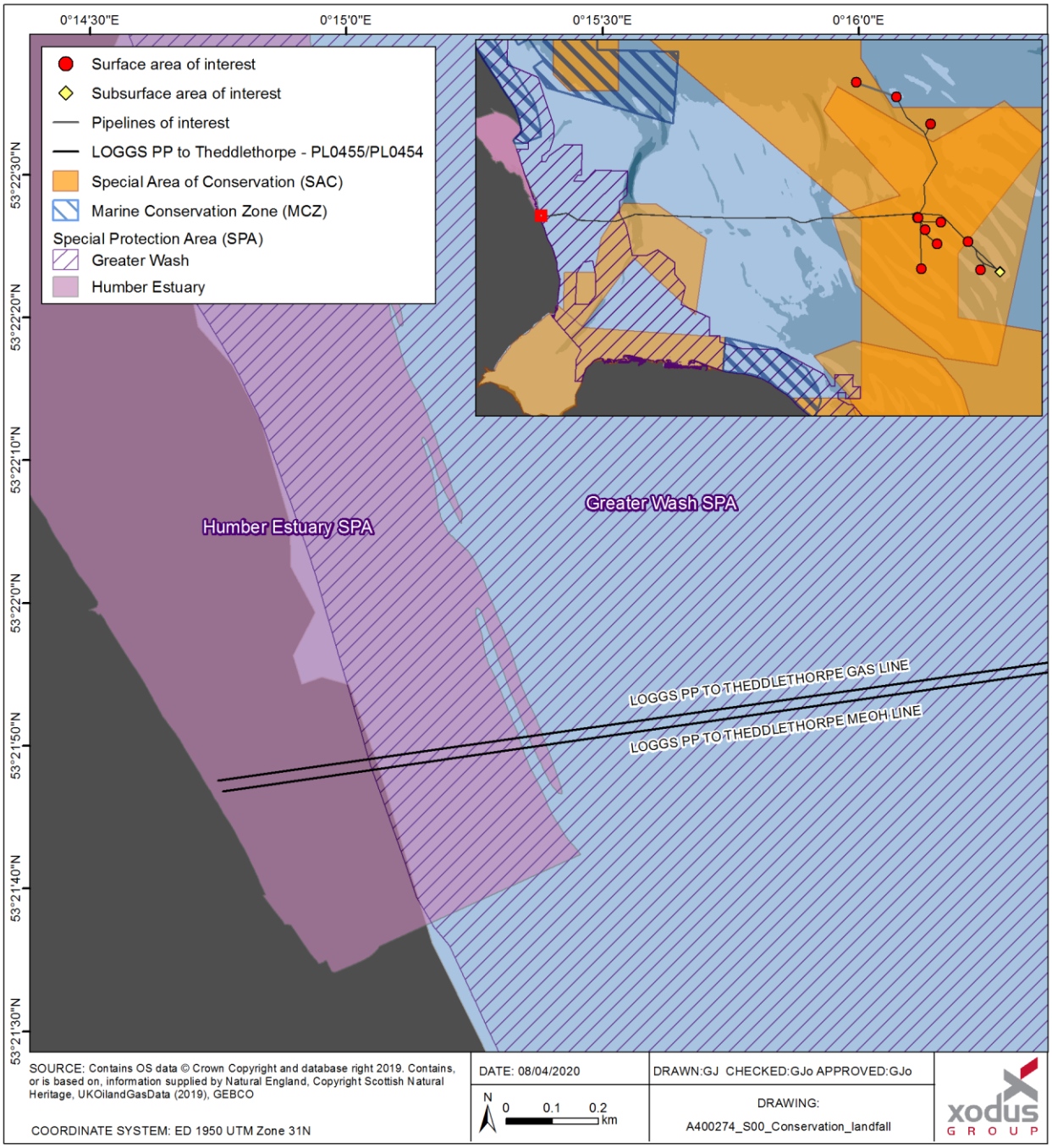


Table 4.2 Sites of conservation importance in the vicinity of the LDP2 – LDP5 infrastructure

Site name	Qualifying features	Distance from LDP2 – LDP5 activities
North Norfolk Sandbanks and Saturn Reef SAC	○ Annex I reefs ○ Annex I sandbanks which are slightly covered by water all of the time See Section 4.5.2 for further detail.	Many of the proposed activities will occur within this site.
Southern North Sea SAC	○ Annex II Species Harbour porpoise. See Section 4.5.3 for further detail.	Many of the proposed activities will occur within this site.
Inner Dowsing, Race Bank and North Ridge SAC	○ Annex I reefs ○ Annex I sandbanks	The SAC is crossed by the LOGGS to MLWM pipeline. There are no significant planned decommissioning activities within the SAC. The length of the pipeline in this SAC is 19.32 km.
Humber Estuary SPA	The Humber Estuary SPA is designated for its regular use by >1% of the twelve Annex I bird species found in Great Britain, including: bittern *Botaurus stellaris*, hen harrier *Circus cyaneus*, marsh harrier *Circus aeruginosus* and avocet *Recurvirostra avosetta*. The site also qualifies as it is regularly used by >1% of the biogeographical populations of a number of bird species including shelduck *Tadorna*, dunlin *Calidris alpina*, bar-tailed godwit *Limosa lapponica,* black tailed godwit *Limosa,* golden plover *Pluvialis apricaria,* little tern *sterna albifrons,* redshank *Tringa tetanus* and ruff *Philomachus pugnax*. In addition, the site also qualifies as it is used regularly by over 20,000 waterbirds in any season (Natural England, 2007).	The LOGGS to MLWM pipeline crosses the SPA for 0.36 km. There are no significant planned decommissioning activities within the SPA, other than decommissioning the pipeline *in situ*.

Site name	Qualifying features	Distance from LDP2 – LDP5 activities
Humber Estuary SAC	It is a designated SAC due to the presence of the Annex I habitats estuaries and mudflats and sandflats not covered by seawater at low tide. The Humber is the second-largest coastal plain estuary in the UK, habitats within the estuary include Atlantic salt meadows, and sandbanks which are slightly covered by seawater all the time. Annex II species present as qualifying features of the SAC are river lamprey, sea lamprey and grey seals (JNCC, 2015). The Humber Estuary is also an internationally important wetland under the Ramsar Convention. Other Annex I habitats present, but are not a primary reason for selection of this site include: sandbanks which are slightly covered by sea water all the time, coastal lagoons, Salicornia and other annuals colonizing mud and sand, Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*), embryonic shifting dunes, "shifting dunes along the shoreline with *Ammmophila arenaria* ("white dunes")", "fixed coastal dunes with herbaceous vegetations ("grey dunes") and Dunes with *Hippophae rhamnoides*. Annex II species present as a qualifying feature but are not primary reason for the site selection include sea lamprey *Petromyzon marinus*, river lamprey *Lampetra fluviatilis* and grey seal.	SAC located 6.5 km north of the LOGGS to MLWM pipeline
Greater Wash SPA	The Greater Wash area provides areas of importance for over-wintering for the red-throated diver *Gavia stellata*, little gull *Hydrocoloeus minutus* and common scoter *Melanitta nigra*. In addition, the site aims to protect ideal coastal feeding waters used by breeding populations of common tern *Sterna hirundo*, sandwich tern *Thalasseus sandvicensis* and little tern *Sternula albifrons.*	The LOGGS to MLWM pipeline crosses the Greater Wash SPA for 25.9 km. There are no significant planned decommissioning activities within the SAC other than decommissioning the pipeline *in situ*.

Site name	Qualifying features	Distance from LDP2 – LDP5 activities
The Wash and North Norfolk Coast SAC	○ Annex I habitats (primary reason for site selection): Sandbanks which are slightly covered by water all of the time, mudflats and sandflats not covered by seawater at low tide, large shallow inlets and bays, reefs, Salicornia and other annuals colonising mud and sand, Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) and Mediterranean and thermos-Atlantic halophilous scrubs (*Sarcocornetea fruticosi*). ○ Annex I habitats (not a primary reason for site selection): Coastal lagoons. ○ Annex II species (primary reason for site selection): Harbour seal. Annex II species (not a primary reason for site selection): Otter *Lutra.*	27 km south of the LOGGS to MLWM pipeline. There are no planned decommissioning activities within the SAC.
Holderness Offshore MCZ	The designation of this site as an MCZ is due to the presence of habitats such as 'Subtidal coarse sediment' and 'Subtidal mixed sediments'. In addition, the presence of the feature of conservation importance habitat 'Subtidal Sands and Gravels' was confirmed for this site (Defra, 2017). The site is significant for crustaceans, including edible crabs and common lobster (Defra, 2019).	24 km north of the LOGGS to Theddlethorpe Gas Terminal pipeline. There are no planned decommissioning activities within the MCZ.
Cromer Shoal Chalk beds MCZ	The designated habitat features for this site include: high energy circalittoral rock, high energy infralittoral rock, moderate energy circalittoral rock, moderate energy infralittoral rock, North Norfolk coast (subtidal) peat and clay exposures, subtidal coarse sediment, subtidal mixed sediments and subtidal sand.	47 km to the south west of LOGGS platform Vulcan 1 RD. There are no planned decommissioning activities within the MCZ.

4.5.2 North Norfolk Sandbank SAC

The site has been selected for designation due to the presence of the Annex I habitats: sandbanks which are slightly covered by water at all times and reefs. The Degree of Conservation of the sandbank feature is C (Average or Reduced Conservation); Reefs are B (Good Conservation). Annex I Reefs and Sandbanks are in Unfavourable Condition). The Conservation Objectives for the NNSSR SAC are for the features to be in favourable condition, thus ensuring site integrity in the long

term and contribution to Favourable Conservation Status of Sandbanks and Reefs. This contribution would be achieved by maintaining or restoring, subject to natural change:

- The extent and distribution of the qualifying habitats in the site;
- The structure and function of the qualifying habitats in the site; and
- The supporting processes on which the qualifying habitats rely.

Annex I sandbanks slightly covered by seawater all the time occur where areas of sand form distinct elevated topographic features which are predominantly surrounded by deeper water and where the top of the sandbank is in less than 20 m water depth. However, the sides of these sandbanks can extend into depths of up to 60 m whilst still being considered as an Annex I feature (JNCC, 2017a). There are 20 sites for which this habitat is a primary feature and a further 17 sites in which the habitat occurs but not identified as a primary reason for site selection (JNCC, 2017b).

4.5.3 Southern North Sea SAC

The SNS SAC has been identified as an area of importance for harbour porpoise. This site includes key winter and summer habitat for this species and covers an area over three times the size of Yorkshire, making it the largest SAC in UK and European waters at the point of designation in 2017. The Degree of harbour porpoise within the site is A (Excellent Conservation). Annex I Reefs and Sandbanks are in Unfavourable Condition). The Conservation Objectives of the site are to ensure that the integrity of the site is maintained and that it makes the best possible contribution to maintaining Favourable Conservation Status (FCS) for Harbour Porpoise in UK waters. In the context of natural change, this will be achieved by ensuring that:

- Harbour porpoise is a viable component of the site;
- There is no significant disturbance of the species; and
- The condition of supporting habitats and processes, and the availability of prey is maintained.

4.5.4 Inner Dowsing, Race Bank and North Ridge SAC

The Inner Dowsing, Race Bank and North Ridge SAC contains two Annex I habitats (1110 Sandbanks which are slightly covered by sea water all the time and 1170 Reefs). The Degree of Conservation of the sandbank feature is C (Average or Reduced Conservation); Reefs are B (Good Conservation). Annex II Harbour porpoise are in Favourable Condition)

The conservation objectives for the Inner Dowsing, Race Bank and North Ridge SAC are to ensure the integrity of the site is maintained and that the Annex I qualifying features are preserved and the site maintains the Favourable Conservation Status of its qualifying features by maintaining or restoring the site.

There are no significant operations being undertaken in the Inner Dowsing, Race Bank and North Ridge SAC as a result of decommissioning the LOGGS infrastructure *in situ.* Given the pipelines will be cleaned prior to decommissioning the risk of degradation products and residual pipeline contents affecting the integrity of the SAC is highly unlikely, therefore no further assessment has been undertaken.

4.5.5 The Humber Estuary SPA

The objectives of the Humber Estuary SPA is to ensure that the integrity of the site is maintained or restored and that the site contributes to achieving the aims of the Wild Birds directive by maintaining or restoring;

- The extent and distribution of the habitats of the qualifying features;
- The structure and function of the habitats of the qualifying features ;
- The supporting processes on which the habitats of the qualifying features rely;
- The population of each of the qualifying features; and,

There are no significant operations being undertaken in the Humber Estuary SPA as a result of decommissioning the LOGGS infrastructure *in situ.* Given the pipelines will be cleaned prior to decommissioning the risk of degradation products and residual pipeline contents affecting the integrity of the SPA is highly unlikely, therefore no further assessment has been undertaken.

4.5.6 The Greater Wash SPA

The conservation objectives of the Greater Wash SPA is to ensure that the integrity of the site is maintained or restored and that the site contributes to achieving the aims of the Wild Birds directive by maintaining or restoring; The extent and distribution of the habitats of the qualifying features;

- The structure and function of the habitats of the qualifying features ;
- The supporting processes on which the habitats of the qualifying features rely;
- The population of each of the qualifying features; and,
- The distribution of the qualifying features within the site.

There are no significant operations being undertaken in the Greater Wash SPA as a result of decommissioning the LOGGS infrastructure *in situ.* Given the pipelines will be cleaned prior to decommissioning the risk of degradation products and residual pipeline contents affecting the integrity of the SPA is highly unlikely, therefore no further assessment has been undertaken.

4.6 Commercial fisheries

The infrastructure to be decommissioned in the LOGGS Decommissioning Project cover the International Council for the Exploration of the Sea (ICES) rectangles 36F0, 36F1, 36F2, 35F0, 35F1 and 35F2. In 2017, Brown & May Marine Ltd undertook a fisheries assessment for Chrysaor in order to identify commercial fishing activity in the vicinity of the LOGGS Decommissioning Project area (ConocoPhillips, 2017b). In this fisheries assessment report, LOGGS North refers to the Mimas, Saturn and Tethys offshore infrastructure or LDP2, and LOGGS South refers to the offshore infrastructure within LDP2 – LDP5. Across LOGGS North and LOGGS South, fishing grounds are fished to varying degrees by the following fleets (ConocoPhillips, 2017b):

- Dutch beam trawlers, demersal otter trawlers, and fly seiners

- UK potters, shrimp beam trawlers, shellfish dredgers, otter trawlers, long-liners, and netters;
- Belgian beam trawlers and demersal otter trawlers;
- Danish sandeelers, midwater and demersal trawlers and seine netters;
- Norwegian purse seiners and midwater otter trawlers;
- German beam trawlers and demersal otter trawlers;
- French otter trawlers (demersal and pelagic); and
- French purse seine netters.

Table 4. provides a summary of the landings statistics over the last five years (2013 to 2019). The main species targeted are shellfish for all ICES rectangles for all years with the exception of ICES rectangle 35F2 where demersal species dominate the landings value.

Table 4. provides a summary of the fishing efforts days over the last five years (2013 to 2019) for ICES rectangles 36F0, 36F1 and 36F2. Fishing effort was a lot higher in ICES rectangle 36F0 compared to the other ICES rectangles, with the highest number of effort days taking place in the summer months (July-September) (Scottish Government, 2018 & 2020).

Table 4. provides a summary of the annual totals of fishing efforts days over the last four years (2013-2016) for ICES rectangles 35F0, 35F1 and 35F2. Fishing effort was lower in comparison to the ICES rectangles in Table 4..

Published AIS data from the UK fishing fleet show that the number of fishing tracks recorded between 2007 - 2015 within 1 km^2 squares is low to moderate at the pipeline ends in comparison to other regions of the North Sea, expect at the Europa platform where fishing intensity is higher (Rouse *et al*., 2017) (Figure 4-8). Along the pipelines within the LDP2 to LDP5 areas, fishing intensity is low to moderate, expect along a section of the pipelines between Vanguard and Vulcan (LDP4) where intensity is high (Figure 4-8).

Table 4.3 Fisheries landings data between 2013-2019 for ICES rectangles 36F0, 36F1, 36F2, 35F0, 35F1 and 35F2 (MMO, 2018: Scottish Government 2020) (Part 1 2013-2017)

ICES rectangle	Fisheries type	Landings data									
		2013		2014		2015		2016		2017	
		Value (£)	Tonnes	Value (£)	Tonnes	Value (£)	Tonnes	Value (£)	Tonnes	Value (£)	Tonnes
36F0	Demersal	12,775	6	30,664	18	44,743	22	15,962	8	10,027	6
	Pelagic	0	0	181	0	4	0	18	0	165	0
	Shellfish	6,523,911	3,000	7,690,635	3,719	7,760,575	3,467	9,433,068	3,728	11,132,493	3,859
Total		**6,536,686**	**3,006**	**7,721,480**	**3,737**	**7,805,322**	**3,489**	**9,449,048**	**3,736**	**11,142,685**	**3,865**
36F1	Demersal	50,712	35	76,336	44	24,511	10	13,192	6	505	1
	Pelagic	7	0	-	-	-	-	-	-	-	-
	Shellfish	496,889	320	1,276,886	1,010	1,584,931	1,266	1,405,270	1,050	2,023,677	1,218
Total		**547,608**	**355**	**1,353,222**	**1,054**	**1,609,442**	**1,276**	**1,418,462**	**1,056**	**2,024,182**	**1,219**
36F2	Demersal	780,392	401	324,436	197	417,493	230	663,862	335	52,711	32
	Pelagic	93	0	24	0	1	0	124	0	2,167	1
	Shellfish	90,185	39	107,776	39	144,607	62	271,904	96	154,202	55
Total		**870,670**	**440**	**432,236**	**236**	**562,101**	**292**	**935,890**	**431**	**209,080**	**88**
35F0	Demersal	8,959	2	28,418	12	25,680	11	9,312	3	4,254	1

ICES rectangle	Fisheries type	Landings data									
		2013		2014		2015		2016		2017	
		Value (£)	Tonnes	Value (£)	Tonnes	Value (£)	Tonnes	Value (£)	Tonnes	Value (£)	Tonnes
	Pelagic	22,400	42	161	0	278	0	22	0	-	-
	Shellfish	3,019,835	3,246	2,161,558	3553	2,501,619	4386	1,380,715	929	2,036,185	2,518
Total		**3,051,194**	**3,290**	**2,190,137**	**3,565**	**2,527,577**	**4,397**	**1,390,049**	**932**	**2,040,439**	**2,518**
35F1	Demersal	115,120	25	76,721	22	27,013	8	8,066	2	267	0
	Pelagic	400	0	-	-	20	0	-	-	628	1
	Shellfish	1,344,793	1,392	1,210,267	1,100	1,129,975	928	1,454,308	1,116	1,571,719	1,167
Total		**1,460,313**	**1,417**	**1,286,988**	**1,122**	**1,157,008**	**936**	**1,462,374**	**1,118**	**1,572,614**	**1,168**
35F2	Demersal	477,082	148	376,390	121	283,654	82	366,215	84	235,571	63
	Pelagic	-	-	0	0	-	-	-	-	0.2	0
	Shellfish	6,029	2	3,277	4	146	0	130	0	417	0
Total		**483,111**	**150**	**379,667**	**125**	**283,800**	**82**	**366,345**	**84**	**235,988**	**63**

Table 4-3 Fisheries landings data between 2013-2019 for ICES rectangles 36F0, 36F1, 36F2, 35F0, 35F1 and 35F2 (MMO, 2018; Scottish Government 2020 (Part 2 2018-2019)*

ICES rectangle	Fisheries type	Landings data			
		2018		2019	
		Value (£)	Tonnes	Value (£)	Tonnes
36F0	Demersal	10,192	9	15,081	15
	Pelagic	87,222	162	-	-
	Shellfish	11,025,148	3679	10,910,287	3,436
Total		11,122,562	3,850	10,925,368	3,451
36F1	Demersal	1,578	1	1161	0
	Pelagic	-	-		
	Shellfish	2,371,256	1,161	3,046,907	1427
Total		**2,371,256**	**1,161**	**3,046,907**	**1427**
36F2	Demersal	394,329	157	268,447	114
	Pelagic	0	0	1101	1
	Shellfish	9,1852	40	207,742	100
Total		**486,181**	**197**	**477,290**	**215**
35F0	Demersal	5573	2.3	Disclosive	Disclosive
	Pelagic	--	--	Disclosive	Disclosive
	Shellfish	2,405,187	1810	Disclosive	Disclosive
Total		**2,410,760**	**1,812**	Disclosive	Disclosive

*Note 35F1 and 35F2 all disclosive data and has not been added to the table.

Table 4.4 Fisheries effort data for ICES rectangles 36F0, 36F1 and 36F2 (Scottish Government, 2020)

ICES Rectangle	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
36F0	2019	142	149	124	173	227	165	277	291	269	243	152	131	2,344
	2018	136	116	207	248	238	211	286	382	285	247	162	139	2,647
	2017	167	141	212	230	260	274	309	430	255	259	241	160	2,938
	2016	106	116	162	158	192	240	299	334	281	227	209	182	2,506
	2015	118	131	184	263	273	234	279	297	300	267	193	128	2,666
	2014	114	85	192	272	244	208	295	249	314	211	207	125	2,518
	2013	112	99	61	120	192	205	247	293	235	187	196	149	2,095
36F1	2019	142	149	124	173	227	165	277	291	269	243	152	131	2,343
	2018	29	D	D	27	29	37	70	84	29	35	21	25	411
	2017	16	D	15	23	23	25	89	93	70	44	33	33	475
	2016	14	25	D	D	D	28	42	86	67	18	35	D	410
	2015	D	D	D	34	51	37	52	67	82	86	42	43	554
	2014	D	15	36	40	D	53	52	42	51	46	51	27	456
	2013	21	D	D	12	17	31	D	D	D	11	13	D	167

36F2	2019	D	37	29	35	42	34	62	33	51	72	59	68	551
	2018	D	D	D	D	D	-	D	D	18	D	D	D	73
	2017	D	D	D	-	D	26	D	D	D	D	-	-	70
	2016	9	-	D	D	27	19	38	45	D	D	D	D	108
	2015	D	D	D	-	D	14	17	47	D	D	D	-	107
	2014	D	-	D	D	D	D	D	20	34	D	D	D	171
	2013	D	D	D	D	D	16	20	12	20	D	21	D	70

Note: Monthly fishing effort by UK vessels landing into Scotland: Blank = no data, D = Disclosive data (indicating very low effort, specifically less than 5 over 10 m vessels undertook fishing activity in that month), green = 0 – 100 days fished, yellow = 101 – 200, orange =201-300, red = ≥301]

Table 4.5 Fishing effort annual totals within ICES rectangles 35F0, 35F1 and 35F2 between 2013-2019 (MMO, 2018/ Scottish Government 2020)

ICES Rectangle	Year	Annual Total (days)
35F0	2019	Disclosive
	2018	Disclosive
	2017	Disclosive
	2016	10
	2015	12
	2014	45
	2013	55
35F1	2019	Disclosive
	2018	Disclosive
	2017	Disclosive
	2016	42
	2015	17
	2014	14
	2013	4
35F2	2019	Disclosive
	2018	Disclosive
	2017	Disclosive
	2016	27
	2015	19
	2014	32
	2013	22

Figure 4-8 UK fishing intensity associated with oil and gas pipelines for mobile gear (2007-2015) (Rouse *et al.*, 2017)

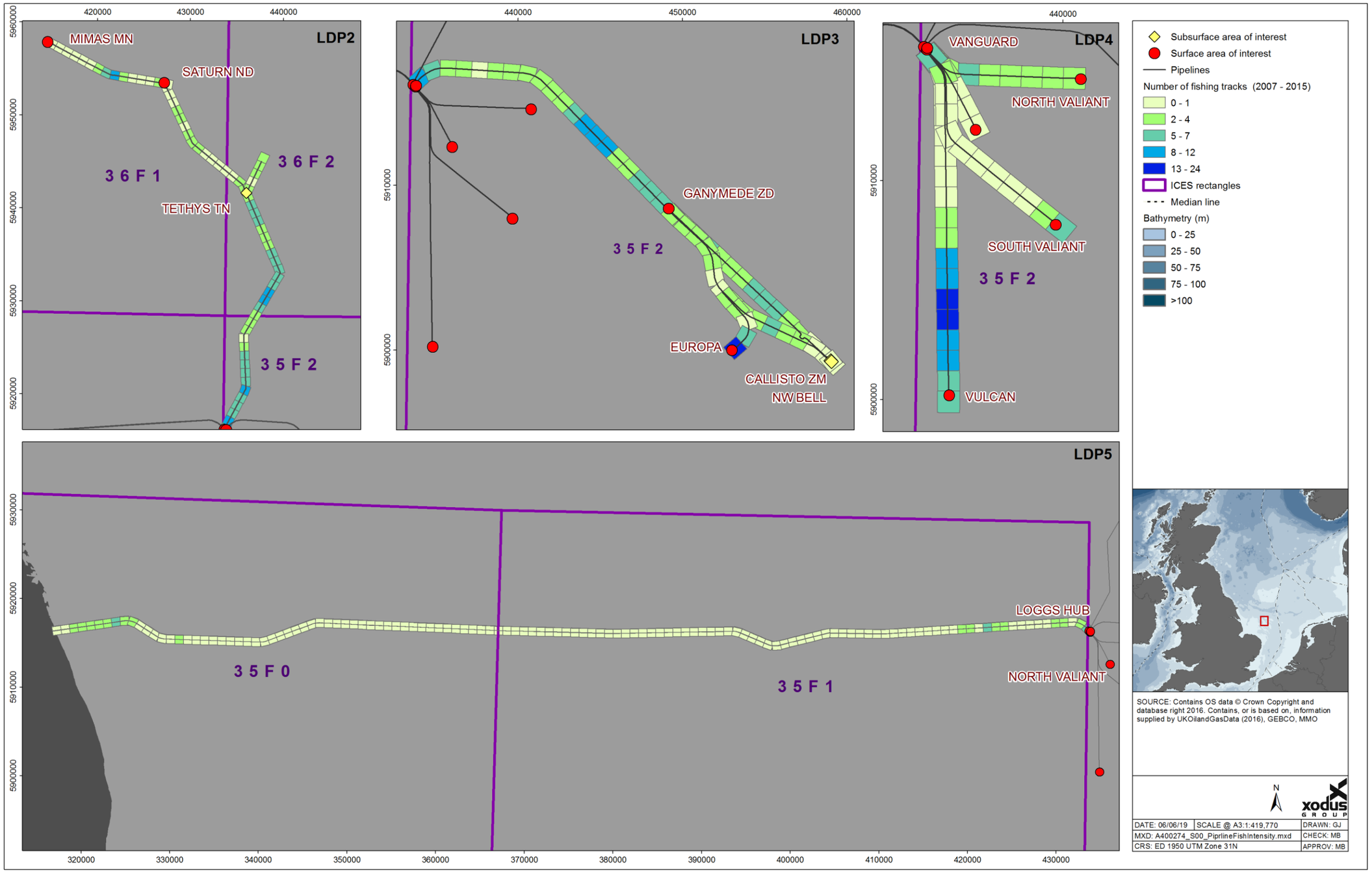


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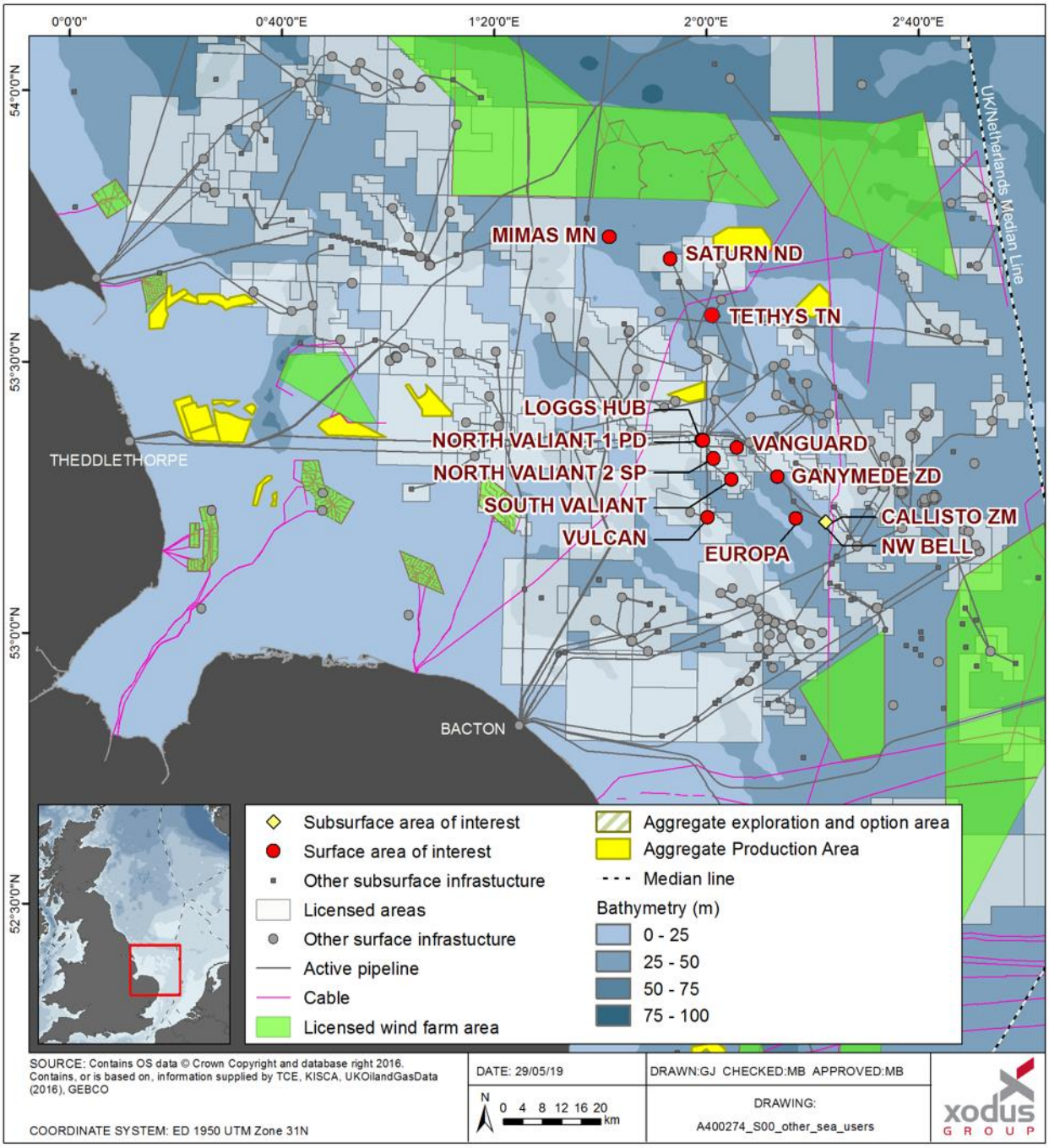
Figure 4-9 Other users in the vicinity of the LDP2 – LDP5 infrastructure



4.7 Other Users

The nearest non-Chrysaor field is the Leman Field and its 33 platforms, located approximately 4 km to the south. Renewable energy developments (specifically wind farms) and aggregate extraction areas are also prevalent in this area of the SNS (Figure 4-9).

4.8 Shipping

Shipping density in the southern North Sea in the vicinity of the proposed decommissioning activities is medium, reaching very high closer to the Norfolk coastline. Average densities range from 0.2 vessels up to approximately 250 vessels per week (DECC, 2016).

A review of AIS data dating from April to July 2017 allowed the identification of shipping routes within the Project area, including merchant vessels over 300 tonnes and fishing vessels of 15 m length and over. The AIS tracks were filtered to remove oil & gas traffic working at nearby fields (including LOGGS), as well as fishing vessels and recreational vessels, which were analysed separately (Figure 4-10 and Figure 4-11). The AIS tracks after filtering are shown on Figure 4-12. It is noted that oil and gas vessels on passage to/from the nearby fields were retained in the analysis. This allowed identifying the main vessel types passing through the Project area, which are cargos (49%), tankers (20%), oil and gas (17%) and passenger vessels (8%).

Figure 4-10 Fishing vessel tracks within 10nm of the LOGGS Area (Anatec, 2017)

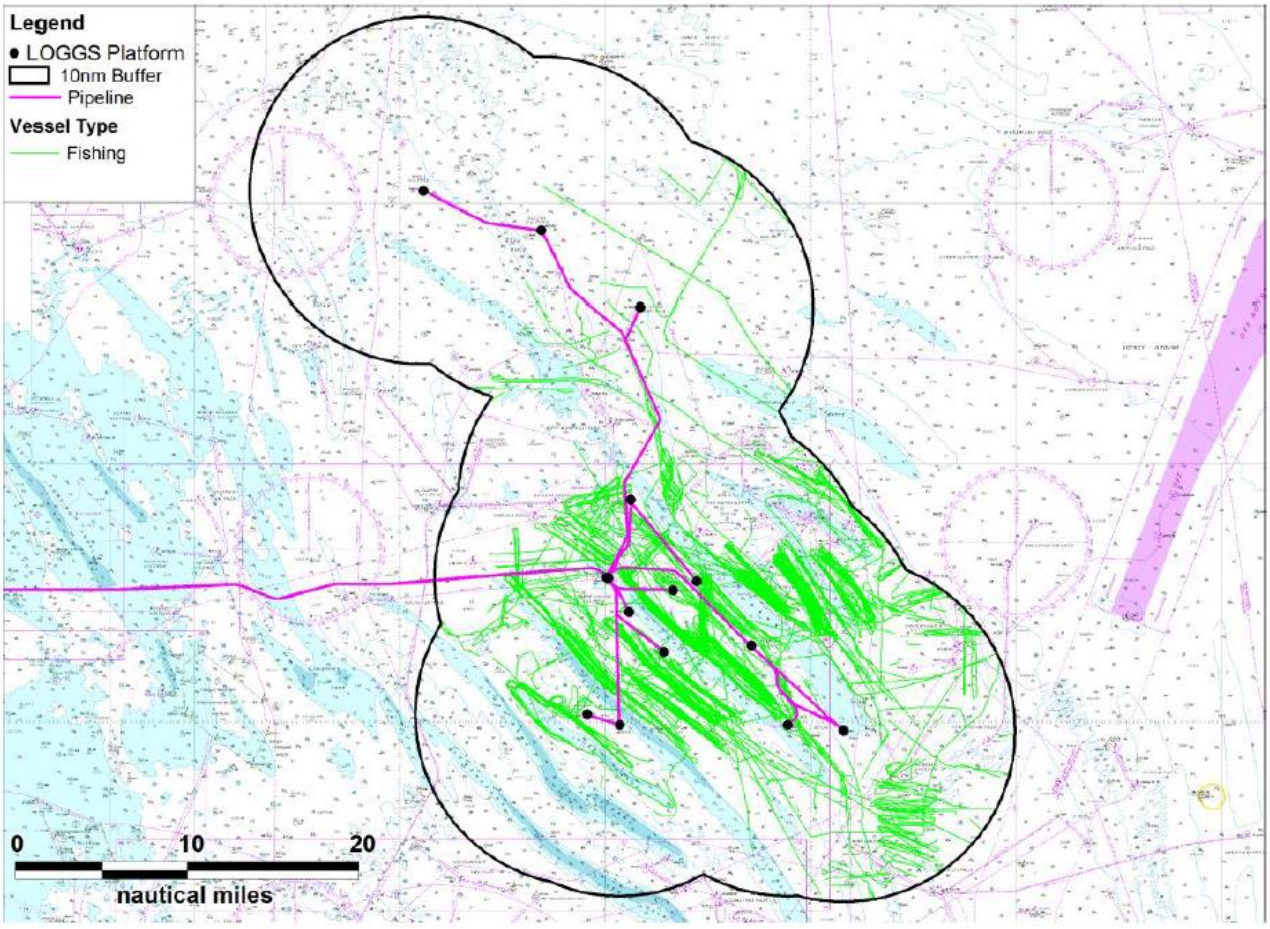


Figure 4-11 Recreational vessel tracks within 10nm of LOGGS Area (Anatec, 2017)

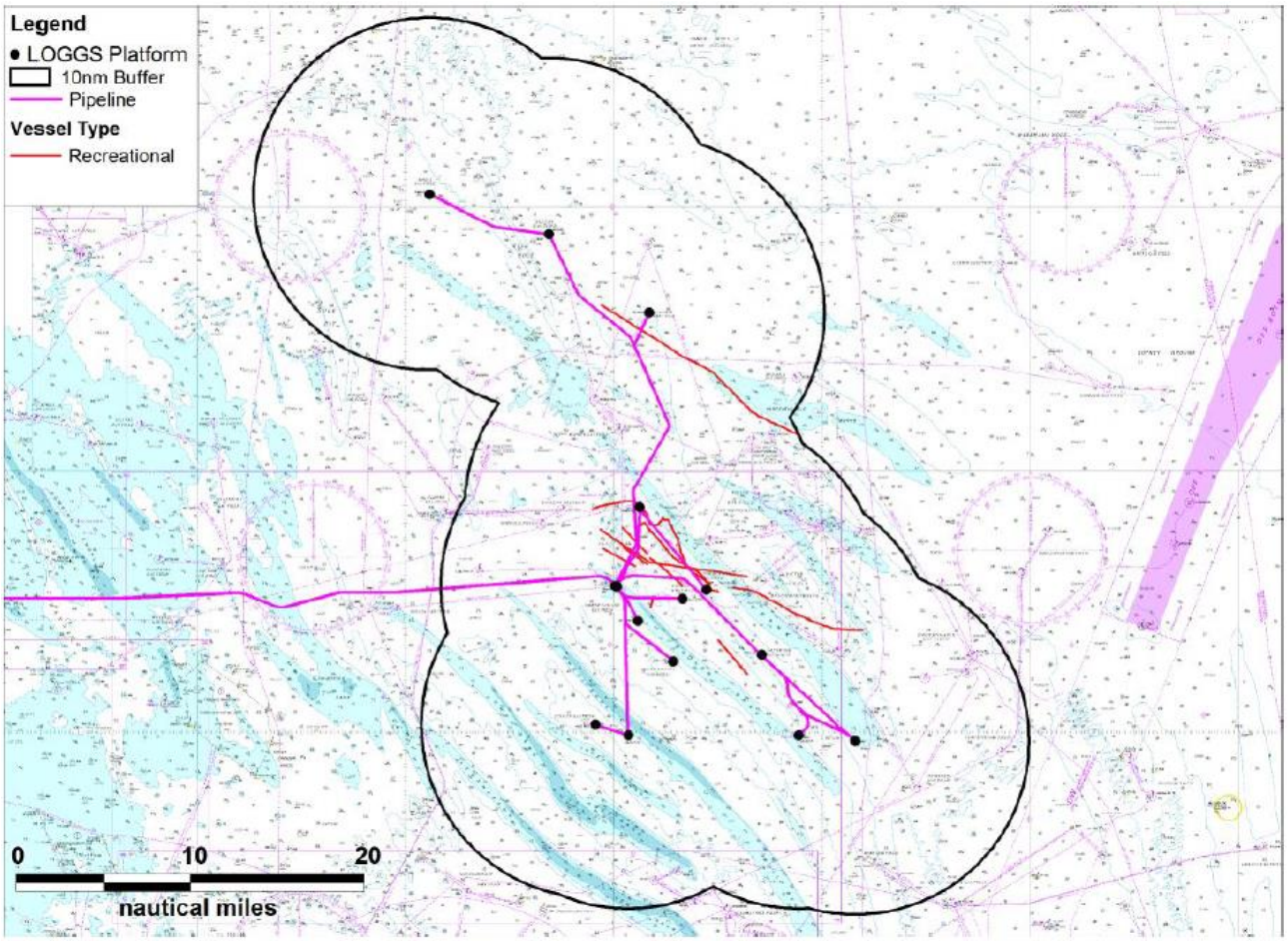
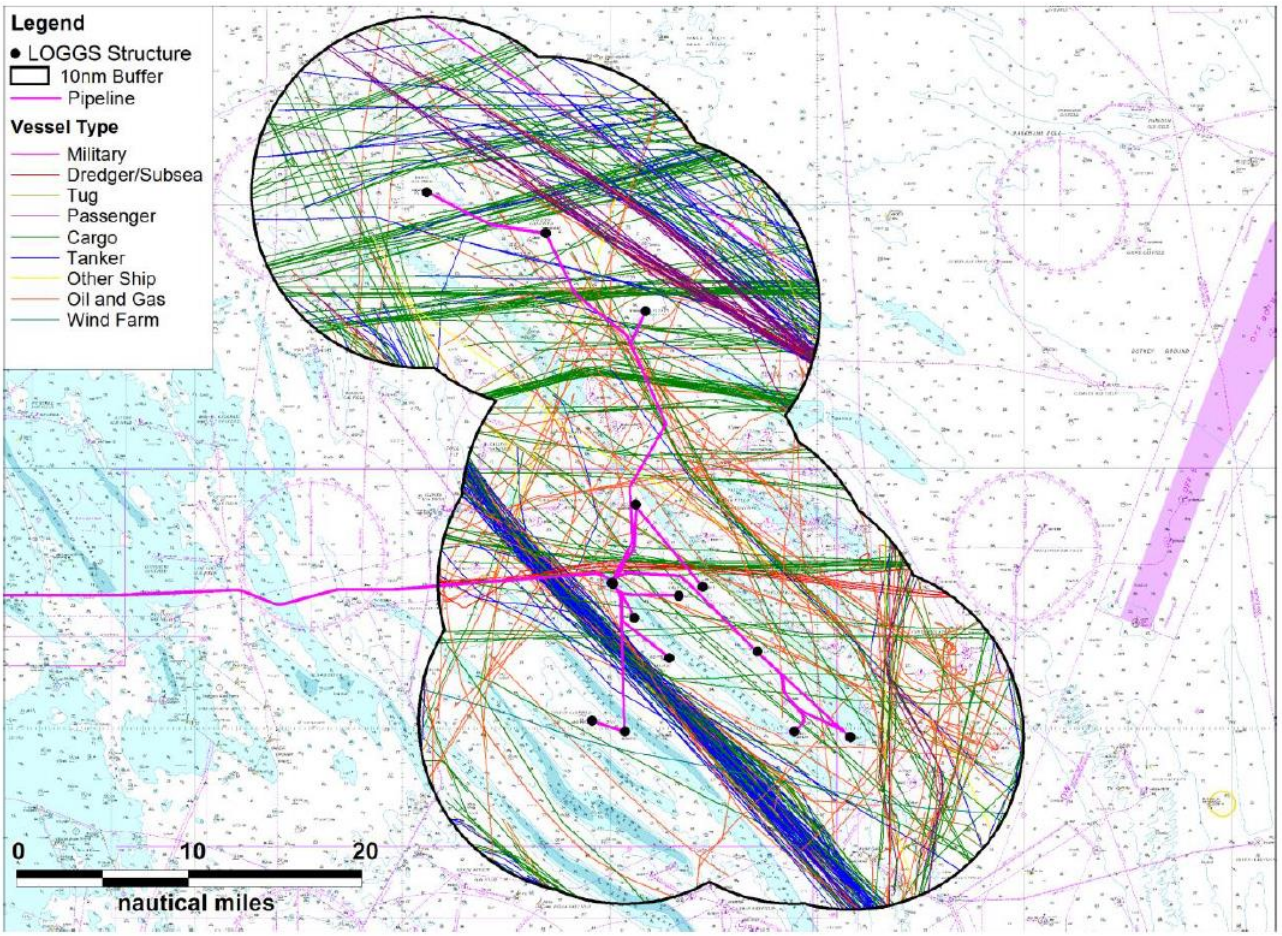


Figure 4-12 Passing vessels tracks within 10 nm of the LOGGS Area (excluding non-passing offshore, fishing and recreational) (Anatec, 2017)



4.9 Telecommunications

The Tampnet telecommunications cable passes 28 km east of the LOGGS Hub. It is very unlikely that there will be any interaction with this cable during decommissioning activities.

4.10 Military activities

A Ministry of Defence (MoD) area combat training zone is partially located within the decommissioning area. This MoD site is a designated Practice and Exercise Area (PEXA), wherein surface danger and firing danger areas are located. Given the concern for potential interference with MoD activities, the OGA has attached the following special condition to licensing applications occurring in these blocks:

"*The Ministry of Defence (MoD) must be notified, at least twelve months in advance, of the proposed siting of any installation anywhere within Blocks(s) 48/1 and 47/5, whether fixed to the seabed, resting on the seabed or floating, that is intended for drilling for or getting hydrocarbons, or for fluid injection. MoD will, within thirty days of receipt of such notification, either notify the Licensee that it is content with this location or else notify it that an MoD activity at the location would require re-siting of the installation from the requested location. In the case of potential difficulties identified either by*

MoD or by the Licensee, discussion should be held between the parties within three months of the original notification with a view to achieving a mutually acceptable location."

4.11 Wrecks

No designated historical wrecks have been recorded in the area; however, there are nine non-designated wrecks, and seven of these are classified as dangerous. However none of these are situated in direct contact with the infrastructure or the proposed decommissioning footprint. There are no known sites of archaeological significance, including wrecks, in the immediate vicinity of the LDP2- LDP5 infrastructure.

5.0 Impact Assessment

5.1 Seabed

5.1.1 Introduction

This section discusses the potential environmental impacts associated with seabed interaction resulting from the proposed LDP2 – LDP5 decommissioning activities. The measures planned by Chrysaor to minimise these impacts are detailed in Section 5.1.5.

The decommissioning activities have the potential to impact the seabed in the following main ways:

- Direct impact through[1]:
  - Removal of subsea infrastructure;
  - Presence of subsea infrastructure left *in situ*;
  - Excavation and cutting of pipeline ends;
  - Rock-placement for pipeline/umbilical termination points , and
  - Rock inclusive of spud cans for Ancillary Work Vessels.

- Indirect impacts through:
  - Re-suspension and re-settling of sediment;
  - Influence of sand movement and scour, and
  - Footprint of remaining infrastructure.

5.1.2 Description and quantification of potential impacts

In order to assess the impacts of the proposed activities, the area of potential disturbance must be quantified. The area of direct disturbance expected for each activity is presented in Table 5-1 to Table 5-6 and summarised in Table 5-7. Areas where decommissioning activities overlap have been accounted for, ensuring that the extent of impact is not unrealistically overestimated.

Jacket removal

As the weight (in air) of the LDP2 – LDP5 jackets are <10,000 tonnes, they fall within the OSPAR 98/3 category of steel structures for which derogation cannot be sought. Therefore, the only option available for these 14 platforms is full removal, as presented in Section 2.1.

The piles on all 14 jackets will be removed to approximately 3 m below the seabed and should be suitable for removal via internal cutting methods. However, access will only be confirmed when

[1]. No overtrawl surveys will be undertaken within any designated sites. Chrysaor will liaise with stakeholders in regard to the most suitable type of survey.

internal inspections are completed for all platforms. The excavation of an area around each jacket pile has therefore been considered here as a worst-case scenario.

If excavation of the footings is needed, removal of the 14 jackets under LDP2 – LDP5 will directly impact the seabed, which is quantified in Table 5-1. Sediment will likely be removed by a mass flow excavator and will be deposited down-current of the jacket piles, where it will undergo natural dispersal which will be transient in nature. As these processes are similar to normal processes in the southern North Sea (as discussed in Section 5.1.3), their impact has not been considered further.

For the majority of the platforms a DP vessel will be deployed, however for four of the platform locations a jack-up vessel will be required to undertake the lift (Vulcan RD, Saturn ND, Mimas MN and Tethys TN). The additional footprint of impact at each location is 0.000785 km^2, based on four legs with each leg utilising 0.000196 km^2, the lift contractor has undertaken preliminary assessments and no rock deposits are required for locating the HLV on site at these locations.

Table 5-1 Potential direct impact area on seabed as a result of jacket removal

Structure	Dimensions[1]	Total direct seabed impact (km^2)[2]	Decommissioning Programme	Located within Designated site
Europa EZ	154 m^2 x 4 piles	0.0006	LDP3	NNSSR SAC
Ganymede ZD	154 m^2 x 4 piles	0.0006	LDP3	NNSSR SAC, SNS SAC
LOGGS Hub PA	154 m^2 x 4 piles	0.0006	LDP5	NNSSR SAC, SNS SAC
LOGGS Hub PC	154 m^2 x 8 piles	0.0012	LDP5	NNSSR SAC, SNS SAC
LOGGS Hub PP	154 m^2 x 8 piles	0.0012	LDP5	NNSSR SAC, SNS SAC
LOGGS Hub PR	154 m^2 x 4 piles	0.0006	LDP5	NNSSR SAC, SNS SAC
Mimas MN	154 m^2 x 3 piles 196.3 m^2 x 4 legs	0.0013	LDP2	SNS SAC
North Valiant 1 PD	154 m^2 x 4 piles	0.0006	LDP5	NNSSR SAC, SNS SAC
North Valiant 2 SP	154 m^2 x 4 piles	0.0006	LDP4	NNSSR SAC, SNS SAC
Saturn ND	154 m^2 x 3 piles 196.3 m^2 x 4 legs	0.0013	LDP2	No
South Valiant TD	154 m^2 x 4 piles	0.0006	LDP4	NNSSR SAC, SNS SAC

Structure	Dimensions[1]	Total direct seabed impact (km^2)[2]	Decommissioning Programme	Located within Designated site
Tethys TN	154 m^2 x 3 piles 196.3 m2 x 4 legs	0.0013	LDP2	SNS SAC
Vanguard QD	154 m^2 x 4 piles	0.0006	LDP4	NNSSR SAC, SNS SAC
Vulcan (1) RD	154 m^2 x 4 piles 196.3 m2 x 4 legs	0.0014	LDP4	NNSSR SAC, SNS SAC
TOTAL		**0.0125**		

[1]Dimensions excavated were based on the worst-case assumption of a 14 m diameter pit centred on each pile.
[2]Where two sites are listed this is the same area in each as the sites overlap.

AWV location and stabilisation

The AWV works in the LOGGS area are now complete. For the purposes of preparing the EA, the use of a jack-up AWV was assumed to be required next to the 14 platforms, to provide extra accommodation space for the work force during decommissioning activities. The AWV uses four spud cans to support the vessel on the seabed. Each deployment of the AWV is estimated to impact an area of 120 m^2 of seabed. The AWV did not require anchors at any location in VDP1-VDP3 or LOGGS LDP1-LDP5.

Whilst there was no requirement for rock placement underneath the jack-up legs, owing to the possibility of scour whilst on location a contingency deposit of 1000 tonnes of graded rock (size ranging from 5 to 20 cm in diameter) was assumed at each location. Seabed disturbance resulting from contingency rock placement would exceed that of the spud cans.

The worst-case deposits profile suggested a total area of approximately 1,100 m^2 would be directly affected by rock placement activities at each platform.

The use of the AWV within the LDP2 – LDP5 scope has concluded with only seven locations being visited and zero contingency rock deposits made.

In addition, the current rock-pads at Vanguard QD and South Valiant TD need to be redistributed as the current configuration isn't suitable for the jack-up vessel being proposed. This will have an impact are of 393 m^2 at Vanguard QD and 1,288 m^2 at South Valiant TD.

Table 5-2 Potential direct impact area on seabed as a result of AWV location and stabilisation to facilitate well abandonment

Activity	DP	Deployments	Direct seabed impact (km^2)	Seabed impact split by designated site[2]	
				Direct impact on SNS SAC (km^2)	Direct impact on NNSSR SAC (km^2)
AWV jack-up using spud-cans 14 platforms x 120 m^2	LDP2	3	0.00036	0.00024	-
	LDP3	2	0.00024	0.00012	0.00024
	LDP4	4	0.00048	0.00048	0.00048
	LDP5	5	0.0006	0.0006	0.0006
		Total	0.00168	0.00144	0.00132
AWV rock-placement as part of footprint stabilisation 14 platforms x 1,100 m^2	LDP2	3	0.0033	0.0022	-
	LDP3	2	0.0022	0.0011	0.0022
	LDP4	4	0.0044	0.0044	0.0044
	LDP5	5	0.0055	0.0055	0.0055
		Total	0.0154	0.0132	0.0121
Rock pad redistribution		LDP4	0.001681	0.001681	0.001681
TOTAL (total only including rock-placement as the spud cans are within this area)			**0.01708**	**0.016321**	**0.015101**

Additional notes, for the purposes of the assessment where the use of rock is required to cover cut pipeline ends, any berms will be overtrawlable as per design and will not be subject to any further mechanical processes or redistribution.

Subsea structures including wellheads, manifolds and tees removal

As discussed in Section 2.1, the recommended option for decommissioning subsea structures of this type is full removal, which has been assumed during the scoping process of the Comparative Assessment (Xodus Group, 2019).

Removal of wellhead, manifolds and tees (with associated mattresses and grout bags) will directly impact a seabed area of 0.0032 km^2, as quantified in Table 5-3.

There are fronded mattresses within the LOGGS decommissioning area (including LDP2 and LDP4) that are of fronded mattresses consisting of a concrete base. The burial status to be determined during decommissioning works. The expectation is that the fronded mattresses will mostly be buried and indistinguishable from the seabed and have not been included in the impact assessment totals.

[2]The SNS SAC and the NNSSR SAC overlap, therefore the total presented in the direct impact seabed column cannot be obtained by adding up the total impacts presented for each SAC.

Table 5-3 Potential direct impact area on seabed as a result of subsea structure removal

Structure	Dimensions (m)	Direct seabed impact from structure (km^2)	Number of piles	Area of impact from excavation of piles (km^2)	Worst-case area of impact (km^2)[2]	Decommissioning Programme	Located within designated site
NW Bell Manifold[1]	2.38 x 2.38	0.00016	4	0.0006	0.0006	LDP3	NNSSR SAC
Callisto ZM Manifold[1]	13.4 x 13.4	0.00018	4	0.0006	0.0006	LDP3	NNSSR SAC
Sinope Tee Structure	12.0 x 6.0	0.000072	4	0.0006	0.0006	LDP3	NNSSR SAC
Sinope Pigging Skid	10.0 x 7.5	0.000075	0	0	0.000075	LDP3	NNSSR SAC
Tethys TN Tee Structure	13.0 x 6.0	0.000078	0	0	0.000078	LDP2	SNS SAC
Tethys TN 10" (PL2334) valve skid	2.8 x 2.0	0.0000056	0	0	0.0000056	LDP2	SNS SAC
Tethys TN 3" (PL2335) valve skid	1.5 x 0.5	0.00000075	0	0	0.00000075	LDP2	SNS SAC
PL454 Tie-in Tee Structure 1	6m x 13m	0.00008	4	0.0006	0.0006	LDP5	NNSSR SAC
PL454 Tie-in Tee Structure 2	23.4 x 16.4	0.00008	4	0.0006	0.0006	LDP5	No
TOTAL					**0.0032**		

[1] Subsea development with a wellhead and a manifold located under a wellhead protective structure.
[2] Worst-case calculated from largest impact for each structure. Area of excavation for piles is expected to overlap direct impact of structure on seabed.

Rock placement over pipeline/umbilical ends

As part of pipeline/umbilical decommissioning[3], an estimated 5 m will be removed from the satellite ends of each pipeline/umbilical, leaving some of the infrastructure exposed, this is expected to disturb the seabed 5 m either side of the cut pipeline/umbilical (i.e. 10 m wide in total) leading to an area of 50 m^2 being potentially disturbed. As some of the pipelines/umbilicals are buried, sediment will be excavated by a work class ROV and will be deposited down-current of the pipeline/umbilical ends, where it will undergo natural dispersal which will be transient in nature. As these processes are similar to normal processes in the southern North Sea their impact has not been considered further.

Chrysaor intends to place rock over the cut pipeline/umbilical ends where natural remediation and backfill not practical. The purpose of the rock is to protect any marine users, particularly fishermen using benthic gear, on a snagging hazard. The intent is to minimise the introduction of hard substrate into the marine environment. Where the pipeline/umbilical is on the seabed and is not buried, the berm will be produced based on a 3:1 profile providing a burial depth over the top of the pipeline/umbilical to at least 0.6 m. This tapered rock berm will have estimated footprints ranging from 13 m^2 to 22 m^2. The estimated worst-case mass of rock-placement required for the burial of each cut pipeline/umbilical end is 25 tonnes, this is based on an average of 16.2 tonnes and a 50% contingency to account for variation at each of the locations. The potential direct seabed impact area due to cutting pipeline/umbilical ends and associated rock placement is presented in Table 5-4.

Where pipeline/umbilical ends are already buried, the intention would be to excavate to allow access for the cut, the pipeline/umbilical end would then be covered to a height of 0.6 m (includes any height of rock) above the top of the pipeline/umbilical and any remaining trench would be left to naturally backfill. This is expected to occur in a relatively short time (as discussed in Section 5.1.3.1) as a result of the dynamic seabed conditions present across the decommissioning areas.

[3] Pipelines are being removed upto the point of burial not the minimum required for heavy lift.

Table 5-4 Potential direct impact area on seabed as a result of rock placement over cut pipeline/umbilical ends

Structure	DP	Total direct seabed impact (km^2)	Total direct impact on SNSSAC (km^2)	Total direct impact on NNSSR SAC (km^2)
Excavation and cutting of pipeline/umbilical ends 50 m^2 per site	LDP2	0.0003	0.0002	0.00005
	LDP3	0.0006	0.0002	0.0006
	LDP4	0.0004	0.0004	0.0004
	LDP5	0.0002	0.0001	0.0001
Total direct impact for all DPs		**0.0015**	**0.0009**	**0.00115**
Rock placement on pipeline/umbilical ends 25 tonnes (13.3 m^2 average) per site	LDP2	0.0000798	0.0000532	0.0000133
	LDP3	0.0001596	0.0000532	0.0001064
	LDP4	0.0001064	0.0001064	0.0001064
	LDP5	0.0000532	0.0000266	0.0000266
Total direct impact for all DPs		**0.000399**	**0.0002394**	**0.0002527**
TOTAL		**0.0015**[1]		

[1] Rock placement area is within the excavation and cutting area and so has not been added to total seabed impact area.

Pipelines, umbilicals, grout bags and mattresses decommissioned in situ or removed

Following the removal of 5 m of pipeline from each of the cut ends, the remaining pipelines/umbilicals and associated support materials will be either decommissioned *in situ* or fully/partially removed. Table 5-5 presents the approximate footprint of seabed affected by decommissioning the pipelines/umbilicals (and any stabilisation materials) *in situ* or by partial removal, assuming a 10 m corridor (5 m each side) around each gas pipeline and umbilical. The 10 m wide corridor takes account of any pipeline/umbilical stabilisation features (mattresses and grout bags) and any excavation works.

Table 5-5 Footprint remaining on seabed as a result of pipeline/umbilical decommissioning *in situ* and alternative option to fully remove the pipelines/umbilical between NW Bell and Callisto and Ganymede ZD – Callisto ZM Umbilical

Pipeline/umbilical decommissioning options	DP	Dimensions	Footprint (km^2)	Remaining infrastructure split by SAC/SPA[1]				
				Area within the SNS SAC (km^2)	Area within NNSSR SAC (km^2)	Area within Inner Dowsing, Race Bank and North Ridge SAC	Humber Estuary SPA (km^2)	Greater Wash SPA (km^2)
Partial removal Group 7	LDP3	0.150 km x 0.01 km	0.0015	-	0.0015	-	-	-
Full removal of Group 2 umbilical	LDP3	0.160 km x 0.01 km	0.0016	-	0.0016	-	-	-
Pipelines Decommissioned in situ	LDP2	60.6 km x 0.01 km	0.606	0.5289	0.2666	-	-	-
	LDP3	52.32 km x 0.01 km	0.5232	0.1893	0.5184	-	-	-
	LDP4	38.5 km x 0.01 km	0.385	0.3848	0.3417	-	-	-
	LDP5	236.6 km x 0.01 km	2.366	0.3790	0.5266	0.3867	0.01374	0.5253
Total	**LDP2-LDP5**	**388.33 km x 0.01 km**	**3.88**	**1.4820**	**1.6965**	**0.3867**	**0.01374**	**0.5253**

[1] These totals represent the area within each specific designated site, however a number of the sites overlap each other.

Rock placement along reported spans

A span on a pipeline is where the seabed sediments have been eroded, or scoured away and the pipeline is no longer supported on the seabed. All spans are a type of exposure, however not all exposures will mean that the pipeline is not supported on the seabed.

There are two Fishsafe reportable spans known in the Decommissioning area. One of the reportable spans is located at KP2.183 on the LOGGS PP to MLWM gas export trunk line (PL454) and the second reportable soon is located at KP0.544 on the Vanguard QD to LOGGS PP gas export line (PL456).

The two known spans are intended to be left in their current state and monitored for any change overtime. If change in burial state is observed, then discussions will be held with OPRED to discuss the appropriate level and method of remediation.

FishSAFE reportable spans are only to be remediated with rock placement pending discussions with the regulator, no rock placement is planned.

Overtrawl surveys post-decommissioning

It should be noted that overtrawl survey techniques along the pipeline corridors has not been assessed as a large number of the pipelines are situated in the NNSSR SAC and the SNS SAC representing an undesirable impact the designated features also no overtrawling occurs within the Inner Dowsing, Race Bank and North Ridge SAC, the Humber Estuary SPA or the Greater Wash SPA.. Therefore, the primary method for post-decommissioning surveys shall be visual inspections using non-intrusive methods. The extent and technique for surveying pipeline corridors is to be agreed with OPRED.

Similarly, appropriate survey techniques will be adopted within the installation 500 m safety zones and subsea installation locations to verify and assure that the seabed has been left in a condition that does not present a hazard for commercial fishing.

No overtrawl activities will be undertaken along pipeline corridors or within sites designated to protect seabed features or supporting habitats. Consideration has been given as a worse case for the potential overtrawl of the 500 m safety zone around the Saturn platform which sits outside of any designated sites. Table 5-6 presents the total potential seabed impact due to overtrawl surveys.

Table 5-6 Potential direct impact area on seabed as a result of overtrawl surveys

Activity	Dimensions	Total direct seabed impact (km^2)	Decommissioning Programme
Overtrawl surveys of, subsea installations	Platforms and subsea installations – (1 installation) x 500 m radius	0.79	LDP2
TOTAL		**0.79**	

Summary

Table 5-7 summarises the estimated potential seabed impacts associated with the decommissioning activities.

Table 5-7 Estimate of direct seabed impacts and footprint of remaining infrastructure post-decommissioning

Activity	DP	Total direct seabed impact during decommissioning activities (km^2)	Direct impact split by SAC[1]		Footprint of remaining infrastructure (km^2)	Footprint of remaining infrastructure split by SAC/SPA[1]				
			Direct Seabed impact in SNS SAC (km^2)	Direct seabed impact within NNSSR SAC (km^2)		Footprint of remaining infrastructure within SNS SAC	Footprint of remaining infrastructure within NNSSR SAC (km^2)	Footprint of Remaining infrastructure within Inner Dowsing, Race Bank and North Ridge SAC (km^2)	Footprint of Remaining infrastructure within Humber Estuary SPA (km^2)	Footprint of Remaining infrastructure within the Greater Wash SPA (km^2)
Presence of pipelines, umbilicals, grout bags and mattresses decommissioned *in situ* (Assumes 388.35 km x 0.01 km pipeline corridor including grout bags and mattresses within footprint)	LDP2	-	-	-	0.606	0.5289	0.2666	-	-	-
	LDP3	-	-	-	0.5232	0.1893	0.5184	-	-	-
	LDP4	-	-	-	0.385	0.3848	0.3417	-	-	-
	LDP5	-	-	-	2.366	0.3790	0.5266	0.3867	0.01374	0.5253
Partial removal of Group 7 pipelines	LDP3	0.0015	-	0.0015	-	-	-	-	-	-
Full removal of Group 2 pipelines	LDP3	0.0016	-	0.0016	-	-	-	-	-	-
Total for all pipelines		**0.0031**	**-**	**0.0031**	**3.88**	**1.4820**	**1.6533**	**0.3867**	**0.01374**	**0.5253**
Full removal of topsides	Not applicable									
Full removal of jackets	LDP2	0.0039	0.0026	0.0023	-	-	-	-	-	-
	LDP3	0.0012	0.0006	0.0012	-	-	-	-	-	-
	LDP4	0.0032	0.0032	0.0032	-	-	-	-	-	-
	LDP5	0.0042	0.0042	0.0042	-	-	-	-	-	-
Total		**0.0125**	**0.0106**	**0.0109**	-	-	-	-	-	-
AWV rock-placement as part of footprint stabilisation (Assumes 14 platform locations x 1,100 m^2).	LDP2	0.0033	0.0022	-	0.0033	0.0022	-	-	-	-
	LDP3	0.0022	0.0011	0.0022	0.0022	0.0011	0.0022	-	-	-
	LDP4	0.0044	0.0044	0.0044	0.0044	0.0044	0.0044	-	-	-
	LDP5	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055	-	-	-
Rock pad redistribution	LDP4[4]	0.001681	0.001681	0.001681	-	-	-	-	-	-
Total		**0.017081**	**0.014881**	**0.013781**	**0.0154**	**0.0132**	**0.0121**	**-**	**-**	**-**
Removal of nine subsea structures including wellheads, manifolds and tees	LDP2	0.000084	0.000084	-	-	-	-	-	-	-
	LDP3	0.001875	-	0.001875	-	-	-	-	-	-
	LDP4	-	-	-	-	-	-	-	-	-
	LDP5	0.0012	-	0.0006	-	-	-	-	-	-
Total		**0.0032**	**0.000084**	**0.002475**	**-**	**-**	**-**	**-**	**-**	**-**
Excavation and cutting of pipeline/umbilical ends	LDP2	0.0003	0.0002	0.0005	0.0005	-	-	-	-	-
	LDP3	0.0006	0.0002	0.0004	0.0004	-	-	-	-	-

[4] Rock Pad redistributions: Vanguard QD & South Valiant TD

Activity	DP	Total direct seabed impact during decommissioning activities (km²)	Direct impact split by SAC[1]		Footprint of remaining infrastructure (km²)	Footprint of remaining infrastructure split by SAC/SPA[1]				
			Direct Seabed impact in SNS SAC (km²)	Direct seabed impact within NNSSR SAC (km²)		Footprint of remaining infrastructure within SNS SAC	Footprint of remaining infrastructure within NNSSR SAC (km²)	Footprint of Remaining infrastructure within Inner Dowsing, Race Bank and North Ridge SAC (km²)	Footprint of Remaining infrastructure within Humber Estuary SPA (km²)	Footprint of Remaining infrastructure within the Greater Wash SPA (km²)
(Assumes 26 sites x 50 m²)	LDP4	0.0004	0.0004	0.0003	0.0003	-	-	-	-	-
	LDP5	0.0002	0.0001	0.0001	0.0001	-	-	-	-	-
Total		**0.0015**	**0.0009**	**0.0013**	**0.0013**	**-**	**-**	**-**	-	-
Rock-placement over pipeline/umbilical ends (Assumes 25 tonnes per site at 26 sites with a 13.3 m² average site footprint)	LDP2	0.000080	0.000053	0.000013	0.000080	0.000053	0.000013	-	-	-
	LDP3	0.000160	0.000053	0.000160	0.000160	0.000053	0.000160	-	-	-
	LDP4	0.000106	0.000106	0.000106	0.000106	0.000106	0.000106	-	-	-
	LDP5	0.000053	0.000027	0.000027	0.000053	0.000027	0.000027	-	-	-
Total		**0.000399[2]**	**0.000239**	**0.000306**	**0.000399**	**0.000239**	**0.000306**	-	-	-
Total from decommissioning operations above		**0.0378**	**0.0267**	**0.0319**	**3.897**	**1.4954**	**1.6657**	**0.3867**	**0.01374**	**0.5253**
Overtrawl surveys (around the Saturn Platform & Saturn Tee)	LDP2	0.79	-	-	-	-	-	-	-	-
Total from decommissioning operations including overtrawl surveys		**0.8278**	**0.0267**	**0.0319**	**3.897**	**1.4954**	**1.6657**	**0.3867**	**0.01374**	**0.5253**
Total broken down by DP	**LDP2**	**0.7976**	**0.0052**	**0.0028**	**0.6094**	**0.5312**	**0.5375**	-	-	-
	LDP3	**0.0092**	**0.0020**	**0.0089**	**0.5256**	**0.1905**	**0.9007**	-	-	-
	LDP4	**0.0099**	**0.0082**	**0.0097**	**0.3899**	**0.3893**	**0.7747**	-	-	-
	LDP5	**0.0113**	**0.0100**	**0.0104**	**2.3717**	**0.3846**	**0.5322**	**0.3867**	**0.01374**	**0.5253**

[1]The SNS SAC and the NNSSR SAC overlap, therefore the total direct impact value does not equal the values presented as the total for each footprint.
[2]Rock placement over pipeline/umbilical ends is within the excavation and cutting area, and disturbance due to AWV spud-cans is within rock-placement area as part of AWV footprint stabilisation.

5.1.3 Direct disturbance of seabed habitats during decommissioning activities

Sediment disturbance and re-distribution due to jacket and subsea infrastructure removal, and overtrawl surveys

Removal of the jackets and subsea infrastructure from the seabed will cause sediment disturbance and re-distribution in the localised area. The area of impact of is estimated to be 0.8278 km^2, including decommissioning activities and overtrawl surveys. It should be noted that there will be no overtrawl surveys undertaken along pipeline corridors or within sites designated to protect seabed features or supporting habitats. Consideration has been given as a worse case for the potential overtrawl of the 500 m safety zone around the Saturn platform which is located outside of any designated sites. Within the NNSSR SAC the area of impact is estimated to be 0.03258 km^2 and the area of impact for the SNS SAC is estimated to be 0.0267 km^2.

Sediments that are redistributed and mobilised as a result of the proposed decommissioning activities will be transported by the seabed currents before settling out over adjacent seabed areas. The marine environment in the southern North Sea is dynamic in nature, with wave energy at the seabed shown to be between 0.21 – 1.2 N/m^2 and increasing above 1.2 N/m^2 towards shore (McBreen *et al.,* 2011). The dynamic environment will result in suspended sediment, in particular the fines, being transported away from the source of the disturbance. The natural settling of the suspended sediments is such that the coarser material (sands) will quickly fall out of suspension with the finer material being the last to settle. This natural process will ensure that all the suspended sediment is not deposited in one location. Based on the mobility of the seabed in the area (Thompson *et al.,* 2011, McBreen *et al.,* 2011), as indicated by the lack of drill cuttings piles around wellheads within the SAC (Gardline, 2015a), the deposition resulting from the decommissioning activities is likely to be comparable to the background sediment redistribution processes. There has been no evidence of any of contamination from previous drilling at LOGGS this has been obtained from the review of site survey information (Gardline 2015a; Gardline 2015b). Therefore, Chrysaor do not anticipate there to be a risk of previous drill cuttings and contaminants being remobilised as a result of decommissioning operations.

In such a high energy area, the expected sediment recovery time from dredging activities is approximately within a year (Hill *et al.,* 2011). For example, areas of dredging on sandbanks which are subject to naturally high sediment mobility may disappear within a few tidal cycles (Hill *et al*., 2011). Following the removal of the Viking A installation and subsequent survey sediment infill of scouring depressions is evident (Gardline 2016). Infrequent, high-energy (storm) conditions will also result in sediment suspension and redistribution. Published calculations of wave and tidal current-induced bed shear stress, clearly show that the large waves have the capability to mobilise seabed sediments, increasing sediment suspension particularly for those sizes of coarse sands and smaller (ABPmer, 2010).

Long-term analysis at the Sean Gas Field in Block 49/25a (Thompson *et al*., 2011) suggests that wave conditions are strong enough to re-suspend medium sand all year round, with peaks indicating re-suspension 51% and 60% of the time in January and March, and generally increased potential re-suspension in the winter months from September to March. Following completion of the proposed activities, the natural physical processes of sediment transportation and natural backfilling are therefore expected to restore the seabed habitat to its equilibrium state within a year and will be qualified by post platform removals surveys.

Benthic disturbance and habitat loss due to removal of jackets, subsea infrastructure, overtrawl surveys and rock-placement

No overtrawl activities will be undertaken along pipeline corridors or within sites designated to protect seabed features or habitats. Consideration has been given as a worse case for the potential overtrawl of the 500 m safety zone around the Saturn installation which is located outside the designated locations in the southern North Sea.

Removal of the jackets and subsea infrastructure from the seabed will physically disturb the benthic fauna living on or in the sediment in the localised area. The area of impact is estimated to be 0.8278 km^2, which arises almost entirely (0.79 km^2) from overtrawl survey within the installation 500 m safety zone for the Saturn platform. Within the NNSSR SAC the area of impact is estimated to be 0.03258 km^2 in the SNS SAC the area of impact is expected to be 0.0267 km^2, however it should be noted that the majority of this overlaps with the area of the NNSSR SAC. No other designated sites are expected to be impacted by overtrawling or other decommissioning activities. The LOGGS to MLWM trunk line passes through the Inner Dowsing, Race Bank and North Ridge SAC, Greater Wash SPA and Huber Estuary SPA, however no decommissioning activities occur within this SAC as the pipeline is decommissioned *in situ*.

The proposed decommissioning activities will cause some direct impact to fauna living on and in the sediments. Mortality is more likely in non-mobile benthic organisms (attached epifauna, such as soft corals *(Alcyonium digitatum*), bryozoans (*Flustra foliacea*) or anemones (*Urticina felina*)) (Parry *et al*. 2015), whereas mobile benthic organisms are more sparsely distributed (as demonstrated from the pre-decommissioning surveys; Section 4.2) and may be able to move away from the area of disturbance. Attached epifauna was typically found on coarser sediment, which in turn is slightly more prevalent in troughs than on crests (particle composition on ridges is >80%, compared with 70-80% in troughs) Parry *et al*. 2015). More mobile sand habitats tend to be characterised by more robust faunas, dominated by organisms which are capable of rapid burrowing, such as mobile polychaete worms, burrowing amphipods and thick-shelled bivalves (DECC 2016). The biological communities present on the sandbanks are representative of the infralittoral mobile sand biotope. Species typical of this biotope include the polychaete worm *Nephtys cirrosa* and the isopod *Eurydice pulchra,* and the sandbanks within the SAC support very similar biological communities (JNCC website).

Upon completion of the subsea decommissioning activities, it is expected that the resettled sediment will be quickly recolonised by benthic fauna typical of the area. This will occur as a result of natural settlement by larvae and plankton and through the migration of animals from adjacent undisturbed benthic communities (Ernie *et al*., 2003). In a series of large-scale field experiments, Dernie *et al*., (2003) investigated the response to physical disturbance (sediment removal down to 10 cm) of marine benthic communities within a variety of sediment types (clean sand, silty sand, muddy sand and mud). Of the four sediment types investigated, the communities from clean sands had the most rapid recovery rate of between 0.45 – 0.6 individuals per day following disturbance.

Studies of seabed dredging sites indicate that faunal recovery times are generally proportional to the spatial scale of the impact (where the impact is between 0.1 m^2 and 0.1 km^2 (Foden *et al*., 2009). Biological recovery is therefore expected to be even quicker in less extensive, dynamic sandy habitats (Hill *et al*., 2011) such as those observed at the LDP2 – LDP5 sites. In low-energy areas of the North Sea subject to extensive dredging, local fauna took approximately three years to recover to the original level of species abundance and diversity). Tyler-Walters, Lear and Allen (2004) report that offshore circalittoral mixed sediments have a high recoverability following disturbance. Although the authors did not feel there were sufficient data to conclude on offshore circalittoral sand recoverability, all other similar habitats for which a recovery description was assigned were

considered to show moderate or high recoverability. In an evaluation of threats and impacts to circalittoral muddy sand and slightly mixed sediment (which is similar to that recorded in the Project area), Budd (2006) suggested that the threat from infrastructure installation offshore was low. Although substratum loss was deemed to cause decline of species in the area of direct footprint, species that inhabit this type of benthic habitat were deemed to be highly recoverable. Based on the dynamic characteristics of the seabed in the LDP2 – LDP5 areas, recovery would be expected to be at the lower end of this scale.

A small number of demersal and pelagic fish and their spawning grounds might also be temporarily disturbed by the removal of the structures. However, fish are highly mobile organisms and are likely to avoid areas of re-suspended sediments and turbulence during the activities. The potential release of contaminants from the sediments may affect the early life stages of some fish species. However, both metal and THC concentrations in the LDP2 – LDP5 area sediments are generally low (see Section 4.2) and the proposed activities will be localised. Therefore, the proposed activities are unlikely to have an impact on species populations or their long-term survival.

5.1.4 Footprint of remaining infrastructure impacts

Habitat change caused by introduced hard substrate due to rock-placement and decommissioning mattresses and grout bags in situ

The decommissioning activities will result in the introduction of approximately 0.016 km^2 of new hard substratum in the form of rock-placement[5]. Whilst this will be influenced by scour from tides and mobile sediments and may even become partially buried in places from time to time, it is likely that parts of it will eventually support a low-diversity epifaunal community typical of the scattered stones and cobbles already present in the area. Survey work (Gardline, 2015a, 2015b) has indicated that such communities are characterised by sessile species such as the bryozoan *Flustra foliacea* and potentially the polychaete *Sabellaria spinulosa*, and mobile forms such as the starfish *Asterias rubens* and *Crossaster papposus*, hermit crabs and swimming crabs, and the common sea urchin *Echinus esculentus*. The introduction of the proposed rock will not change the character of the species typically present in the area as a whole.

The decommissioning of the mattresses and grout bags *in situ* will reduce the amount of additional rock placement material needed to be introduced into the SNS SAC and NNSSR SAC. If mattresses and grout bags were to be removed, further stabilisation material (rock-placement) would need to be added to the pipelines to ensure the stability and burial of the pipelines is maintained in this highly dynamic marine environment.

Seabed morphological change due to presence of rock placement, support structures and pipelines/umbilicals decommissioned in situ

The long-term presence of the pipelines, existing support materials and the introduction of rock for the pipeline ends and in a worst case scenario to remediate free-spans, could influence sediment dynamics in the LDP2 – LDP5 areas. The rate at which sandbanks are reported to move varies depending on their location. It has been estimated that at the rate that the Norfolk sandbanks (an example of a system of open shelf linear sand banks) move it could take in excess of 100 years for the sandbanks to move 100 m (Cooper *et al*. 2008). Although, movements of between 11 m and 15 m/year are also known to occur (ABPmer, 2005, Cooper *et al*., 2008). The Norfolk Banks extend from active, sinuous inshore banks near the Norfolk coast to the active, linear banks. The outermost

[5] Rock placement due to covering cut pipeline/umbilical ends.

banks of this group have low slopes and are regarded as moribund (Kenyon et al 1981). At these outermost banks, sand movement will be low. A comparison of charts of the Norfolk Banks between 1956 and 1980 showed all the banks extended their tails to the NW and most banks extended their heads to the SE. The Swarte Bank and Broken Bank moved to the SW whereas the majority moved to the NE (ABPmer, 2005). Surveys of Ower Bank (reported in Johnson and Caston 1984, in ABPmer, 2005) show an uneven NE movement, (the direction of the steeper slope) that had a maximum of 40 m/year, but was typically about 15 m/year. At these relatively slow rates of movement, any possible effect the physical presence of rock may potentially have on the mobility of the sandbank feature would be difficult to detected. Modelling suggests that circular depressions, of the sort that might be generated by decommissioning activity, on linear banks and sinuous banks will elongate and deepen over time (Roos & Hulscher, in ABPmer, 2005). Scour, such as that which may be generated by placed rock, was found to be minimal. There was considered to be little scope for “cumulative” scour which would be likely to alter the equilibrium conditions of the sandbank at windfarms where normal distance between turbines is maintained (Cooper & Beiboer, 2002). It is likely that rock placement in the decommissioning zone will be at least as well spaced.

To assess the potential for long-term cumulative impacts on sediment dynamics from installed pipelines and associated support structures, Chrysaor commissioned an independent review of pipeline route inspection data at points along four pipelines, including where they cross the Swarte Bank sandbank (Senergy Floyds, 2008). Sidescan sonar data was collected from pipelines that had been in place for between 3 and 37 years and was examined for evidence of exposed pipelines, and of any apparent damage or alteration to the form and function of the sandbank. Seabed surface features such as ripple marks were recorded and appear to continue uninterrupted across the sediment overlying the pipelines (Senergy Floyds, 2008). These results indicate that the presence of the LDP2 – LDP5 pipelines, mattresses and grout bags are unlikely to compromise the integrity of the NNSSR SAC. Furthermore, the presence of monopiles as part of Scroby Sands Wind Farm, which is located in a highly mobile sandbank environment, have not been shown to influence the overall form and function of the sandbank (Cefas, 2006).

Bathymetry and seabed data collected during pre-decommissioning baseline environmental surveys show evidence of megaripples in a north-easterly elongation across each platform area. The continuation of these megaripples in areas containing a platform and pipelines suggests that small scale installations such as these do not present barriers to sandbank maintenance or formation. As such, it is not expected that the elongation and subsequent structure of the sandbanks that JNCC (2017a) report to be occurring would be compromised by the proposed decommissioning activities.

The Inner Dowsing, Race Bank and North Ridge SAC, Humber Estuary SPA and the Greater Wash SPA also contain infrastructure that is to be decommissioned *in situ.* All subsea structures are located within either the SNS SAC or NNSSR SAC and the associated footprints have been highlighted in Table 5-3. The Inner Dowsing, Race Bank and North Ridge SAC, Humber Estuary SPA and the Greater Wash SPA only contain pipeline infrastructure which is being decommissioned *in situ*. There are no direct decommissioning activities expected within these sites and therefore no likely significant effects.

Impact on sediment and benthos due to subsea infrastructure breakdown

Structural degradation of the pipeline and mattresses in the LDP2 – LDP5 areas will be a long-term process caused by corrosion and the eventual collapse of the pipelines under their own weight and that of the overlying mattresses, pipeline coating material, scale and sediment. 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:

- Pipeline scale;
- Steel;
- Sacrificial anodes;
- Coal tar enamel coating;
- Concrete coating; and
- Plastic coating.

Note: pipeline contents will be limited to treated seawater and are not discussed further herein.

Heavy metals

Metals with a relatively high density or a high relative atomic weight are referred to as heavy metals. It is expected that these metals will be released into the sediments and water column during the breakdown of the components of the pipeline scale, steel and sacrificial anodes.

The toxicity of a given metal varies between marine organisms for several reasons, including their ability to take up, store, remove or detoxify these metals (Kennish, 1997). Concentrations of the metals are not expected to exceed acute toxicity levels at any time. However, chronic toxicity levels may be reached for short periods within the interstitial spaces of the sediments or in close proximity to the pipelines. At these levels, heavy metals act as enzyme inhibitors, adversely affect cell membranes, and can damage reproductive and nervous systems. Changes in feeding behaviour, digestive efficiency and respiratory metabolism can also occur. Growth inhibition may also occur in crustaceans, molluscs, echinoderms, hydroids, protozoans and algae (Kennish, 1997). It is expected that any toxic impacts will be short lived and localised with minimal potential to impact populations of marine species. The potential for uptake and concentration of metals would also be limited to the local fauna and due to the slow release of these chemicals not likely to result in a significant transfer of metals into the food chain.

A benthic species of concern in the area is *S. spinulosa*. Some practitioners consider *S. spinulosa* relatively insensitive to metal or chemical contaminants (Holt *et al*., 1998), although direct evidence is limited. Studies of the response of *S. spinulosa* to an outfall from a bromide extraction works containing free halogens (Hoare and Hiscock, 1974) suggest that it is generally tolerant of changes in water quality (UK Biodiversity Group, 1999). A further study by Walker and Rees (1980) recorded that down-tide of a sewage discharge in Dublin Bay *S. spinulosa* was present in greater densities and diversities than elsewhere in the bay, indicating a level of tolerance for environmental change.

Given its few key environmental requirements, and its tolerance of poor water quality, *S. spinulosa* is naturally common around the British Isles. A good supply of sand grains put into suspension by strong water movement (either tidal currents or wave action) such as that found in the North Norfolk Sandbanks and Saturn Reef SAC, is thought to be essential for tube building (JNCC, 2007). *S. spinulosa* are also known to have life history strategies which enable them to exist in variable or unpredictable environments, responding to suitable conditions with a high rate of reproduction and rapid development (Krebs, 1985, MacArthur and Wilson, 1967).

The slow release of the metals associated with the pipeline steel and steel associated with the concrete coating and mattress protection is expected to have a negligible impact on the local environment. It is anticipated that failure of the pipelines due to through-wall degradation would only begin to occur after many decades (of the order of 60 to 100 years) (HSE, 1997).

Along buried pipeline corridors there may be accumulations of heavy metals in the sediments. Where present, the finer fraction of these sediments (silts and clays) are likely to form bonds with these metals, making them less bioavailable to marine organisms. The sandy (coarser fraction) of the sediments surrounding the pipelines are less likely to retain metals (MPE, 1999). Much of the surrounding seabed is composed of sand and will therefore release any metals to the surrounding seawater, making them bioavailable, but also diluting them into the wider environment.

Due to the highly localised nature of any degradation products and the low concentrations of contaminants being released over an elongated period it is highly unlikely that these products will be detectable above current background conditions in the area given proximity to production assets or the run-off via the Humber Estuary. As a result no likelihood of significant effect is expected to the Inner Dowsing, Race Bank and North Ridge SAC, SNS SAC, Humber Estuary SPA or the Greater Wash SPA.

Naturally Occurring Radioactive Material (NORM)

The presence of NORM was reported in the scale taken from LOGGS infrastructure. The radiochemical analysis recorded the presence of radium-226, actinium-228, polonium-210, lead-210 and thorium-228. The most significant radioactive element in NORM scale and produced water is radium (Ra) and in particular the stable isotope ^{226}Ra which has a half-life of 1,620 years (OGUK, 2015b). Marine organisms can potentially bioaccumulate radium from solution in seawater, from ingested seabed sediments or from their food. Studies of the impacts of ^{226}Ra released into the North Sea via produced water and natural processes indicate that it is unlikely that observed levels of radioactive substances entrained in sediments or found in seawater will cause effects on marine organisms (Hylland and Erikson, 2013).

NORM scale discharged from offshore installations is known to be insoluble in seawater and when produced water rich in barium and radium is discharged to sulphate rich seawater, the radium precipitates rapidly as a complex of barium, radium and sulphate which is also insoluble. ^{226}Ra therefore has a very low concentration in solution in seawater and has a low bio-availability to marine organisms. Dissolved cations in seawater, particularly calcium and magnesium, also inhibit the bioaccumulation of NORM (OGUK, 2015b).

Due to the highly localised nature of any degradation products and the low concentrations of NORM being released over an elongated period it is highly unlikely that these will be detectable above current background conditions in the area given proximity to production assets or the run-off via the Humber Estuary. As a result no likelihood of significant effect is expected to the Inner Dowsing, Race Bank and North Ridge SAC, SNS SAC, Humber Estuary SPA or the Greater Wash SPA.

Polycyclic Aromatic Hydrocarbons

The base material of some of the concrete coated pipelines is coal tar. There is no standardised formula for the composition of coal tar, but it is thought that its constituents are over 60% inert and may comprise up to 15% of PAHs (MPE, 1999).

The coal tar coating degrades when the internal pipeline steel corrodes or if the concrete coat is damaged. There are no known records of concrete durability, but it is expected that the concrete will decay at a very slow rate. It is presumed that PAH will be released once the coal tar layer is open to the seawater, and over time will be released into the surrounding environment. PAHs in marine sediments will have a low biodegradation potential due to low oxygen and low temperatures

(Cerniglia, 1992). PAHs are almost insoluble and only become available to marine organisms through ingestion of particulate matter (MPE, 1999, Cox and Gerrard, 2001).

Two factors, lipid and organic carbon, control to a large extent the partitioning behaviour of PAHs between sediment, water, and tissue. Accumulation of PAHs occurs in all marine organisms; however, there is a wide range in tissue concentrations from variable environmental concentrations, level and time of exposure, and a species' ability to metabolize these compounds. There are many variables, such as chemical hydrophobicity, uptake efficiency, feeding rate, and ventilatory volume, which may affect the outcome. The route of uptake may be an important issue for short-term events; however, under long-term exposure and equilibrium conditions between water, prey, and sediment, the route of uptake may be immaterial because the same tissue burdens will be achieved regardless of uptake routes (Meador *et al*., 1995). Due to their poor solubility in water these substances will partition in organic material including plankton and marine snow (cell water release) and marine sediments (cell water and sediment release). All substances in this group are persistent with a half-time in the marine environment ranging from weeks (water column) to several years (sediments). Evidence of carcinogenicity, mutagenicity or teratogenicity attributable to PAHs in the marine environment is very limited and the amounts concerned are not thought to pose a threat to marine organisms (MPE, 1999). Given that PAHs are expected to be released in very low concentrations during the deterioration of the coating over time, it is unlikely that marine organisms will accumulate them to a significant extent.

Due to the highly localised nature of any degradation products and the low concentrations of contaminants being released over an elongated period it is highly unlikely that these products will be detectable above current background conditions in the area given proximity to production assets or the run-off via the Humber Estuary. As a result no likelihood of significant effect is expected to the Inner Dowsing, Race Bank and North Ridge SAC, SNS SAC, Humber Estuary SPA or the Greater Wash SPA.

Plastics

Methanol and gas pipelines in the LDP2 – LDP5 area are coated with 3 Layer Polyethylene (3PLE) and Fusion-bonded Epoxy (FBE). 3PLE and FBE are considered non-toxic in the marine environment (DNV, 2006). 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 (OGUK, 2013). As biodegradability in the marine environment is also low, it can be assumed that the environmental effect of leaving these plastics in place is insignificant (MPE, 1999).

Physical degradation of plastics into smaller fragments then eventually microplastic particles can occur when plastic material is exposed to abrasive processes. Providing that the plastics remain adequately buried in the seabed there will be no anticipated microplastics generated from these pipelines into the sea.

Chrysaor have reviewed all instances where there are plastic exposures, one instance of a small exposure at Jupiter is being remediated in Q2 2021, with the intention of cutting out the pipeline. There are no other instances where plastics are directly exposed to the sea, therefore there is not expected to be any generation of microplastics via abrasion / degradation of these.

Due to the highly localised nature of any degradation products and the low concentrations of contaminants being released over an elongated period it is highly unlikely that these products will be detectable above current background conditions in the area given proximity to production assets or the run-off via the Humber Estuary. As a result no likelihood of significant effect is expected to the

Inner Dowsing, Race Bank and North Ridge SAC, SNS SAC, Humber Estuary SPA or the Greater Wash SPA.

5.1.5 Mitigation measures.

Mitigation measures to minimise seabed impacts within the LDP2 – LDP5 areas are detailed below:

- Cutting and lifting operations will be controlled by ROV to ensure accurate placement of cutting and lifting equipment and minimise any impact on seabed sediment;
- The requirements for further excavation will be assessed on a case-by-case basis and will be minimised to provide access only where necessary. Internal cutting of piles will be used preferentially where access is available;
- Heavy lift vessels are most likely to be equipped with dynamic positioning (DP) rather than relying on anchors to remain in position which interact with the seabed. By using vessels equipped with DP for lifting the 10 jackets and 2 subsea installations, seabed impact will be reduced, however a jack-up will be required at 4 locations;
- A rock-placement vessel or ROV support vessel will be used. The rock mass will be carefully placed over the designated areas of the pipelines and seabed by the use of an ROV. Accurate control of location of rock will be achieved via geolocation coordinates and the use of video. This will control the profile of the rock covering and accurate placement of rock over the pipeline and on the seabed to ensure rock is only placed within the planned footprint with minimal spread over adjacent sediment, minimising seabed disturbance;
- Vessel orientation has been reviewed and selected to minimise the requirements for rock whilst allowing for the safe locating of the accommodation work vessel and access i.e. crane reach to undertake essential scopes of work;
- The *in situ* decommissioning of the existing pipeline stabilisation material (mattresses, grout bags and rock) will prevent the need for additional rock placement as support on pipelines to be decommissioned *in situ*;
- The profile of the rock-placement over the pipeline on the seabed will allow fishing nets to trawl over the rock unobstructed. Suitably graded rock will be used to minimise the risk of snagging fishing gear; and
- A review of survey data collected in the area will be reviewed for potential sensitive habitats of seabed and mitigated against as appropriate.
- Post decommissioning debris clearance, surveys and monitoring shall be carried out using non-intrusive methodologies such as side scan sonar, using ROVs etc. The use of chain mats is presented as an absolute worst case impact and has only been utilised for Saturn and will not be expected to be used in any protected area.

5.1.6 Cumulative impact

Note: This section outlines the seabed footprint related to potential cumulative impact. It describes project activities, those associated with Chrysaor's wider SNS decommissioning activities, and those

outwith the control of Chrysaor (e.g. other oil and gas activity). This information is used to inform the conclusions on significance of environmental impact given in Section 5.1.8, as well as to inform the assessment of protected sites given in Section 5.1.7.

The SNS SAC will also be impacted and in many cases is overlapped by the NNSSR SAC, however, the SNS SAC covers a far greater area and any impact is likely to be insignificant on the prey populations within the Harbour porpoises range within the SAC.

Within the NNSSR SAC and SNS SAC there are 69 surface installations, including the 13 relating to LDP2 – LDP5. A further installation, Saturn ND, is located outwith the NNSSR SAC and SNS SAC.

The nature of impacts on the seabed can be categorised as follows: habitat loss, which occurs due to the placement of rock deposits and is relatively long-term; and disturbance, which is cause by the physical removal of assets which is relatively short-term.

The area of physical disturbance on the seabed within the NNSSR SAC from the existing installations is dependent on the size of each installation. Based on the size of the installations present it is estimated that the total area of seabed impacted within the SAC by all existing installations (for all operators) is approximately 63,546 m^2 (0.063 km^2)[6]. This is the total area of seabed covered by each installation. It does not, however, include the footprint of subsea installations such as manifolds, for which there are very limited data.

A total of 706.7 km of gas pipeline (all operators) is present within the NNSSR SAC and SNS SAC[7], including the pipelines line associated with the current decommissioning programme. This does not include the small diameter methanol, chemical and hydraulic lines that are normally piggybacked or laid alongside the existing gas lines and therefore their presence does not increase the overall area of seabed impacted. Based on an estimated 10 m corridor of impact along each pipeline, a total area of 7.1 km^2 of seabed within the SAC is estimated to have been impacted by the installation of existing gas pipelines. However, following burial the seabed is known to recover and only pipelines remaining on the seabed surface cause on-going physical impacts. Within the NNSSR SAC, approximately 94% of all operators' pipelines were trenched and buried by natural sediment and therefore do not affect the surface of the seabed or surface related processes. An estimated 0.4 km^2 of seabed may be impacted by those pipelines which remain on the surface. However, it should be noted that the figures stated are subject to a degree of variability reflecting the fact that this is a natural system which is subject to cyclical and seasonal changes.

The impacts associated with well P&A are grouped into the following activities;

- Locating of the Drill Rig (Table 5-8);
- Seabed Stabilisation for Safe Locating of Drill Rig (Table 5-8); and
- Well P&A (Table 5-9).

The footprint of locating the rig at each location is 2,989 m^2, where 589 m^2 is a result of locating the spud cans and 2,400 m^2 is as a result of the anchor and chain arrangements.

[6] The area of impact is estimated based on known areas of installations within the SAC. For installations for which the area is unknown an average has been used.

[7] It should be noted that the area in both SACs is largely the same as they two sites overlap each other.

The area of seabed disturbance associated with the removal of one conductor is 3.142 m^2, within the LOGGS and Viking asset groups there are 110 conductors that require removal giving a total footprint for conductor removal of 345.62 m^2.

Table 5-8 The cumulative habitat loss as a result of jack-up rig deployments

Activity	Total area of seabed impacted (km^2)					
	VDP1, & LDP1	VDP2 & VDP3	LDP2 – LDP5 (activities described herein)			*SNS* Programme
			SNS SAC	NNSSR SAC	Total	
Decommissioning impacts						
Total area of habitat loss	0.024	0.015	0.03288	0.03586	0.045	0.084

The wellheads associated with the LOGGS infrastructure are located within the footprints of the jackets and are to be cut internally, therefore the worst case scenario of excavation of the jacket piles incorporates the area associated with any wellhead removal. In line with previous environmental submissions related to Chrysaor's activities in the SAC, Table 5-9 shows the estimated area of impact for decommissioning all existing Chrysaor infrastructure within the NNSSR SAC this SAC is the main SAC listed for Annex I habitats expected to be impacted directly by decommissioning activities. This footprint is additional to that described above for existing infrastructure and represents the estimate of the additional potential impact from the SNS decommissioning programmes.

The SNS SAC will also be impacted and in many cases is overlapped by the NNSSR SAC, however, the SNS SAC covers a far greater area and any impact is likely to be insignificant on the prey populations within the Harbour porpoises range within the SAC. As a result information in the following tables (Table 5-9 to Table 5-13) is relating only to comparisons with the NNSSR SAC.

Table 5-9 Estimated area of impact for decommissioning all existing Chrysaor infrastructure within the NNSSR SAC

Activity	Total area of seabed impacted (km^2)					Individual DP breakdown			
	VDP1 & LDP1	VDP2 & VDP3	LDP2 – LDP5 (activities described herein)	SNS Programme	SNS Programme to Date*	LDP2	LDP3	LDP4	LDP5
Decommissioning impacts									
Total area of habitat loss	0.051	0.042	0.0017	0.259	0.028	0.003433	0.002306	0.00448	0.005527
Total area of physical disturbance	17.269***	47.621***	0.0169	131.089	0.062	0.79	0.006575	0.0027	0.006
Total	17.344	47.678	0.0339	131.434****	0.091	0.793433	0.008881	0.007180	0.011527
Existing impacts									
Total area of habitat loss	0.546	2.239	1.7086	5.484	-	0.26661	0.52063	0.38916	0.53215
Total Habitat Loss P&A**	0.024	0.015	0.045	0.087	-		0.011956	0.011956	0.011956
Cumulative loss and disturbance									
Total	17.89	49.917	1.806	136.918	0.091	0.27005	0.52952	0.36934	0.54367

*Activities associated with all DPs
** Assessed separately as part of P&A permit applications
***Area of disturbance reduced as non-intrusive debris clearance is being undertaken
**** SNS programme totals are based on a worst case and include temporary disturbance only and is based around a worst-case scenario, accounting for external excavation of every pile.

The total impact associated with well abandonment is 0.045 km^2 however only 0.036 km^2 of this impact occurs within the NNSSR SAC.

In addition to the existing footprint and that of Chrysaor's SNS decommissioning activities, it is necessary to consider other, recent activities executed by Chrysaor in the region. This is largely related to historical stabilisation work undertaken within the NNSSR SAC. Such stabilisation, including the deposit of rock and mattresses, results in a loss of sediment habitat, as detailed in Table 5-10.

Table 5-10 Historical stabilisation work undertaken in the NNSSR SAC by Chrysaor

Platform visited	Date on location	Campaign and vessel	Max. permitted area of habitat loss (m^2)	Actual area of habitat loss (m^2)	Permitted deposits (tonnes)	Actual deposits (tonnes)
Vulcan RD	Aug. 2012-Feb. 2013	AIR Campaign- GMS Endurance	0	0	0	0
Vanguard QD	Feb. 2013-June 2013	AIR Campaign- GMS Endurance	2,400	2,400	-	8,000
North Valiant SP	June 2013-Nov. 2012	AIR Campaign- GMS Endurance	0	0	0	0
Victor JD	Nov. 2013-Mar. 2014	AIR Campaign- GMS Endurance	0	0	0	0
South Valiant TD	Apr. 2014-Aug. 2014	AIR Campaign- GMS Endurance	5,178	5,178	-	30,000
LOGGS PA and North Valiant 1 PD Platforms	Sep. 2014-Dec. 2014	AIR Campaign- GMS Endurance	-	-	50 mats	7 mats
North Valiant 1 PD Platforms	Dec. 2014-Sep. 2015	AIR Campaign- GMS Endurance	3,303	3,303	-	11,000
Total Area of habitat loss in the SAC (km^2)			**0.011**			

Furthermore, it is necessary to consider decommissioning plans being undertaken within NNSSR SAC by operators other than Chrysaor. For projects with approved or submitted Decommissioning Programmes, these are Ann, Alison, Saturn (Annabel) and Audrey fields all operated by Spirit Energy (Centrica 2017a; Centrica 2017b). A summary of these activities occurring is presented in Table 5-11 (OPRED 2019c). In addition to the assets outlined in Table 5-11, Perenco could commence the decommissioning of the following assets which are located within the NNSSR SAC prior to 2024 however seabed impact areas are not known at present:

- Indefatigable (Inde) 18A (49/18A)
- Leman 27J (49/27J)
- Leman 27E (49/27E)
- Waveney (48/17c)

Table 5-11 Other decommissioning activities occurring in the vicinity of the LDP2 – LDP5 activities

Activity	Year of activities	Total seabed impact (km^2)	Percentage of SAC seabed impact (%)[1]
Spirit Energy Ann and Alison fields decommissioning programme (Centrica, 2017a)	2018-2023	15.4*	0.427*
Energy Saturn (Annabel and Audrey fields decommissioning programme (Centrica, 2017b)	2018-2022	11.7 (physical disturbance) 0.1 (habitat loss)	0.382 (physical disturbance) 0.003 (habitat loss)
Anglia Decommissioning Environmental Appraisal (Ithaca Energy (UK) LIMITED, 2019)	2018-2025	0.04 (physical disturbance) 0.002 (Habitat loss)	0.001 (physical disturbance) 0.00005 (Habitat loss)
Ensign Decommissioning Environmental Appraisal, (Spirit Energy, 2019)	2018-2025	0.0242*	0.0007*
Total physical disturbance		11.74	0.38
Total habitat loss		15.53	0.43
Total		**27.27**	**0.81**

* Combined impact – assumed to be habitat loss as a worst-case scenario, there was no separate data provided for physical disturbance.
Note: There has been no relevant change in the status of Decommissioning Plans (nor new plans submitted) since this table was compiled.

It is recognised, however, that it is not only other Chrysaor activities or decommissioning activities of other operators that could act cumulatively with the proposed activities – indeed, any other licensable activities which could interact with the seabed require consideration. This includes other oil and gas activity aside from decommissioning, aggregate extraction, and renewables development. Table 5-12 (OPRED, 2019b) outlines recent works by other operators in the NNSSR SAC and Table 5-13 presents marine aggregate and renewables activities within or close to the SAC. Only comparisons with the NNSSR SAC have been made, although the SNS SAC does overlap with the majority of the area covered by the NNSSR SAC the impacts will be insignificant in relation to the overall size of the SNS SAC and will be largely undetectable above natural change. For most of the projects outlined in these tables, it is not possible to state whether there will be long-term habitat loss from infrastructure being left *in situ*, since the projects are not at the stage of making

such decisions. It can be assumed as a worst case that there will be long-term impacts from these projects, however, many of the renewables projects already have decommissioning plans in place, including the full removal of assets. The projects are therefore best considered in terms of nature of impact and order of magnitude, rather than in terms of specific estimates of footprint made at this stage.

It should be noted than in Table 5-13 the area presented and associated percentage is for the NNSSR SAC, the area within the SNS SAC is not presented as this SAC is much larger than the NNSSR SAC so any impacts will affect a much smaller percentage of the SAC.

Table 5-12 Recent works by other operators in the NNSSR SAC (OPRED, 2019b)

Operator	Block	MAT Reference	SAT Reference	SAT Start Date*	SAT Expiry/ Completion Date	Area of Impact (m2)	Impact (Habitat Loss / Disturbance)
ENI HEWITT LIMITED	48/30	PLA/640	DEP/1603/0	01/02/2019	28/02/2019	697	Habitat loss
FRASER WELLL MANAGEMENT LIMITED	48/24	DRA/657	CL/1005/0	01/07/2019	30/11/2019	3,020	Disturbance
INEOS UK SNS LIMITED	48/19	PRA/121	ML/530/0	18/10/2019	30/11/2019	2	Disturbance
ITHACA ENERGY (UK) LIMITED	48/19	SA/1248	CL/1069/0	12/12/2019	-	600	Habitat loss
ODE ASSET MANAGEMENT LIMITED	49/26	PLA/747	DEP/1892/1	03/06/2020	-	10	Habitat loss
	49/21	PRA/300	CL/1199/0	15/10/2021	-	N/A	N/A
	49/21	PRA/300	CL/1170/0	13/04/2021	-	N/A	N/A
	49/12	PRA/305	CL/1201/0	16/09/2021	-	N/A	N/A
SHELL U.K. LIMITED	48/20	DRA/585	DR/1461/0	19/11/2018	30/06/2019	348,000	Disturbance
	48/20	PLA/513	DEP/1379/0	25/05/2018	31/10/2018	1,897	Habitat Loss
	48/20	PLA/513	PL/1378/0	25/05/2018	31/10/2018	-	-

Operator	Block	MAT Reference	SAT Reference	SAT Start Date*	SAT Expiry/ Completion Date	Area of Impact (m2)	Impact (Habitat Loss / Disturbance)
	48/8	PLA/668	DEP/1709/2	18/06/2019	31/08/2020	4,550	Habitat loss
	49/20	SA/130	CL/90/4	29/03/2021	-	N/A	N/A
	49/20	SA/129	CL/93/7	30/04/2021	-	N/A	N/A
SPIRIT ENERGY NORTH SEA LIMITED	49/16a	PLA/574	ML/382/1	01/08/2018	30/09/2018	300	Disturbance
	49/11A	WIA/764	ML/405/1	21/10/2018	31/07/2019	N/A	N/A
	49/11a	PRA/214	CL/534/5	25/09/2018	15/10/2018	N/A	N/A
	48/15b	PRA/216	CL/535/3	29/01/2018	31/01/2018	N/A	N/A
	48/14a	PRA/114	CL/156/5	22/11/2018	05/12/2018	N/A	N/A
	49/11A	DCA/80	ML/411/3	23/11/2018	31/10/2020	1,890	Disturbance
	49/11a	DCA/85	ML/431/1	01/04/2019	30/04/2020	1,000	Disturbance
	48/15	WIA/858	ML/429/2	21/03/2019	31/12/2019	3	Disturbance
	48/14	WIA/885	CL/981/2	25/05/2019	31/10/2019	3,020	Disturbance
	48/14	WIA/885	ML/456/1	25/05/2019	31/10/2019	N/A	N/A
	49/11	DCA/93	ML/557/0	04/04/2020	31/12/2020	1,536	Disturbance

Operator	Block	MAT Reference	SAT Reference	SAT Start Date*	SAT Expiry/ Completion Date	Area of Impact (m2)	Impact (Habitat Loss / Disturbance)
	49/11	DCA/85	ML/559/0	04/04/2020	31/12/2020	2,000	Disturbance
PERENCO UK LIMITED	53/1	PLA/409	DEP/1083/7	15/05/2017	28/02/2019	728	Habitat Loss
	49/28	ML/405/0	CL/363/5	21/03/2018	10/04/2018	N/A	N/A
	49/28	DCA/15	ML/84/4	05/01/2018	31/03/2018	N/A	N/A
	48/24	PLA/709	DEP/1786/0	13/11/2019	31/01/2020	1,220	Habitat loss
	49/23	PLA/707	DEP/1785/0	13/11/2019	31/01/2020	9,656	Habitat loss
	49/27	PLA/706	DEP/1790/0	20/11/2019	31/01/2020	55,504	Habitat loss
	53/1	PLA/409	DEP/1083/8	15/05/2017	15/03/2019	37,898	Habitat loss
	49/28	SA/1227	ML/528/0	17/10/2019	31/03/2020	N/A	N/A
	49/26	PLA/778	DEP/1981/1	21/10/2020	-	1,362	Habitat loss
	49/27	PLA/786	DEP/1984/2	12/11/2020	-	3,230	Habitat loss
	49/27	PLA776	DEP/1993/0	01/10/2020	-	311	Habitat loss
	49/28	DCA/118	ML/614/0	12/07/2020	31/10/2020	200	Disturbance
	49/27	PLA/651	DEP/1639/0	25/02/2019	30/04/2019	3,020	Habitat loss

Operator	Block	MAT Reference	SAT Reference	SAT Start Date*	SAT Expiry/ Completion Date	Area of Impact (m2)	Impact (Habitat Loss / Disturbance)
PERENCO GAS (UK) LIMITED	49/28	DCA/88	ML/455/0	20/06/2019	30/09/2019	404	Disturbance
PETROFAC FACILITIES MANAGEMENT LIMITED	49/28	WIA/887	CL/993/0	12/06/2019	15/08/2019	3,020	Disturbance
	49/28	WIA/887	ML/461/1	12/06/2019	15/08/2019	6	Disturbance
	49/28	WIA/886	CL/977/0	24/05/2019	30/06/2019	3,020	Disturbance
	49/28	WIA/886	ML/454/0	24/05/2019	30/06/2019	6	Disturbance
	49/28	SA/1104	ML/434/0	29/03/2019	31/05/2019	313	Disturbance
	49/28	SA/1103	ML/435/0	29/03/2019	31/05/2019	313	Disturbance
	49/21	DRA/893	DR/2182/0	29/09/2021	-	N/A	N/A
	49/21	DRA/894	DR/2183/0	29/09/2021	-	N/A	N/A
TULLOW OIL SK LIMITED	49/28	DCA/91	ML/468/0	25/06/2019	31/08/2019	51	Disturbance
					Total	**368,104**	**Disturbance**
					Total	**120,683**	**Habitat Loss**

Assumptions: i) Jack-up drilling rig = 3,020 m^2 disturbance, unless another value is specifically stated in the ML; ii)1 Mattresses = 6 m x 3 m; iii) Grout bag = 0.53 m x 0.24 m; iv) 1Te rock/gravel = 2 m^2
Note: Greyed out rows represent work that has been completed since this Table was first compiled.

Table 5-13 Non-oil and gas activities occurring in the vicinity of the NNSSR SAC

Site including licence number	Status of licence	Block	Area (km^2)	Distance and direction from the SAC	Percentage of SAC seabed impacted (Habitat loss)* (%)
Humber Overfalls (493)	Aggregate production area	47/17, 47/18	12.21	78.56 WSW	0.00
Off Saltfleet (197)	Aggregate production area	47/17, 47/18	26.18	74.18 WNW	0.00
Humber Estuary (106/1)	Aggregate production area	47/18	3.94	69.23 WNW	0.00
Humber Estuary (106/2)	Aggregate production area	47/18, 47/19	3.20	65.65 WNW	0.00
Humber Estuary (106/3)	Active license	47/18, 47/19	35.36	66.36 WNW	0.00
Humber Estuary (400)	Aggregate production area	47/18	14.25	72.74 WSW	0.00
Outer Dowsing (515/1 & 515/2)	Aggregate production area	48/16, 48/17, 47/20	26.17	25.62 WNW	0.00
Inner Dowsing (481/1)	Aggregate production area	47/24	6.07	62.61 WSW	0.00
Inner Dowsing (481/2)	Aggregate production area	47/24	1.93	62.09 WSW	0.00
Humber 3 (484)	Aggregate production area	48/20, 49/11, 49/16	17.20	within	0.40
Humber 5 (483)	Application and extended option	49/11, 49/12	28.24	within	0.78
Race Bank Wind Farm Limited	In operation	47/19, 47/20, 47/24, 47/25	62.36	47.11 WSW	0.00
Dudgeon Offshore Wind Limited	In operation	48/22, 48/23	55.13	14.60 WSW	0.00
Triton Knoll Offshore Windfarm	In construction	47/14, 47/15, 47/19, 47/20	149.46	40.73 WNW	0.00
Lincs Wind Farm Limited	In operation	47/23, 47/28	38.31	75.33 WSW	0.00

Site including licence number	Status of licence	Block	Area (km^2)	Distance and direction from the SAC	Percentage of SAC seabed impacted (Habitat loss)* (%)
Inner Dowsing Wind Farm Limited	In operation	47/23	8.81	79.26 WSW	0.00
SCIRA Offshore Energy Limited	In operation	48/21, 48/26, 48/27	34.97	35.38 WSW	0.00
Lynn Wind Farm Limited	In operation	47/28	7.88	79.85 WSW	0.00
Hornsea 3**	In application (Pending)		690.00	Cable route is within SAC, license area 9.25 NNE	0.03
Norfolk Vanguard East & West	Under Consent		592	Site is outside SAC	0.00
		Total	**1221.00**		**1.21%**

*Assumed as a worst-case scenario to represent long-term habitat loss.
** The cable running from Hornsea 3 to the shore will run through the SAC, the application has been formally submitted the outcome of the application is currently pending.
Note: No relevant changes to licences since initial compilation of this table have been identified following a review of information

Looking solely at the physical disturbance element, cumulatively from the above activities it is clear that a substantial area, and percentage, of the NNSSR SAC could experience such an impact. However, as outlined in Section 5.1.3, the impact will be temporary in nature, and rapid recovery is expected. Some of the activities will overlap in time but many, such as Chrysaor's SNS decommissioning programme overall, will occur sequentially or with much greater separation in time, such that only small areas of the total physical disturbance will occur at any one time. Given the anticipated recovery from physical disturbance, the areas described above are unlikely to result in a significant negative environmental impact to any species or habitats present the area of impact. Consideration is given below in Section 5.1.7 to the potential for the temporary physical disturbance to affect the integrity of the protected site itself.

The area potentially impacted by infrastructure being decommissioned *in situ*, leading to potential habitat loss, is much smaller than that affected by physical disturbance, but the impact mechanism will be present for a much longer period (i.e. until the infrastructure has broken down). The infrastructure that will be decommissioned *in situ* as part of Chrysaor's SNS decommissioning programme will be present alongside a range of other infrastructure from oil and gas and renewables projects. The cumulative impact from decommissioning the LDP2 – LDP5 infrastructure *in situ* could lead to a habitat loss of 3.88 km^2 (Table 5-5) and in total five sites are impacted through decommissioning, either via the decommissioning of infrastructure *in situ* or through removal of infrastructure. It is estimated that 1.65 km^2 of this impact would be within the NNSSR SAC (Table 5-9). However, as outlined in Section 5.1.4, evidence from survey work around installed infrastructure suggests that the physical processes that see sediment moving through the area are unaffected by the installed infrastructure. Furthermore, the footprint of the installed infrastructure that will be decommissioned is, in relative terms, small compared to the wider area and will not result in significant habitat loss.

The SNS SAC conservation objective three is to ensure the condition of supporting habitats and processes, and the availability of prey is maintained in the context of natural environmental change. The SNS SAC contains infrastructure being decommissioned *in situ* however there are no direct decommissioning activities being undertaken that would significantly impact the prey populations at the scale of this SAC. Given the pipeline infrastructure is being decommissioned *in situ* this poses the minimal risk to the supporting habitats/ prey species which harbour porpoise may seasonally utilise in the SAC. The Norfolk Vanguard Windfarm will be located within the SNS SAC, occupying and area of 592 km^2 (1.6% of the SAC). However, offshore works are not expected to commence until 2024, and so is unlikely to cumulatively impact the site alongside the LOGGS Decommissioning Programmes.

On this basis, the area in which various infrastructure could be decommissioned *in situ* is unlikely to result in a significant negative environmental impact to any species or habitats that comprise the area of impact. Consideration is given below in Section 5.1.7 to the potential for the permanent decommissioning of infrastructure *in situ* to affect the integrity of the protected site itself.

5.1.7 Transboundary impact

The LDP2 – LDP5 decommissioning activities (from the closest installation) are located approximately 45 km east of the UK/Netherlands median line. Decommissioning activities are not anticipated to create any transboundary impacts with regards to the seabed.

5.1.8 Protected sites

Screening

The first step in determining the potential impact on protected sites is to identify which sites could experience an impact. In the case of sites protected for seabed features, a simple method of identifying which sites sit within the direct and indirect footprint of the activities is required. Comparing the location of the LDP2 – LDP5 infrastructure and the potential impact footprint presented in Section 5.1.2 with the location of protected sites shown in Section 4.5, there is potential for overlap with the following sites:

- North Norfolk Sandbanks and Saturn Reef SAC (Annex I Reefs and Sandbanks: Unfavourable condition); and
- Inner Dowsing, Race Bank and North Ridge SAC (Annex I Reefs and Sandbanks: Unfavourable condition).

In addition to considering sites designated for seabed features, it is also necessary to consider sites where features are not benthic in nature, but which rely on the seabed for vital life functions. Considering other SACs and SPAs where protected features may make significant use of the seabed, the following site is also taken forward for further assessment where relevant:

- Southern North Sea SAC (Annex II Harbour porpoise: Favourable condition).

The Humber Estuary SPA and Greater Wash SPA have LOGGS infrastructure located within them however as no physical decommissioning activity occurs within this SPA they have not been taken forward for further assessment. As any impacts associated with decommissioning the infrastructure *in situ* (e.g. degradation of pipeline over time) will be negligible and present no likely significant effect to the SPAs features or supporting habitats.

Information pertinent to Appropriate Assessment of the activities against the above protected sites is given in the following sections.

Comparison of the 2017 HRA with the current proposed LDP2 – LDP5 activities

The majority of assumptions in terms of the area affected by each decommissioning activity have been consistent with those in the HRA undertaken for the LDP1 and VDP1 decommissioning programmes (BEIS, 2017; described further in Section 3.6). As the design engineering continues to evolve, opportunities to minimise the actual impacts are realised and continue to be adopted. However, where engineering is yet to be completed the worst case assumptions continue to be consistently included within the impact assessments. The only exceptions are:

- The heavy lift vessel, where anchors will not be required, and it will instead be remaining on station using DP or jack-up legs (only 4 locations) assuming 4 x of 196.3 m^2 equating to 785.2 m^2 disturbance per location.

- The redistribution of existing rock-pads for the safe locating of a jack-up drilling rig. Previous rock-pads have been deposited for the safe locating of a four legged accommodation work vessel (AWV). The rock pad does not support the safe locating of a three legged rig. In order to avoid the introduction of further rock to the marine environment, the existing rock is to be re-deployed.

    - Vanguard QD - impact 393 m^2

    - South Valiant TD - impact 1,288 m^2

- SIMOPS have been successfully trialled on the satellite installations with a higher well count eliminating the requirement for AWV visits to six locations.

- No overtrawling will be undertaken within a designated site or protected area.

- There are no plans to remediate spans with rock. At the time of undertaking the pipeline disconnect scope, the disconnects are being undertaken at the point of burial to remove the spans within the platform 500 m safety zones.

- Where safety conditions permit, it is the intention to avoid rock pad deposits for the safe locating of jack-up vessels. Dependent upon site survey results any evidence of scouring it may be a requirement to add rock as was the need for Vulcan RD Plug and Abandonment campaign in 2020.

North Norfolk Sandbanks and Saturn Reef SAC

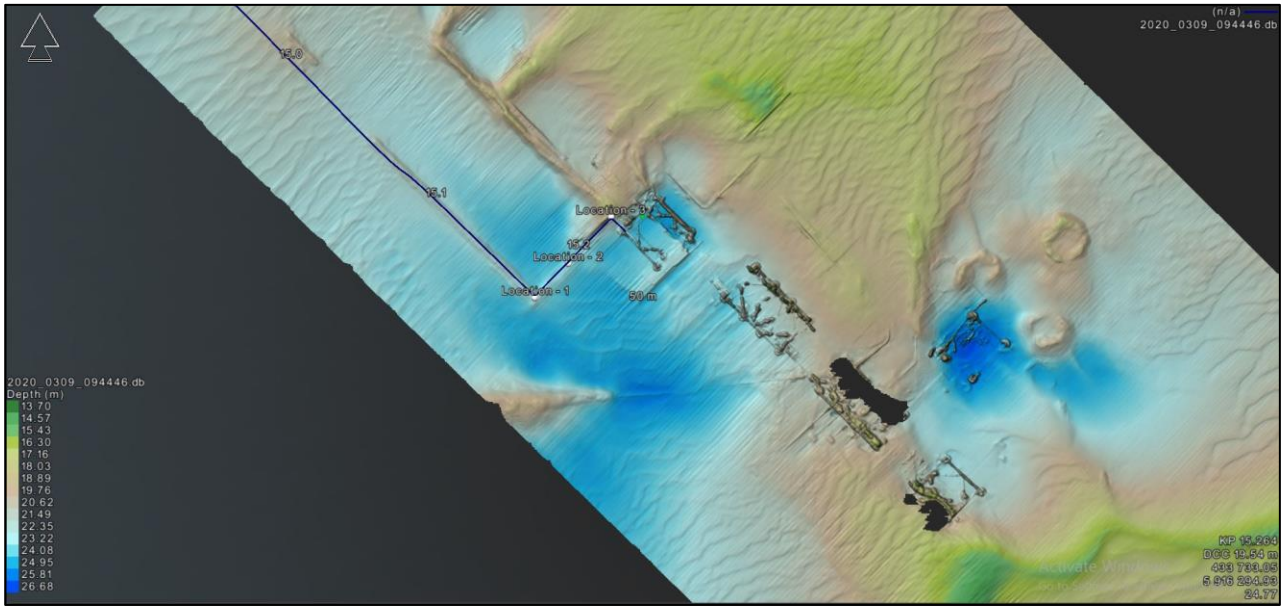
Impact from LDP2 – LDP5 activities

The potential impacts from the proposed decommissioning associated with LDP2 – LDP5 activities within the NNSSR SAC will cause a localised area of physical disturbance within the SAC due to suspension and resettlement of sediments potentially smothering sessile seabed organisms. The area at potential risk of being impacted is relatively small compared to the extent of habitat within the SAC and it is predicted that no more than 0.00045%, see Table 5-7, of the site may be temporarily impacted. Although, even on sandbanks, a shift from predominately sand and rock/gravel to finer sediments may result in a dramatic drop in species richness, abundance and biomass (Despr, 2000, in JNCC, 2017a), sensitivity of sandbanks to changes in suspended sediment is assessed as low within this site due to the dynamic nature of the ambient environment (JNCC, 2017a). Species are therefore likely to be well adapted to fluctuations in suspended sediment levels and the biological communities on the sandbanks are sensitive to smothering only at a low level (JNCC, 2017a). JNCC (2017a) assesses sandbanks to be only moderately sensitive to physical disturbance and abrasion because there is a possibility of recovery. Upon completion of the subsea decommissioning activities including over-trawlability surveys (note Saturn only), it is expected that the resettled sediment will be quickly recolonised by benthic fauna. This will occur as a result of recovery of some of the fauna directly disturbed by the activity, together with natural settlement by larvae and plankton and through the migration of animals from adjacent undisturbed benthic communities (Dernie *et al*., 2003). The features at risk of being impacted are widespread and not sensitive to physical disturbance. As much of the physical disturbance is temporary, the habitat and benthic communities will recover once decommissioning activities are completed.

Chrysaor have committed to a comprehensive post decommissioning survey that will be able to conclude and verify statements made regarding the recovery of sandbanks and their associated features. The evidence base for anticipated recovery of the sandbanks can be derived from analysis and review of survey data that has been collected in the wider area, a number of examples have been extracted and discussed in this section to support the Environmental Assessment, and where necessary the HRA.

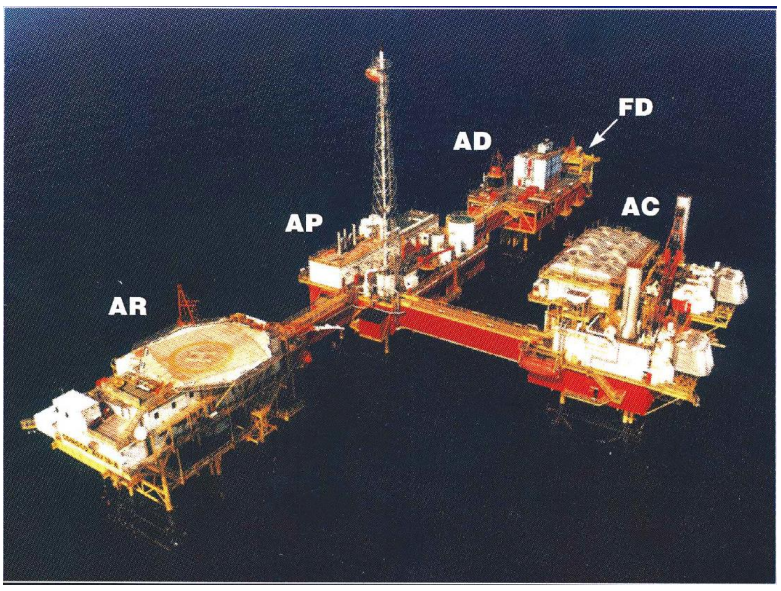
Fixed installations have been evidenced to create scour, and this appears to be particularly prevalent around large complexes, such as LOGGS. Shown in Figure 5-1 is bathymetry data from 2020 collected by Chrysaor; this shows prominent scouring around the LOGGS platform complex. Mega-ripples of sand are still clearly visible in the immediate area, crossing pipelines that are not buried by rock.

Figure 5-1 Seabed Bathymetry of the LOGGS Platform Complex (Scour indicated by blue)



The Viking Complex consisted of Viking AR, AP, AD, FD and AC installations. In 1991 the reservoirs produced by the Viking A Complex and Viking FD satellite became uneconomic and AP, AD, FD and AC installations were removed in 1996 (Figure 5-2). The Viking AR platform was re-designed as a Normally Unattended Installation (NUI) and transported export gas from the Viking B Complex to TGT until 2009.

Figure 5-2 Viking Complex



The evidence of sandbank recovery post installation removal can be seen from the Viking Alpha seabed geotechnical survey that was carried out in 2016 (ConocoPhillips 2016). This supports the evidence for mobility of sand adjacent to structures and pipelines. The survey has indicated almost complete absence of scour 20 years post removal, which confirms seabed recovery within these timeframes. From the bathymetry chart (Figure 5-3) minor depressions can be observed at AD and FD locations, these would be expected to have been further reduced since removal of the Viking AR

platform in 2020. The sidescan sonar chart of the same area indicates sand wave formation in the wider area which supports evidence for seabed recovery (Figure 5-3). The survey data did not indicate any noticeable restrictions or limitations of sand movement associated since removal of the pipelines and infrastructure.

Similar sand migration is expected throughout the Viking and LOGGS areas, which are influenced by the same sandbank system. Localised differences in back-fill may be apparent at some locations. Post removal surveys will indicate degree of infill at each location.

Figure 5-3 Bathymetry chart from Viking Alpha Geotechnical survey carried out in 2016 showing flat seabed post installation removal, with minor seabed depressions evident from Viking AD and FD removal locations (Gardline 2016).

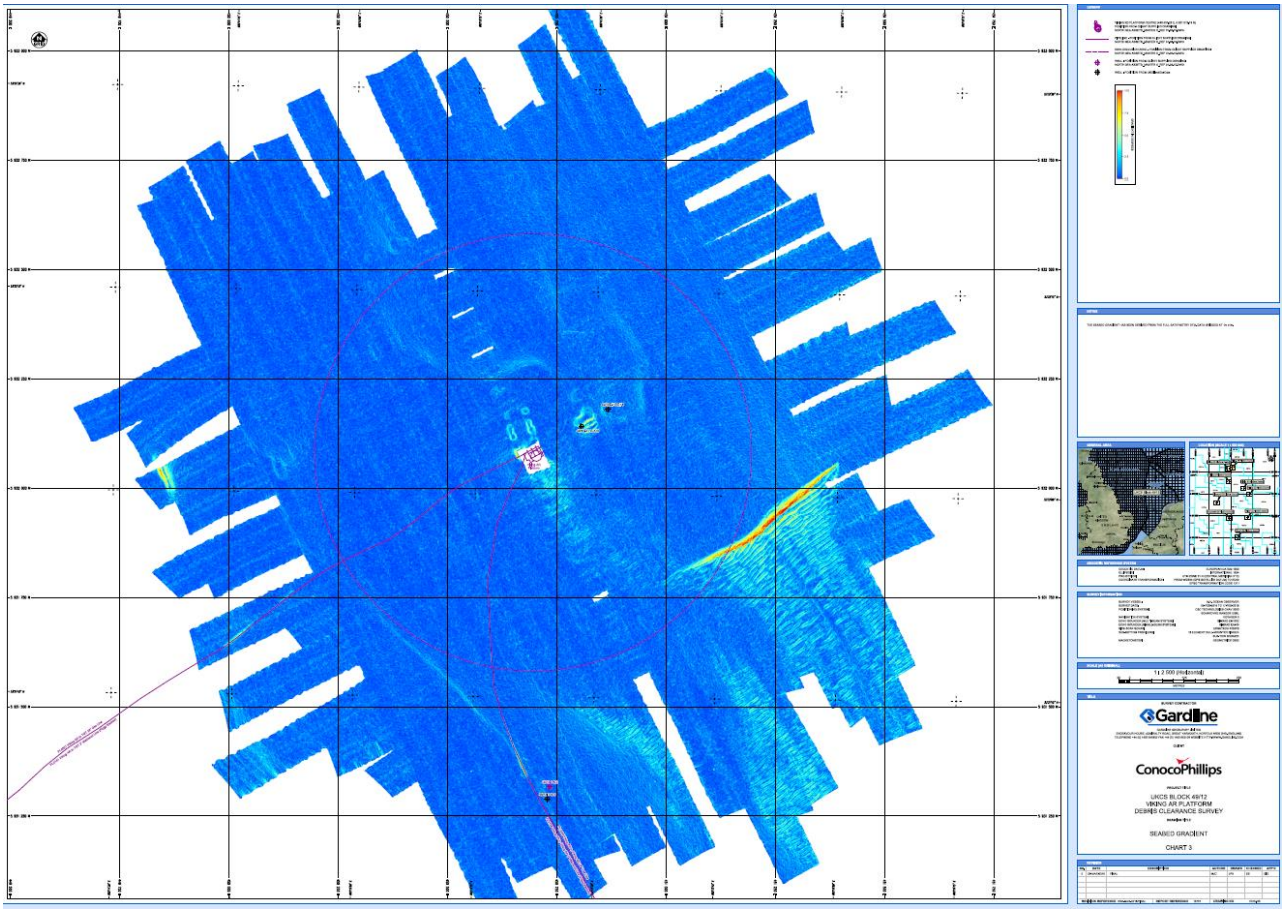
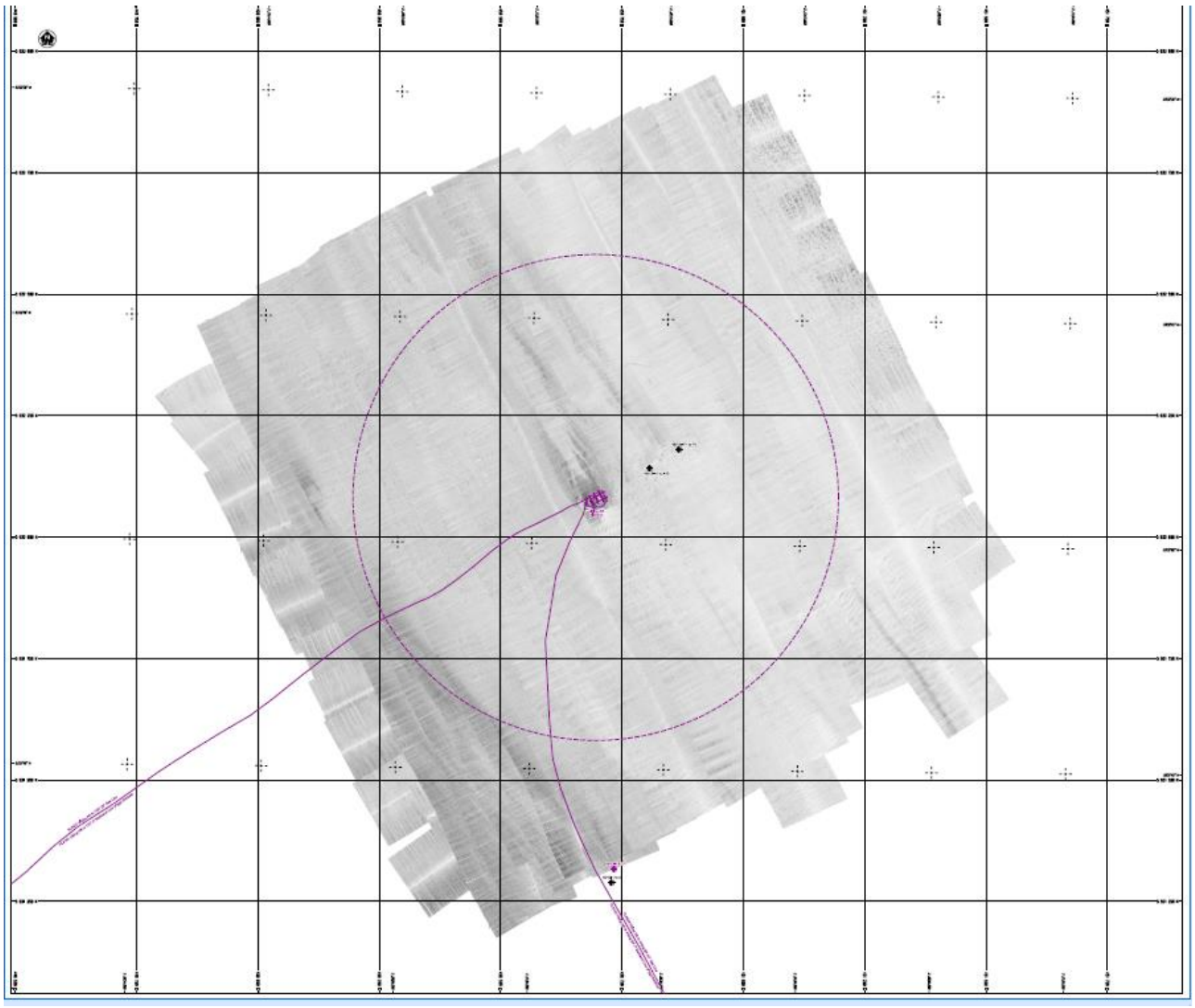


Figure 5-4 Sidescan sonar output from Viking Alpha Geotechnical survey carried out in 2016 showing flat seabed post installation removal, with minor(Gardline 2016).

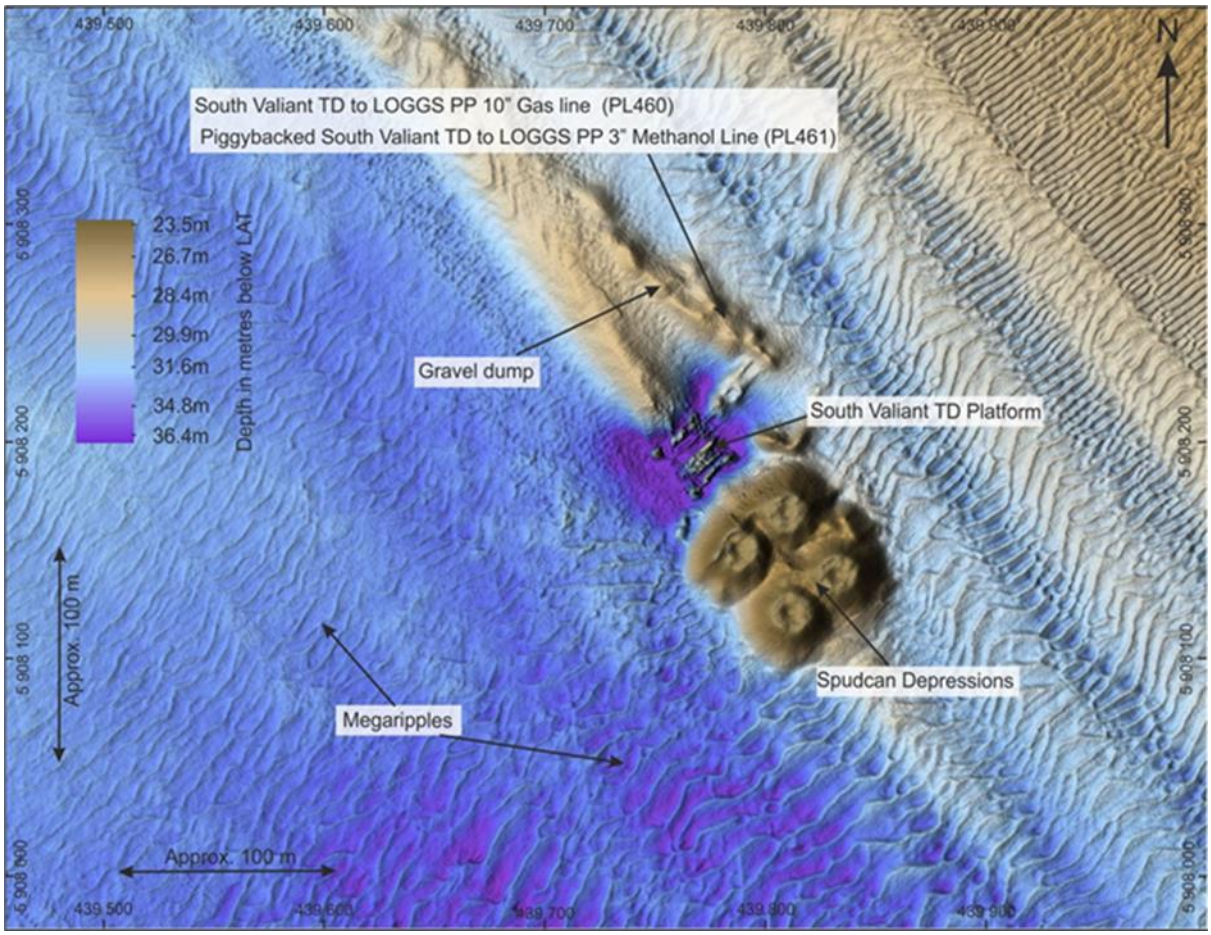


The potential impacts from the proposed decommissioning activities within the NNSSR SAC will also cause a permanent loss of habitat within the SAC. The loss of habitat through the introduction of hard substrate is presented as a worse case area of impact aligned with the footprint of the hard substrate to be deposited. However, the extent of potential habitat loss is estimated to be relatively small compared to the extent of habitat within the SAC and it is predicted that approximately 0.05% of the site may be impacted. This is including the pipelines and associated supporting structures decommissioning in situ. The extent of habitat loss does not take into account the natural reburial of the hard substrate and return to the natural surrounding sediment. Over time, it is predicted that a proportion of the rock placed on the seabed will be buried due to natural sediment accretion and will not cause an ongoing long-term loss of habitat.

Throughout the operational life of the associated pipelines Chrysaor have obtained evidence through pipeline survey programmes to demonstrate the natural re-burial of rock placement and mattresses installed to provide pipeline stabilisation. However, a proportion of deposits on the pipeline will be buried, although in some instances, will remain exposed and subject to cyclical tidal sand migration.

A rock berm was placed at the South Valiant TD platform in the nearby LOGGS area, due to concerns over potential scour at the site. While the purpose of the berm was to provide stability, and thus maintain integrity, it is likely that in time, the rock will disperse to some extent and become partially buried. Seabed imagery would suggest that this process has already begun at the TD site, however as expected the rock berm is still prominent a feature on the bathymetry chart (Figure 5-1) (Fugro, 2017). The process of recovery would be expected to increase once the decommissioning of the field and removal of the platform has been completed. While the platform remains in position, platform induced dynamics will continue to impact rates of recovery. The presence of sandwaves and megaripples in the area with wavelengths of up to 13 m and 40 m respectively and heights of up to 3.2 m which are greater than the height of the rock berm, are indicative of potential for recovery (Gardline, 2013:Fugro 2017). The movement of ripples across affected areas, will be likely to lead to the recovery of these locations. However, the recovery process would be expected to increase following removal of the platform.

Figure 5-5 South Valiant TD to LOGGS PP 10" Gas Line (PL460) (Fugro 2017)



A number of examples to illustrate the impact and longevity of rock and mattresses on the sandbanks will be provided. The Clipper South pipelines: PL2810 & PL2811 that tie into LOGGS Riser Platform (PR) required rock to be deposited during 2012 (Figure 5-6). ROV surveys of the area carried out in 2014 and 2016 have allowed for the observation of how the sand coverage on the rock has changed with time and a gradual build-up of sand amongst the rock, whilst the rock is still clearly visible after 4 years (Figure 5-7).

Figure 5-6 Cross Section over the Clipper South Pipeline PL2810 & PL2811 that tie into LOGGS Riser Platform (PR) approximately 50m away

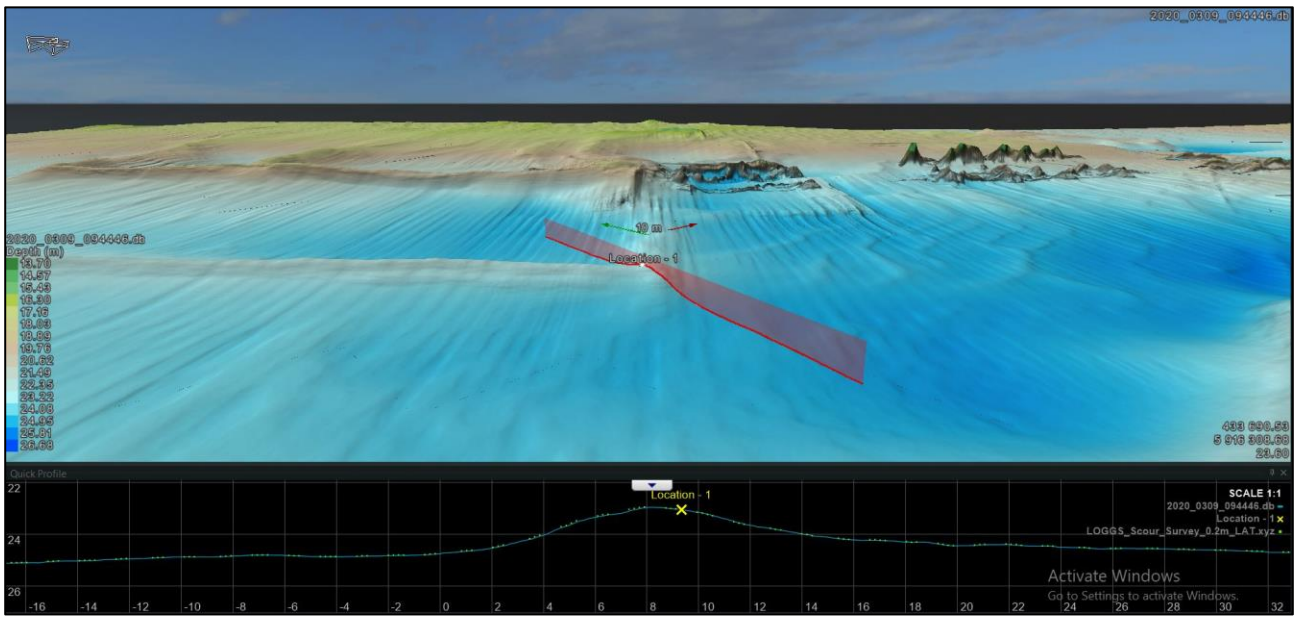


Figure 5-7 ROV footage taken in 2014 (left) and 2016 (right) at the Clipper South pipeline near LOGGS Riser Platform illustrating progressive sand build up amongst the rock since it was deposited in 2012

This evidence confirms that the area of habitat loss through the introduction of hard substrate deposits for pipeline stabilisation is an overestimate as this does not allow for the observed re-burial and also provides further confirmation that the low elevation deposits of graded rock do not impact the migration of the sandwaves or impede the free movement and transportation of sediment.

The debris clearance and bathymetry survey Chrysaor has collected survey data that confirms partial recovery of the seabed via coverage by sand after installation of rock and mattresses. Pipelines PL1690/PL1691 located between NW Bell and Callisto were covered by mattresses installed in 1996, and rock deposits were also made in the area. A bathymetry and side-scan survey carried out in 2020 has confirmed all of these are completely buried in sand, with sand waves evident across the area (Figure 5-8). The side-scan sonar imagery collected demonstrates that rock can still be identified, along with scouring near the Callisto and NW Bell infrastructure locations (Figure 5-9).

Figure 5-8 Pipeline PL1690/PL1691 between NW Bell and Callisto was covered by mattresses in 1996, these are completely buried by sand from bathymetry survey (Gardline 2020).

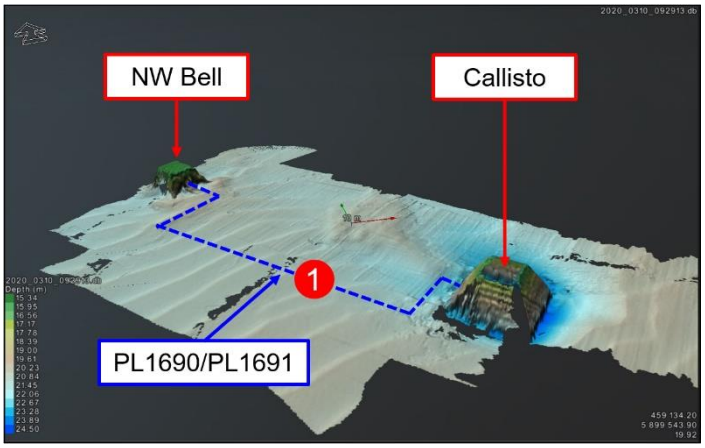
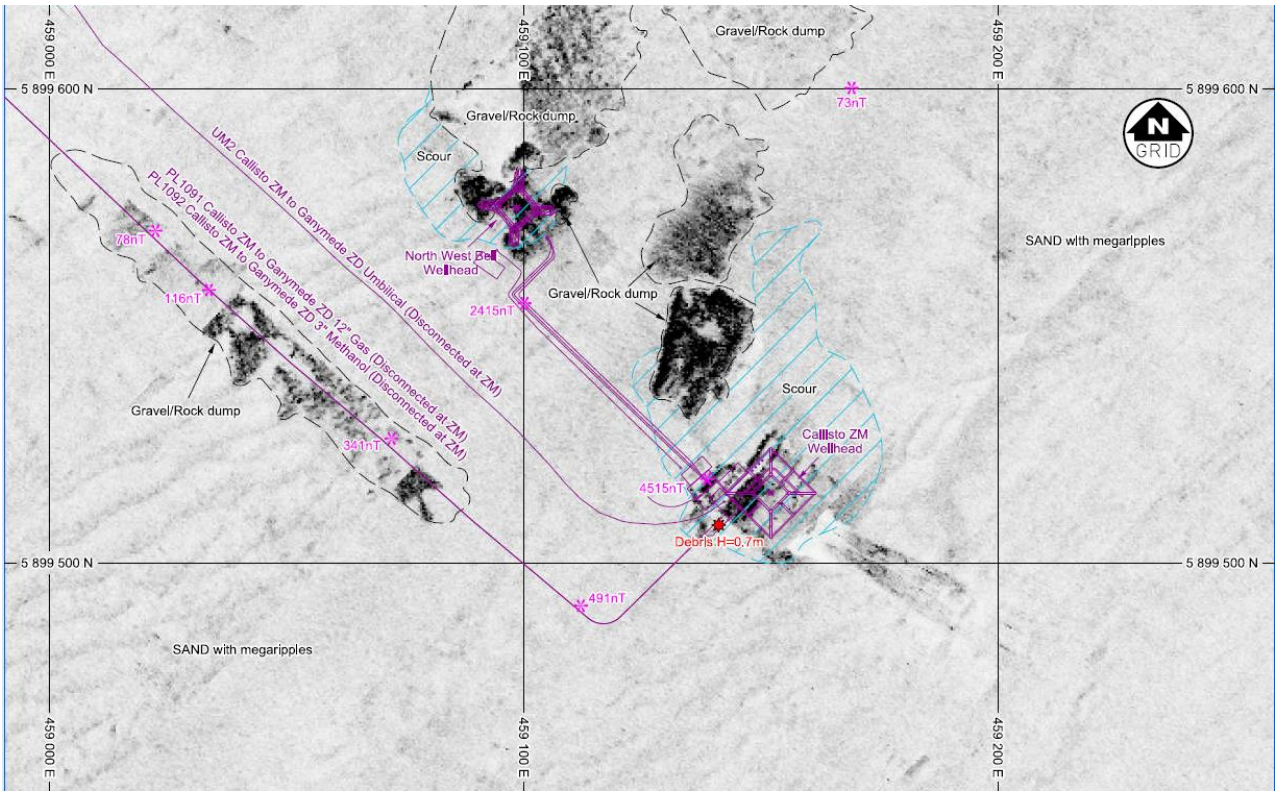
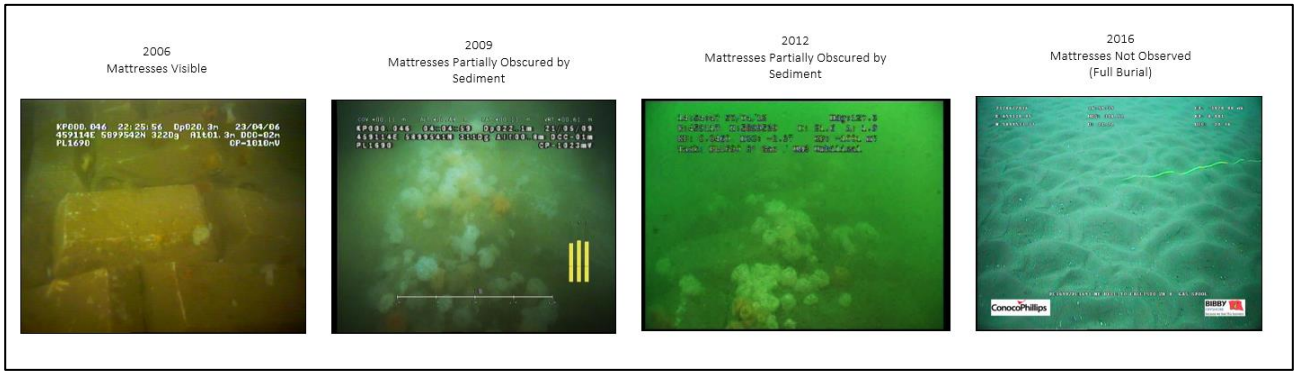


Figure 5-9 Side-scan sonar of Pipeline PL1690/PL1691 between NW Bell and Callisto was covered by mattresses in 1996, these are completely buried by sand from bathymetry survey albeit the gravel and rock dump can still be seen on sonar image (Gardline 2020).



Concrete mattresses were placed on the pipelines between Callisto ZM and Ganymede ZD (PL1091 and PL1092). The mattresses were installed in 1996. These remained visible in 2006 but were confirmed to be fully buried by 2016 with no evidence of their presence and the seabed characteristic of the surrounding natural sediments (Figure 5-10).

Figure 5-10 Visual surveys of the same mid-location on PL1091/PL1092 between 2006 and 2016.



Chrysaor have also observed similar re-burial of pipeline deposits alongside platform locations whereby the increasing level of re-burial is demonstrable with distance away from the platform structure. Furthermore demonstrating the natural re-burial of the hard substrate and confirming that the actual area of long term habitat loss by the deposit of hard substrate is not necessarily representative of the long term area of habitat loss but also demonstrates the influence of the platform structures whilst they remain present. Removal of these structures as intended will remove any influence on the localised hydrodynamic regime and allow for further re-burial of surrounding rock deposits. Alongside the LOGGS PR platform structure the Clipper South gas import and methanol export pipelines PL2810 and PL2811 are observed. Rock deposits were placed on these pipelines in 2012. Through subsequent surveys in 2014 and 2016, the rock has remained visible at the platform location however, increasing cover with sediment is observed up to complete burial approximately 50 m from the platform structure. This is similarly observed with the Saturn pipelines PL2107 and PL2108 where re-burial is evident at a distance of 131 m from the LOGGS PR platform location

The slow release (on a scale of 60 – 100 years) of the metals associated with the pipeline steel and steel associated with the concrete coating and mattress protection is expected to have a negligible impact on the integrity of the SAC and the existing biological communities. The sandy (coarser fraction) of the sediments surrounding the pipelines are less likely to retain metals (MPE, 1999). Much of the surrounding seabed is composed of sand and will therefore release any metals to the surrounding seawater, making them bioavailable, but also diluting them in the wider environment.

Any construction on the sandbanks could lead to the obstruction of their natural movement. The natural development of a sandbank in terms of shifts in location and/or shape may be altered by the addition of materials or constructions. This could also affect sandbank recovery through changes in the local hydrographic regime. Sensitivity to obstruction is therefore considered high. Should this be the case, the presence of the existing infrastructure and other southern North Sea infrastructure could have enacted such a change. However, the bathymetry and seabed feature data collected during the baseline environmental surveys show evidence of megaripples around the installations. The continuation of these megaripples in areas of platforms and pipelines suggests that small scale disturbance such as these are no barrier to sandbank maintenance or formation. The physical presence of structures on sandbanks have been shown to not cause morphological impacts on sandbanks over anything but a localised area (Cefas, 2006) furthermore the sandbanks are likely to recover (Hill *et al*., 2011). Existing pipelines are not predicted to affect sandbank features, with surface features being uninterrupted by their presence and leaving them *in situ* is not predicted to increase the current extent of possible habitat loss or physical impact to the site. The communities and typical species across the SAC are predicted to remain the same with recovery occurring in areas of disturbance shortly after activities cease.

The sandbanks support communities of invertebrates which are typical of sandy sediments in the southern North Sea, including polychaete worms, isopods, crabs and starfish. Disturbance of these species is a possibility. However, it is likely that this will be temporary, and any species displaced or disturbed are expected to return rapidly to the area following operations. JNCC (2017a) consider sensitivity of invertebrates to be moderate given the ability of sandy communities to recover with sufficient time.

Cumulative Impact

Table 5-14 links back to previous tables in this section and includes the total potential (worst-case) impacts from physical disturbance and habitat loss within the NNSSR SAC. The Chrysaor LDP2 – LDP5 activities will physically disturb approximately 0.00045% of the seabed within the NNSSR SAC. Considering also the other SNS activities from Chrysaor and other operations (including non-oil and gas operations) this increases to a cumulative total of 5.73% of the SAC (Table 5-14). The footprint of the LDP2-LDP5 infrastructure within the NNSSR SAC is estimated to be 1.806 km^2, representing habitat loss in 0.05% of the NNSSR SAC (Table 5-5). Cumulatively with other activity within the SAC, this increases to 3.8%, (Table 5-14) but represents an absolute worst-case as some activities that represent temporary, physical disturbance have also been accounted for here.

Whilst a cumulative total area of SAC seabed affected by the SNS Programme activities of 3.8% (Table 5-14) might appear likely to result in significant impact, this area is affected by temporary disturbance only and is based around a worst-case scenario, accounting for external excavation of every pile.

For many of the activities identified in this section, the mobile sandbank habitat is expected to recover quickly, and there will be no long-term impact. On this basis, there will be no long-term cumulative impact on the SAC habitats from this temporary physical disturbance.

The long-term habitat loss resulting from the decommissioning of infrastructure *in situ* (and the rock that will remain) represents a small percentage of the SAC, at around 1.85% (Table 5-14). This infrastructure, provided it is adequately buried, will not prohibit the natural processes of the SAC from continuing (as outlined in Section 5.1.7). There is recognition that local species compositions can change following changes to the substrate type (rock / mattresses), however the prevalence of robust faunas, dominated by organisms which are capable of rapid burrowing should result in recovery and no actual long-term impact to species (DECC 2016). The ability of the sandbank species to recovery, and the fact that rock should gradually get covered by sand, should also ensure that any food chain linkages to prey species utilised by the Harbour Porpoise are not impacted.

Table 5-14 Seabed impacts (physical disturbance and habitat loss) due to LDP2 – LDP5 decommissioning activities predicted within the NNSSR SAC in relation to other activities occurring within the SAC

Table Reference	Activity	Area within NNSSR SAC (km^2)		Percentage of NNSSR SAC (%)	Area within SNS SAC (km^2)
Physical Disturbance (short-term)					
Table 5-9	LDP2 – LDP5 decommissioning impacts (including overtrawl surveys)	LDP2	0.00005	0.00000139	0.0036
		LDP3	0.006775	0.00018803	0.0019
		LDP4	0.0044	0.00012212	0.0072
		LDP5	0.0050428	0.00013996	0.0098
		Total	0.0162	0.00045149	0.022462
Table 5-9	Other elements of Chrysaor's SNS decommissioning programmes	131.089		3.6	
Table 5-11	Other oil and gas decommissioning activities[8]	11.74		0.38	
Table 5-12	Other oil and gas development works[9]	0.364		0.01	
	Total physical disturbance	**143.23**		**3.98**	**0.022**
Habitat Loss (long term)					
Table 5-8	LDP2 – LDP5 decommissioning impacts	LDP2	0.0000133	0.00000037	0.002253
		LDP3	0.0023064	0.000063977	0.00115
		LDP4	0.0051661	0.00014338	0.0045064

[8] The value presented here is a worse case estimate based on published DPs (Centrica, 2017a; Centrica, 2017b; Ithaca, 2019; Spirit Energy, 2019).

[9] The value presented here is a minimum based on currently available information.

		LDP5	0.0062694	0.00017400	0.0055266
Table 5-9	LDP2 – LDP5 existing impacts (excluding well P&A)	LDP2	0.26661	0.0074	
		LDP3	0.52063	0.0144	
		LDP4	0.38916	0.0108	
		LDP5	0.5321	0.0148	
Table 5-9	LDP2 – LDP5 well P&A impacts	LDP2			0.005978
		LDP3	0.011956	0.000331705	0.002989
		LDP4	0.011956	0.000331705	0.011956
		LDP5	0.011956	0.00033185	0.11956
Table 5-9	Other elements of Chrysaor's SNS decommissioning programmes	0.26		0.007	
Table 5-9	Chrysaor's SNS decommissioning programmes existing impacts	2.79		0.08	
Table 5-10	Historical stabilisation work in the SAC	0.01		0.0003	
Table 5-11	Other oil and gas decommissioning activities[10]	15.53		0.43	
Table 5-11 Table 5-12	Other oil and gas development works[11] (OPRED, 2019b)	0.0026		0.00052	
Table 5-12 Table 5-13	Other activities (Renewables and aggregate)	46.37		1.21	
	Total Habitat loss	**66.72**		**1.85**	**0.33**

[10] The value presented here is a minimum based on currently available information.

[11] The value presented here is a worst case based on information from published DPs.

The Other Activities includes the potential impact from Hornsea 3 windfarm cable, the application has been submitted but a decision is still pending. The value for habitat loss resulting from other activities is the impact within the SAC while Table 5-13 gives information on all the activities occurring within the vicinity of the SAC.

Consideration of Impact against Conservation Objectives within Areas of Decommissioning Activities

Table 5-15 summarises the impact assessment discussion above in the context of the Conservation Objectives for the site.

Table 5-15 Seabed impact due to LDP2 – LDP5 decommissioning activities predicted within the NNSSR SAC in relation to other activities occurring within the SAC

Conservation Objective Element	Will the proposed LDP2 – LDP5 activities affect the ability to meet this element?	Justification
The extent and distribution of the qualifying habitats in the site	No	The largest element of seabed disturbance will be temporary in nature, with full recovery expected in a short timescale. Permanent habitat loss through decommissioning of infrastructure *in situ* is estimated cumulatively for the entire SNS decommissioning programme at less than 0.4 km^2. In reality, the habitat loss will mostly be long term rather than permanent, since the infrastructure will degrade over time and be subject to natural burial. Rock will not degrade in the same manner but will be subject to erosion and burial over time. It should be noted also that no reef habitat is expected to experience any impact from the decommissioning activities, on account of no such habitat having been recorded within the project footprint.
The structure and function of the qualifying habitats in the site	No	Sandbanks are mobile in nature, and the sand waves and ripples exhibit a greater degree of mobility as the travel across the sandbanks. The associated sediments require unimpeded movement to maintain habitat function. As outlined above, evidence suggests installed infrastructure does not impede sediment or sand wave movement, and this the structure and function of the sandbank habitat will be unaffected by decommissioning *in situ* of some infrastructure. No interaction with reef habitat is expected on account of no such habitat having been recorded within the project footprint. Furthermore, the pipelines are being decommissioned *in situ* and so will not disturb the reef structures within the

		SAC. Therefore, there will be no impact on structure and function of this habitat type.
The supporting processes on which the qualifying habitats rely	No	Natural processes such as tidal flow, wave action, current velocity and direction and sediment transport will be unaffected.

Conclusion

The potential impacts from the proposed decommissioning activities in-combination with other plans or projects, including existing infrastructure, proposed renewables developments and aggregate extraction will cause physical impacts and a loss of habitat within the SAC. However, the extent of habitat loss and physical disturbance is estimated to be relatively localised and small in total area compared to the extent of habitat within the SAC. The ability to meet the site's Conservation Objectives will not be undermined by the proposed activities (including through cumulative impact), and the integrity of the site will not be compromised.

Southern North Sea SAC

Although the primary impact on the SNS SAC from the decommissioning activities is due to vessel noise, there is potential for a localised, temporary effect on the supporting habitats and their prey from the removal of installations and associated infrastructure. The physically impacted seabed is predicted to recover over a period of time depending on the local environment. Any disturbance to the seabed habitat that could affect either harbour porpoise or their prey within the SAC will be temporary. In the event that fish do relocate away from the decommissioning activities, they will return once the sound has stopped. Harbour porpoise will be able to find prey elsewhere within the SAC during the relatively short period of time that the activities are occurring within any one area. They will return once activities stop.

For these reasons, the planned decommissioning activities at LDP2 – LDP5, including planned cumulative activities, will not undermine the ability to meet the site's Conservation Objectives, and the integrity of the site will not be compromised.

Inner Dowsing, Race Bank and North Ridge SAC

The LOGGS PP to Theddlethorpe pipeline travels through the Inner Dowsing, Race Bank and North Ridge SAC. This site is designated for sandbanks slightly covered by water at all times and for reefs, both seabed features which have the potential to be impacted by the decommissioning of the pipeline.

The pipeline is planned to be decommissioned *in situ*; only non-intrusive post decommissioning surveying shall be carried out. As described in Section 5.1.3.1, sediments that are redistributed and mobilised as a result of the proposed decommissioning activities will be transported by the seabed currents before settling out over adjacent seabed areas. Disturbance to the seabed will be short term and due to the natural processes of sediment transportation the sites are expected to restore the seabed habitats to equilibrium within a year or similar timeframe.

For these reasons, the planned decommissioning activities at LDP2 – LDP5, including planned cumulative activities, will not undermine the ability to meet the site's Conservation Objectives, and the integrity of the site will not be compromised.

Humber Estuary SPA

The LOGGS PP to Theddlethorpe pipeline travels through the Humber Estuary SPA. It is a designated SPA due to the area being breeding ground for a number of species as well as providing suitable foraging habitats for many other birds.

The pipeline is planned to be decommissioned *in situ*; only non-intrusive post decommissioning surveying shall be carried out. As described in Section 5.1.3.1, sediments that are redistributed and mobilised as a result of the proposed decommissioning activities will be transported by the seabed currents before settling out over adjacent seabed areas. Disturbance to the seabed will be short term and due to the natural processes of sediment transportation the sites are expected to restore the seabed habitats to equilibrium within a year or similar timeframe.

For these reasons, the planned decommissioning activities at LDP2 – LDP5, including planned cumulative activities, will not undermine the ability to meet the site's Conservation Objectives, and the integrity of the site will not be compromised.

Greater Wash SPA

The LOGGS PP to Theddlethorpe pipeline travels through the Greater Wash SPA. It is a designated SPA due to the area providing areas of importance for over-wintering for the red-throated diver Gavia stellate, little gull *Hydrocoloeus minutus* and common scoter *Melanitta nigra*. In addition, the site aims to protect ideal coastal feeding waters used by breeding populations of common tern *Sterna hirundo*, sandwich tern *Thalasseus sandvicensis* and little tern *Sternula albifrons*.

The pipeline is planned to be decommissioned *in situ*; only non-intrusive post decommissioning surveying shall be carried out. As described in Section 5.1.3.1, sediments that are redistributed and mobilised as a result of the proposed decommissioning activities will be transported by the seabed currents before settling out over adjacent seabed areas. Disturbance to the seabed will be short term and due to the natural processes of sediment transportation the sites are expected to restore the seabed habitats to equilibrium within a year or similar timeframe.

For these reasons, the planned decommissioning activities at LDP2 – LDP5, including planned cumulative activities, will not undermine the ability to meet the site's Conservation Objectives, and the integrity of the site will not be compromised.

5.1.9 Residual impact

The residual impact to seabed habitat and benthic communities due to the planned decommissioning activities is summarised in Table 5-16.

The Humber Estuary SPA, Inner Dowsing, Race Bank and North Ridge SAC and Greater Wash SPA are not impacted by decommissioning activities as the infrastructure is planned to be decommissioned *in situ* and no physical decommissioning activity occurs within these sites. Any impacts associated with decommissioning the infrastructure *in situ* will be negligible and present no likely significant effect to these sites designated features or supporting habitats.

No MCZs are impacted as a result of decommissioning activities. There is no need to go assess the residual impacts on the Humber Estuary SPA, Greater Wash SPA, Inner Dowsing, Race Bank and North Ridge SAC and SNS SAC and MCZs

Table 5-16 Residual impact to seabed habitat and benthos

Receptor	Consequence	Likelihood
Sessile seabed organisms	Low	Frequent
Mobile organisms	Low	Frequent
NNSSR SAC seabed habitat	Low	Frequent

Rationale
Decommissioning activities at LDP2 – LDP5 will cause a physical disturbance to the local seabed environment due to subsea infrastructure removal. Physical disturbance not including overtrawl surveys is predicted to be limited to 0.0339 km^2. Recovery of sessile seabed and mobile organisms is predicted to be relatively quick due to the activities being in a high energy environment combined with the limited spatial and temporal scale of impact. On this basis the consequence, to mobile and sessile benthic organisms is considered to be low. The decommissioning activities will also cause direct habitat loss and habitat change due to the remaining footprint of subsea infrastructure and rock placement introducing hard substrata to the seabed. Additional rock placement will add approximately 0.016 km^2 of new hard substratum. Whilst this will be influenced by scour from tides and mobile sediments and may even become partially buried in places from time to time, it is likely that it will eventually support a low-diversity epifaunal community typical of the scattered stones and cobbles already present in the area. The added rock placement combined with 1.7086 km^2 of pipeline being decommissioned *in situ* may cause seabed morphological change and impact sediments due to subsea infrastructure breakdown. However, continuation of megaripples recorded in the NNSSR SAC in areas containing a platform and pipelines suggests that small scale installations such as these do not present barriers to sandbank maintenance or formation. Primary degraded products such as plastics, NORM, PAHs and heavy metals are predicted to cause negligible impacts on the surrounding sediments. For these reasons the consequence on the NNSSR SAC habitat are considered to be low. As the decommissioning activities are planned to occur in the near-future, therefore the likelihood of impact occurring is considered frequent for all receptors. Combining the consequence and likelihood rankings, the risk significance is defined as medium and thus not significant.

Risk significance	Impact significance
Medium	Not significant

5.2 Noise

5.2.1 Introduction

Many species found in the marine environment use sound to understand their surroundings, track prey and communicate with members of their own species. Some species, mostly toothed whales, dolphins and porpoise, also use sound to build up an image of their environment and to detect prey and predators through echolocation. Exposure to natural sounds in the marine environment may elicit responses in marine species; for example, harbour seals have been shown to respond to the calls of killer whales with anti-predator behaviour (Deecke *et al*., 2002). In addition to responding to natural sounds, marine species may also respond to man-made sound. The potential impacts of industrial noise on species may include impacts to hearing, displacement of the animals themselves and potential indirect impacts which may include displacement of prey species. Whilst there is a lack of species-specific information collected under controlled or well-documented conditions, enough evidence exists to suggest that sound may have a potential biological impact and that noise from man-made sources may affect animals to varying degrees depending on the sound source, its characteristics and the susceptibility of the species present (e.g. Nowacek *et al*., 2007, report this specifically for cetaceans). As well as potential behavioural impacts of noise, animals exposed to an adequately high sound source may experience a temporary shift in hearing ability (termed a temporary threshold shift; TTS) (e.g. Finneran *et al.*, 2005). In some cases, the source level may be sufficiently high such that the animal exposed to the sound level might experience physical damage to the hearing apparatus and the shift may not be reversed; in this case there may be a permanent threshold shift (PTS) (Southall *et al*., 2007), and the animal could be considered as being injured.

There are a number of activities that will occur during the LDP2 – LDP5 decommissioning activities that could emit noise to the marine environment, and which could potentially impact to some degree on marine animals:

- Use of vessels;
- Underwater cutting of the jacket (piles, risers and members); and
- Underwater cutting of the exposed ends of the pipeline and umbilicals/jumpers.

During the scoping for the impact assessment outlined herein, the potential for impact on a number of marine species groups was considered. Marine mammals were considered generally to be at a greater risk of potential impact from injury and disturbance from noise, both individually and at the population level, than other species groups. Furthermore, the location of the LDP2 – LDP5 activities within the SNS SAC elevates the sensitivity of this receptor group. The potential impact of the noise-emitting activities from the LDP2 – LDP5 activities on marine mammals is, therefore, discussed in the following sections. There is no decommissioning activities envisioned in any other designated sites which may be affected by these noise generating activities. All subsea structures, significant spans and jackets are located either in the SNS SAC or the NNSSR SAC. However, only the SNS SAC designated features or habitats have the potential to be impacted to any level of significance above negligible.

NOAA technical memorandum NMF-OPR-55, July 2016

Recently, the U.S. National Oceanic and Atmospheric Administration (NOAA) has updated its marine mammal noise exposure criteria to reflect recent advances in the field (Technical Memorandum NMFS-OPR-55) (NOAA, 2018) based on the Southall *et al*. (2007) paper and more recent studies including Southall *et al*. (2019). These recommendations are discussed as follows.

NMFS-OPR-55 provides technical guidance for assessing the effects of anthropogenic sound on the hearing of marine mammal species under the jurisdiction of the National Marine Fisheries Service (NMFS) and was completed in collaboration with the National Ocean Service (NOS), Office of National Marine Sanctuaries. Specifically, it identifies the received levels, or acoustic thresholds, at which individual marine mammals are predicted to experience changes in their hearing sensitivity for acute, incidental exposure to all underwater anthropogenic sound sources. The Guidance document is intended for use by developers and stakeholders to determine whether and how their activities are expected to result in impacts to marine mammal hearing via acoustic exposure albeit in the US. The JNCC is yet to adopt these recommendations (see below).

It states that the acoustic thresholds presented in the document do not represent the entirety of an effects analysis, but rather serve as one tool among others (e.g., behavioural impact thresholds, auditory masking assessments, evaluations to help understand the effects of any particular type of impact on an individual's fitness, population assessments, etc.), to help evaluate the effects of a proposed action.

The NOAA underwater acoustic thresholds for the onset of permanent and temporary threshold shifts for cetaceans and pinnipeds (both sub-species phocid and otariid are covered) are summarised in Table 5.19.

Table 5.19 Suggested marine mammal criteria for onset of injury (per 24 hr period) (US NOAA, 2018)

Marine mammal group	Type of sound	Injury criteria	
		Peak pressure, dB re 1 µPa[1]	Cumulative SEL[2], dB re 1 µPa2s (M-weighted)
Low-frequency cetaceans	Single or multiple pulses – e.g. impulsive	219	183
	Non-impulsive e.g. continuous sound	-	199
Mid-frequency cetaceans	Single or multiple pulses – e.g. impulsive	230	185
	Non-impulsive e.g. continuous sound	-	198
High-frequency cetaceans	Single or multiple pulses – e.g. impulsive	202	155
	Non-impulsive e.g. continuous sound	-	173
Phocid Pinnipeds (underwater)	Single or multiple pulses – e.g. impulsive	218	185
	Non-impulsive e.g. continuous sound	-	201
Otariid Pinnipeds (underwater)	Single or multiple pulses – e.g. impulsive	232	203

[1] Peak sound pressure should be unweighted within the generalised hearing range

[2] The recommended accumulation period is 24-hour

	Non-impulsive e.g. continuous sound	-	219

It should be noted that for very high frequency cetaceans (such as harbour porpoise (Southall *et al*. 2019)) the cumulative SEL limits for a Permanent Threshold Shift are significantly more prescriptive (multi-pulse 155 vs 198 re 1 μPa^2s) and therefore the impact is also likely to be significantly greater when adopting the NOAA's limits. Limits for a Temporary Threshold Shift are 140 re 1 μPa^2s (cumulative SEL) and 196 re 1 μPa^2s (peak SEL) (Southall *et al*. 2019).

5.2.2 Description and quantification of potential impact

Vessels

Noise emissions from vessels occur continuously during operation of the vessel, appearing louder as animals approach the vessels, and appearing quieter as animals move away. Such continuous noise sources are generally of less concern than intermittent sources (e.g. such as seismic conducted during exploration activities) where relatively high doses of noise can be received by animals over a very short period of time with little warning. Indeed, source levels for vessels rarely exceed 190 dB re 1 µPa @ 1 m and are typically much lower. Nevertheless, comparison of the noise emitted from vessels against noise levels at which injury or disturbance might occur can be made to better understand the potential for impact. Typically, such a comparison is done as part of a quantitative noise propagation modelling exercise, since that exercise can also make predictions about the range over which noise levels may exert some sort of negative impact. As part of its Southern North Sea Decommissioning Project, Chrysaor commissioned underwater noise propagation modelling; this modelling gives an indication of likelihood of injury and disturbance occurring, and the potential spatial extent of impact. The modelling made use of the Nedwell *et al*. (2007) $dB_{ht(species)}$ approach which says that all species with well-developed hearing are likely to avoid sound when the level exceeds 50 to 90 dB above their hearing threshold and receive damage to hearing organs at 130 dB above their hearing threshold. The approach permits use of species-specific audiograms (i.e. descriptions of hearing ability) to filter received noise levels according to the hearing ability of a species, giving sound levels in $dB_{ht(species)}$ which represent the loudness of the sound perceived by that species. The distance from the operations to the points at which 130 $dB_{ht(species)}$ and 90 $dB_{ht(species)}$ are exceeded represents, respectively, an estimate of the limits within which injury and likely avoidance might be expected. Predictions are summarised in Table 5.20.

Table 5.20 Predicted injury and disturbance (i.e. avoidance) zones resulting vessel use

Species	Maximum radii of injury from vessel use	Maximum range of disturbance from vessel use (m)
Harbour porpoise	No injury predicted	95
Bottlenose dolphin	No injury predicted	106
White-sided dolphin	No injury predicted	29
White-beaked dolphin	No injury predicted	14
Minke whale	No injury predicted	16
Long-finned pilot whale	No injury predicted	16
Grey seal	No injury predicted	9
Common seal	No injury predicted	26

It should be noted that the noise propagation modelling conservatively assumed that up to eight vessels could be at a single location at any one time during the decommissioning operations; where fewer vessels are present, the maximum ranges quoted in Table 5.20 would be reduced.

Cutting

The jacket removal methodology retains an option to cut using a number of possible methods, including diamond-wire cutting, abrasive water jetting and hydraulic shearing. As part of the underwater noise modelling study for its southern North Sea decommissioning activities, a review of cutting noise emissions was undertaken and few relevant studies were found to be available in the literature. Of the limited literature specifically citing source levels that is currently available, Anthony *et al*. (2009) report the peak source level for oxy arc cutters as 148 dB re 1 µPa @ 1 m and for cable cutters at 163 dB re 1 µPa @ 1 m. Pangerc *et al*. (2016) report very recent analysis of sound radiating from diamond wire cutting of a conductor in the North Sea, stating that the noise was not easily discernible above the background noise (which included the presence of several operational vessels). Since field measurements undertaken to record cutting emissions in the context of potential effects on marine life are otherwise limited, a worst-case assumption has been made in this assessment that noise emissions from diamond-wire cutting and abrasive water jetting may extend up to 195 dB re 1 µPa @ 1 m (André et al, 2009). As such, as this is a worst-case scenario assumption and in the absence of recorded field measurements, it is not possible to further inform the source levels used in the assessment and subsequent injury and disturbance ranges. It seems likely that this form of cutting would generate less noise than mechanical cutting techniques and may not be detectable above other sources operating simultaneously (i.e. vessels).

The subsea decommissioning options involve the cutting of the ends of lines by hydraulic shears and diamond wire prior to rock placement on, or burial of, the ends. Since the cutting will be conducted using only hydraulic shears, further assessment of cutting for subsea decommissioning activities is not necessary.

5.2.3 Injury

The sound propagation model results outlined above indicate that injury is unlikely to occur for any of the cetacean or seal species within the vicinity of the vessel operations. Source levels for cutting activities are similar to or below those expected from vessels. Given that the noise modelling undertaken for vessels show no injury is likely, the same can be concluded for cutting activities. As such, no injury is expected from the decommissioning activities.

5.2.4 Disturbance

Vessels will be present intermittently within the project area over an eight-year period and the potential for disturbance cannot be excluded based on a limited time period of activity. It is important therefore to review the potential avoidance zones outlined in Table 5.20 to understand whether the presence of vessels for such a period of time could result in significant disturbance (taken to mean changes in the population of the species). The threshold disturbance (in the form of an avoidance reaction) may be exceeded during vessel operations and there could be some impact on marine mammals in close proximity of vessel operations. Although the size of the avoidance zones will vary by species, potential avoidance is predicted to be limited to a maximum of 106 m, and for most species is less than 30 m. JNCC (2010b) note that behavioural changes such as moving away from an area for short periods of time, reduced surfacing time, masking of communication signals or echolocation clicks, vocalisation changes and separation of mothers from offspring for short periods, do not necessarily imply that detrimental effects will result for the animals involved. Given these potential avoidance zones are so small, animals are likely to have to move only a matter of tens of metres away from vessels. Therefore, even though vessels will be present intermittently at different locations, the highly limited zone of potential avoidance means that there is no mechanism to impact the population of any marine mammal species. As such, no significant disturbance is expected from the vessel activities.

Cutting using diamond-wire cutting or abrasive water jetting is retained as an option for cutting of the jacket structure and the piles which fix the jackets to the seabed. For the purposes of worst-case assessment, the cutting of 14 jackets (and associated 61 piles) and the piles associated with two of the subsea and pipeline structures (NW Bell ZX, Callisto ZM and the two PL454 Tees) can be assumed to occur. Such activities will occur intermittently over a four-year period, with each cut taking a matter of hours each. For the 61 jacket piles, cutting will occur internally, limiting somewhat the propagation of noise compared to an open water cut. Additionally, the piles will be cut approximately 3 m below the seabed, providing further limitation on the propagation. Given that the estimated source level for cutting is similar to those predicted for vessels, it is likely that estimated avoidance zones would be similar to those predicted for vessels (Table 5.20). As described above for vessels, the likely avoidance zones are so limited that significant disturbance is not likely to occur.

5.2.5 Mitigation measures

On the basis of the expected noise emissions, there is no requirement to adopt additional mitigation to limited potential for impact. However, there are control measures built into the project that will ensure noise emissions are not greater than would be required to execute the decommissioning activities. For example, machinery and equipment will be well-maintained and the number of vessels will be minimised as far as possible.

5.2.6 Cumulative impact

It is possible that the various noise sources (e.g. vessels, cutting) associated with the LDP2 – LDP5 decommissioning activities as described herein could act cumulatively to impact negatively on marine mammals. However, the impact assessment above has considered the use of multiple vessels at any one time (up to eight as a worst case) and demonstrates that injury through cumulative noise emissions is not expected. Whilst disturbance zones will exist from multiple use of vessels, the predicted zones are sufficiently small that significant disturbance is not expected. As such, cumulative impact from sources within the LDP2 – LDP5 decommissioning activities are therefore not expected.

In theory, any activities that will emit underwater noise in the southern North Sea have the potential to act cumulatively with the LDP2 – LDP5 decommissioning activities to impact upon marine mammals. This includes well plug and abandonment activities for the wells associated with the LDP2 – LDP5 infrastructure, which will see 59 wells plugged and abandoned. As per the schedule in Section 2.2, there could be some overlap in the period during which well plug and abandonment and jacket/subsea decommissioning activities take place. Whilst assessment of those well plug and abandonment activities is taking place through the MATs/SATs process (i.e. outside of the DP submission), since those activities will be undertaken as part of Chrysaor' wider southern North Sea decommissioning activities it is important that they are considered as part of this cumulative impact assessment.

The well plug and abandonment activities will make use of a jack-up rig, where the legs of the drilling rig are placed on the seabed for the duration of the well plugging and abandonment activities. The use of a jack-up rig as opposed to a dynamically positioned rig means relatively little noise emissions. The jack-up rig expected to be used for the well plug and abandonment activities is not self-propelled and requires towing to and from location. On this basis, the noise emissions from the manoeuvring of the jack-up rig onto site are likely to be below those anticipated from the jacket and subsea decommissioning activities (since they consider eight vessels rather than the one or two required for well plug and abandonment). Temporally, the noise emissions will be limited to the manoeuvring of the jack-up rig between well locations, which should extend only to a matter of days.

The actual well plug and abandoning that will occur once the jack-up is in place should involve relatively little noise emissions and are noted by JNCC (2010b) to be of little concern for cetaceans in most situations (the exception being extended activities in close proximity to very small populations that are spatially restricted, which does not apply to the offshore southern North Sea). During well abandonment operations, there may be a requirement to use either a tubing conveyed perforating gun or jet (explosive) cutter during cutting and perforating operations on the wells. Explosives will be used deep in the well (circa 6000 ft below mudline) as part of the initial suspension to allow communication between the tubing and annulus. Explosive perforating and cutting tools will also be used at circa. 200 ft below the mudline as part of the final environmental cap setting operations.

Although the proposed operations are located in the SNS SAC for harbour porpoise (Annex II species), it is demonstrated that even by using a large zone of behavioural change that <0.0002% of the population would be impacted. The source of noise will be slightly higher than background levels for a brief period during abandonment operations. However, significant impacts are not expected to cetaceans using the area and in particular the harbour porpoise which qualifies for European protection. As these explosives will be used downhole, they are not expected to generate levels of underwater noise that could be of any concern to marine mammals (Genesis, 2010). It is concluded that operations would be largely undetectable against natural variation and would have no significant effect at the population level. On the basis of the limited noise emissions from well plug and abandoning, there is considered to be no mechanism to injure marine mammals and thus

no potential for cumulative impact with the other LDP2 – LDP5 activities. Whilst it is possible that some disturbance could occur within a few tens of metres of the well plug and abandonment activities, such disturbance would not result in animals having to move away from the well plug and abandonment activities. Even if the animals did, the highly limited disturbance zones from the jacket and subsea decommissioning activities would not prevent normal feeding, breeding and functioning taking place, and there will be no significant cumulative impact between the well plug and abandonment and the jacket/subsea decommissioning activities. It is not considered likely that harbour porpoises would be excluded from more than 20% (or more than an average of 10% during the season) of the relevant area of the site due to in-combination effects of WIA activities with ongoing decommissioning with the SNS SAC.

The LDP2 – LDP5 activities (including well plug and abandonment) will occur as part of Chrysaor's wider southern North Sea decommissioning activities over a ten-year period, which will include activities assessed in the LDP1 and VDP1 Environmental Statements. Since injury is not anticipated from any decommissioning activities, cumulative impact could only occur through disturbance to marine mammals. If the activities involved in each phase of the decommissioning resulted in animals avoiding large parts of the southern North Sea, such an extended period of activities could have the potential to significantly negatively impact marine mammals. However, as described above for the jacket, subsea and well plug and abandonment activities, avoidance of activities is anticipated to occur only within tens of metres around even the loudest sources. Since the Viking and LOGGS decommissioning activities will be phased, there will be a limited number of areas within which activities will be occurring at any one point in time. As such, animals are anticipated to avoid only a few areas immediately around vessels over the duration of the southern North Sea decommissioning programme. Given the extent of the southern North Sea, and the area over which marine mammals are known to range (i.e. for harbour porpoise this is the entire North Sea, as per IAMMWG, 2015), avoidance of such a small area will not negatively affect feeding, foraging and normal functioning. As such, the ten-year period of decommissioning activities will not result in significant disturbance to marine mammals.

Further to Chrysaor's wider southern North Sea decommissioning programme, it is recognised that the southern North Sea is utilised for a number of other purposes, including other oil and gas extraction, fishing, renewable energy (including the Norfolk Vanguard Windfarm), aggregate extraction and dredging. Animals experiencing noise emissions from the LDP2 – LDP5 activities, and indeed Chrysaor's wider southern North Sea decommissioning activities, would likely experience noise from these other activities. If the noise overlaps in time and space, additional injury or disturbance compared to the activities alone could occur. For cutting of the jacket and seabed piles associated with the LDP2 – LDP5 structures and for vessel use associated with the platform and subsea decommissioning, injury is not expected, and disturbance will be limited to tens of metres. Given there should be no non- Chrysaor activities occurring within such close proximity to the platforms, there will be no potential for injury through cumulative impact. The potential avoidance zones from the cutting and vessel use will be localised, noise will be intermittent and will occur in isolation, therefore not contributing to a wider (cumulative) impact. This activity is not deemed sufficient to exclude marine mammals from a significant remaining portion of their habitat. On this basis, the impact is not deemed significant and there can be no cumulative noise-related impacts from the decommissioning activities.

Chrysaor will have the opportunity to assess cumulative impacts of acoustic activities generated by other developments in combination with decommissioning activities via the submission of Marine Licences for individual activities.

5.2.7 Transboundary impact

The LDP2 – LDP5 decommissioning activities (from the closest installation) are located approximately 45 km west of the UK/ Netherlands median line. Given the noise sources involved in the project, direct transboundary impact from noise emissions is not likely to occur. However, marine mammals are free-ranging animals and any impact that occurs in UK waters is likely to involve individuals that belong to a much wider ranging population and which are likely to cross median lines. Such a potential impact could qualify as a transboundary impact. However, since injury and disturbance from the activities associated with LDP2 – LDP5 are not expected to result in significant impact to any population, potential transboundary impacts are also therefore considered not significant.

5.2.8 Protected sites

Sites designated under the Habitats Directive

There are four species of marine mammal listed on Annex II of the Habitats Directive that are known to occur in UK waters, and these species are those for which Special Areas of Conservation can be designated. Any plan or project which either alone or in-combination with other plans or projects would be likely to have a significant effect on a qualifying site must be subject to an Appropriate Assessment to determine the implications for a site's integrity and conservation objectives. Whist it is the decision of the Competent Authority (in this case, OPRED) to determine the need for, and undertake if required, an Appropriate Assessment, the onus is on the project applicant to provide the necessary information to support such an assessment, should it be required.

The first step in this process is to understand which sites could potentially be affected by the proposed activities; in Appropriate Assessment terms, any activities which could exert a 'Likely Significant Effect' on the integrity of a site require further assessment. Initially, therefore, a filter can be applied to protected sites based on known range of animals; if animals will not reach the project area, the protected sites to which they belong can be ruled out of further consideration of potential for Likely Significant Effect.

No overtrawling will take place along the pipeline lengths or within designated sites for seabed features or habitats. Other than the noise that has been previously assessed within the EA there are no significant impacts of SACs and SPA species or supporting habitats as a result of decommissioning activities. All subsea structures are either located in the SNS SAC or within the NNSSR SAC, however the operations are unlikely to have any significant effect on either the species ore the supporting habitats for the NNSSR SAC designated features/ species, resulting in no likely significant effect on this SAC or any other SACs or SPAs. The pipelines associated with the Greater Wash SPA and the Humber Estuary SPA will have no decommissioning activities taking place which generate any underwater noise.

The LDP2 – LDP5 decommissioning activities are beyond the predicted foraging range for bottlenose dolphin from either the Moray Firth or Cardigan Bay SACs and these protected sites can be ruled out of further assessment. These activities, as well as other activities including the installation of wind turbines and the potential for unexploded ordnance detonations could potentially occur within the SNS SAC, which is designated for harbour porpoise and the potential for Likely Significant Effect on this site requires consideration. For harbour and grey seals, whilst density in the vicinity of the LDP2 – LDP5 activities is low (Section 4.4.2), typically accepted foraging ranges for these species are 50 km and 200 km respectively, which means that the LDP2 – LDP5 activities are within range of harbour seals from The Wash and North Norfolk Coast SAC and grey seals from the Humber

Estuary SAC. As such, the potential for Likely Significant Effect requires consideration; this assessment is detailed in Table 5-17.

Table 5-17 Potential for Likely Significant Effect on SACs

Site	Qualifying feature	Potential for Likely Significant Effect?	Justification
Southern North Sea SAC	Harbour porpoise	No	The LDP2 – LDP5 decommissioning activities will occur largely within the SNS SAC, and animals from this site are known to range throughout the North Sea. The potential avoidance zones from the cutting and vessel use associated with oil and gas and other users will be localised, noise will be intermittent and will occur in isolation, therefore not contributing to a wider (cumulative) impact. This activity is not deemed sufficient to exclude harbour porpoise from a significant (20% or 10% over a season) remaining portion of their habitat. On this basis, the impact is not deemed significant and there can be no cumulative noise-related impacts from the decommissioning activities.
The Wash and North Norfolk Coast SAC	Harbour seal	No	Although there is connectivity between the site and the area within which the activities will occur there is expected to be no injury to grey seals and the levels of disturbance from underwater noise expected to be highly localised and temporary in nature. Given the limited use of the offshore area by grey seals, there is considered to be no potential to significantly impact grey seals at the individual or the population level, even cumulatively with other projects. As such there will be no adverse effects on the integrity of the SAC.
Humber Estuary SAC	Grey seal	No	Although there is connectivity between the site and the area within which the activities will occur there is expected to be no injury to grey seals and the levels of disturbance from underwater noise expected to be highly localised and temporary in nature. Given the limited use of the offshore area by grey seals, there is considered to be no potential to

Site	Qualifying feature	Potential for Likely Significant Effect?	Justification
			significantly impact grey seals at the individual or the population level, even cumulatively with other projects. As such there will be no adverse effects on the integrity of the SAC.

Note: The impact of overtrawl on inshore SACs, MCZs and SPAs is not considered as there is not any overtrawling planned to occur within any of these sites.

As can be seen from Table 5-17, the potential for Likely Significant Effect from the proposed activities cannot be ruled out at the early screening stage for the SNS SAC. Further information for this site and the potential for interaction is therefore required to support any potential Appropriate Assessment. As part of the approvals process for the VDP1 and LDP1 Decommissioning Programme, OPRED undertook a Habitats Regulation Appraisal (i.e. an Appropriate Assessment) for the SNS SAC which considered the activities associated with that programme of activities (BEIS, 2017) and a look-ahead consideration of Chrysaor's forthcoming decommissioning activities, including those proposed for LDP2 – LDP5 (i.e. those activities assessed herein). BEIS (2017) concluded that, based on the best available information on current and likely forthcoming activities, it was "satisfied that the planned decommissioning activities will not have an adverse effect upon the integrity of the Southern North Sea cSAC". To understand whether the conclusions of the HRA are likely to still be applicable, it is useful to review the assumptions regarding noise emissions that were made at the time with the current proposed activities for LDP2 – LDP5; this is reviewed in Table 5-18. On the basis that the assumptions made in the HRA remain appropriate, it is likely that the conclusions of the HRA will remain unchanged, should OPRED determine a requirement to update the HRA on the basis of the information presented in this assessment.

Table 5-18 Comparison of assumptions made in the HRA with the current proposed LDP2 – LDP5 activities

Assumption made in the HRA	Current proposed activities for LDP2 – LDP5	Likely implication for HRA conclusion
The activities assessed in the HRA as likely to emit noise were cutting of the jacket, piles and infield lines, and the use of vessels.	The activities proposed for LDP2 – LDP5 which may emit noise are cutting of the jacket, piles and infield lines, and the use of vessels.	No implication for the conclusion on site integrity, as activity types are the same.
The HRA assumed that disturbance could occur around vessels out to 1 km. Assuming eight vessels operating more than 1 km apart, harbour porpoises within a total of 25.12 km^2 of sea area were assumed to be disturbed.	Up to eight vessels may be present for the LDP2 – LDP5 activities, as assumed in the HRA. Modelling to support Chrysaor's Southern North Sea decommissioning activities assumed eight all vessels would be present at one location, to ensure that the worst-case noise levels at any location were considered. In reality, all eight	The HRA assumes worst case disturbance zones and there is no implication for the conclusion on site integrity.

Assumption made in the HRA	Current proposed activities for LDP2 – LDP5	Likely implication for HRA conclusion
	vessels would be ordinarily be distributed further apart so more avoidance zones would exist. However, the avoidance zones assessed herein would be smaller since the noise emissions would be lower at each location, and on balance this would is likely to result in no more or less disturbance than assessed herein. If the modelling presented herein was incorporated into the HRA, the potential for impact on the SAC would be further reduced.	
Harbour porpoise baseline data relied on density information from Heinanen and Skov (2015)	Updated information on harbour porpoise density in the southern North Sea is available from the latest SCANS-III surveys (Hammond *et al.*, 2017). Hammond *et al.* (2017) note that the observed distribution of harbour porpoises in the SCANS-III surveys was similar to that observed from SCANS-II surveys in 2005 and there is no reason to assume the baseline densities used in the HRA report are not still representative of harbour porpoise use of the area.	No implication for the conclusion on site integrity, as baseline data is likely still current.
Population estimate for the protected site was taken to be analogous to the North Sea management unit for harbour porpoise. This estimate was 227,298 animals (IAMMWG, 2015).	Hammond *et al.* (2017) report no evidence to support a change in abundance in harbour porpoise in the North Sea since 1994.	No implication for the conclusion on site integrity, as the population estimate against which impact was assessed in the HRA is likely still current.
Information to inform the assessment of cumulative impact with non-Chrysaor noise sources relied on vessel data from 2014.	The information on vessel use of the southern North Sea was based on data from the Marine Management Organisation covering 2014. Since the HRA was conducted, a new dataset covering 2015 has been released. The two datasets have been compared and appear to show no	No implication for the conclusion on site integrity, as baseline data is still current.

Assumption made in the HRA	Current proposed activities for LDP2 – LDP5	Likely implication for HRA conclusion
	substantive change in vessel use between the two years.	

Sites designated under the Marine and Coastal Access Act

In addition to sites designated for Annex II species under the Habitats Directive, sites can also be designated under the Marine and Coastal Access Act for a wide range of species and habitats. As described in Section 4.5, a number of such sites have been designated in the southern North Sea. In terms of noise emissions, it is sites designated for marine mammals that are of relevance, and only those sites within known ranges of those marine mammals. Filtering on this basis, there are no designated sites under the Marine and Coastal Access Act of relevance to this assessment as none of these sites protect marine mammals.

5.2.9 Residual impact

The residual impact on marine mammals resulting from noise emissions due to the planned decommissioning activities is summaries in Table 5-19.

Table 5-19 Residual impact to marine mammals resulting from noise emissions

Receptor	Consequence	Likelihood
Marine mammals	Negligible	Frequent
Rationale		
Decommissioning activities associated with LDP2 – LDP5 will result in the emission of noise. However, noise emissions are expected to be sufficiently low that injury will not occur from any of the activities. With regards disturbance, potential zones of avoidance around vessels or cutting activities are not predicted to extend beyond approximately 100 m. Even though the decommissioning activities will take place over a number of years, these highly limited potential avoidance zones will not result in significant disturbance to any marine mammal population. On this basis that the impact will be transitory, highly localised and largely undetectable against natural variation, the consequence to marine mammals is ranked as negligible. As the decommissioning activities are planned to occur in the near future, the likelihood of impact occurring is considered frequent. Combining the consequence and likelihood rankings, the risk significance is defined as medium and thus not significant.		
Risk significance	**Impact significance**	
Medium	Not significant	

5.3 Waste

5.3.1 Overview

The duty of care with regards to appropriate handling and disposal of waste rests with the LDP2 – LDP5 project team. In order to identify appropriate measures for handling waste safely, it is necessary to understand the regulations under which waste is handled and the key sources of waste. Section 5.3.2 describes the regulatory control of waste material whilst Sections 5.3.3 outline the types of waste material that will be generated as a result of the proposed decommissioning activities. Section 5.3.4 details the measures that will be in place to ensure waste is appropriately managed. It should be noted that waste operations for the Decommissioning Programmes for LDP2 through to LDP5 will be managed as one along with Chrysaor's other southern North Sea decommissioning activities.

5.3.2 Regulatory control

The EU's Revised Waste Framework Directive (Directive 2008/98/EC) was adopted in December 2008. The aim of the directive is to ensure that waste management is carried out without endangering human health and without harming the environment. Article 4 of the directive also states that the waste hierarchy shall be applied as a priority order in waste prevention and management legislation and policy.

Decommissioning activities will generate quantities of controlled waste, defined in Section 75(4) of the Environmental Protection Act 1990 as household, industrial and commercial waste or any such waste. The sequence and quantities of controlled waste generated at any one time will depend on the processes used for dismantling and the subsequent treatment and disposal methods.

Three key challenges are associated with waste management for the LDP2 - LDP5 infrastructure.

Generation of large quantities of controlled waste within short timeframes. This will require detailed planning to manage the logistics associated with the transport to shore, temporary storage and onward treatment/ disposal of materials.

Potential for "problematic" materials, generated due to cross–contamination of non-hazardous waste with substances that have hazardous properties, which results in the material being classified as hazardous waste. Hazardous waste is defined as material that has one, or more, properties that are described in the Hazardous Waste Directive (91/689/EEC) as amended by Council Directive 94/31/EC.

Problems associated with materials with unknown properties at the point of generation. These quantities of 'unidentified waste' require careful storage and laboratory analysis to determine whether they are hazardous or non-hazardous waste.

In accordance with the OPRED Offshore Oil and Gas Decommissioning Guidance Notes (2018) under the Petroleum Act 1998, the disposal of such installations should be governed by the precautionary principle. Chrysaor will assume the worst-case, especially when dealing with hazardous and unidentified wastes, and choose waste treatment options which would result in the lowest environmental impact.

5.3.3 Sources of waste

Routine vessel waste

The discharge of food waste, bilge water and grey water (water and chemicals from washing and laundry facilities) from vessels to sea during the decommissioning operations has the potential to cause short-term, localised organic enrichment of the water column and an increase in biological oxygen demand. This could contribute to a minor increase in plankton and attract fish to the area. However, food waste is typically macerated to increase the rate of dispersion and biodegradation at sea and wastewater will be treated appropriately before being discharged to sea, in accordance with the requirements of the MARPOL convention. Ballast water discharges will be in accordance with the International Maritime Organisation Ballast Water Management Convention, including a ballast water plan and logbook.

Radioactive waste and Naturally Occurring Radioactive Waste (NORM)

Radioactive wastes including sources (e.g. smoke detectors) and NORM associated with pipework and sand from vessels will be managed in line with current legislative requirements. Chrysaor has a procedure in place for managing radioactive waste, and the local rules for working with radioactive materials will be revised to include the removal and transportation of radioactive materials during decommissioning in consultation with the relevant authority depending on the location of disposal/treatment site. Any NORM and radioactive materials will be disposed of via a licensed facility capable of taking contaminated material and disposing of it using an appropriate method (e.g. incineration). Chrysaor will work to current NORM procedures in existence for southern North Sea operations.

Waste generated during preparation for decommissioning

During cleaning, the topside systems will be depressurised, purged, flushed and rendered safe for removal. Pipelines and tanks will be drained to remove oil residues and other fluids. All pipelines have been flushed with the aim of cleaning the lines down to 30 mg/l hydrocarbon content. The flushed contents will be deposited in the North Valiant PD 05/03 disposal well. Diesel and lubricating oils will be returned to shore for disposal. Mobilised solids recovered from pipeline flushing will be sent to fully permitted onshore treatment facility. Waste disposal will be in line with Chrysaor's Waste Management Strategy, as discussed in Section 5.3.4.

Waste from dismantling of offshore structures

Facilities requiring removal as part of the LOGGS Decommissioning Programmes will be transferred to shore by a heavy lift vessel for decontamination, dismantlement, disposal, recycling or reuse. Typically, around 95% of the materials from decommissioning projects can be recycled (OGUK, 2016a). OGUK (2016b) reported that all of the 4,300 tonnes of scrap metal brought onshore from decommissioning projects in 2015 was reused or recycled.

For materials where reuse or recycling is not an option, these will be sent to appropriate disposal facilities for recovery, or landfill where other options are not viable. In terms of the waste hierarchy, recovery is more beneficial than landfill since it means a waste product is used to replace other materials that would otherwise have been used to fulfil a particular function; in the case of concrete, for example, any mattresses recovered may be crushed to form construction aggregate, meaning that construction aggregate need not be created from scratch.

Any hazardous wastes remaining in the recovered infrastructure will be disposed of under an appropriate permit. It is likely that there will be small volumes of residual hydrocarbons, chemicals (such as in the umbilical jumpers) and naturally occurring radioactive material; such equipment will be disposed of in accordance with relevant Safe Operating Procedures and the Chrysaor Waste Management Strategy with consideration of specific sampling, classification, containment, and consignment conditions.

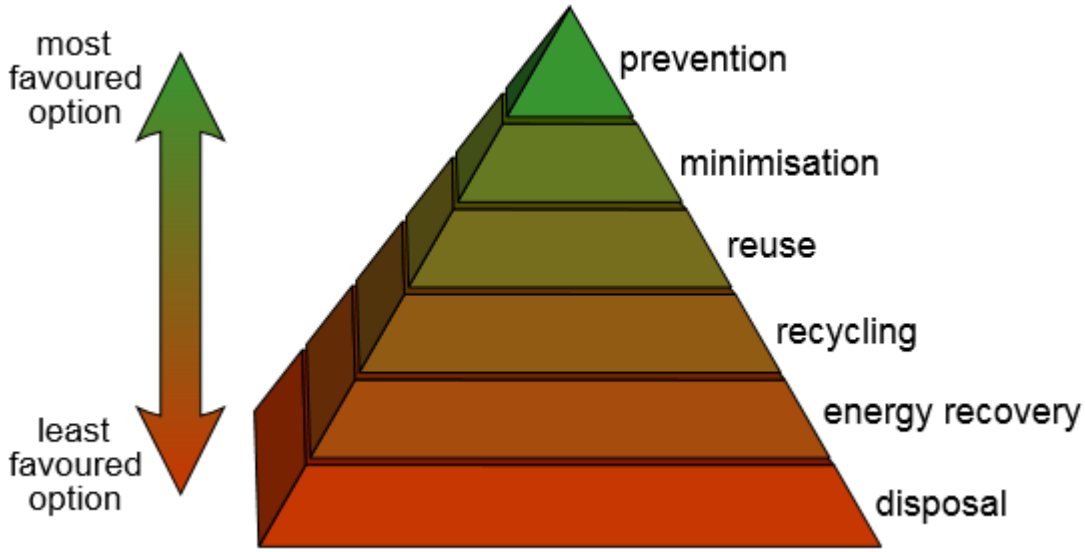
Most of the marine growth recovered will be soft marine growth (e.g. anemones and the soft coral), but hard marine growth is likely to include tube worms, barnacles and mussels. The receiving dismantling yard will strip the installation into its components before they undergo further processing and it is proposed that marine growth be either disposed of to landfill or composted. An alternative option is to send some of the marine growth to be disposed of at an anaerobic digestion facility for use as a fertiliser on land. However, these facilities can only take limited volumes of material.

5.3.4 Waste management strategy

The onshore treatment of waste from the LDP2 – LDP5 activities will be undertaken according to the principles of the waste hierarchy, a conceptual framework which ranks the options for dealing with waste in terms of sustainability (Section 5.3.4). The waste hierarchy is a key element in OSPAR Decision 98/3 and OPRED Offshore Oil and Gas Decommissioning Guidance Notes (2018) under the Petroleum Act 1998.

Non-hazardous waste material, such as scrap metal, concrete and plastic not contaminated with hazardous waste, will, where possible, be reused or recycled. Other non-hazardous waste which cannot be reused or recycled will be disposed of to a landfill site. Hazardous waste resulting from the dismantling of the LDP2 – LDP5 facilities will be pre-treated to reduce hazardous properties or render it non-hazardous prior to recycling or disposing of it to a landfill site. Under the Landfill Directive, pre-treatment is necessary for most hazardous wastes destined to be disposed of to a landfill site.

Figure 5-11 Waste management hierarchy[12]



The management of waste generated from operations and drilling activities has been addressed by Chrysaor through an ISO14001 certified Environmental Management System (EMS). The EMS initially comprised a procedure for waste management designed to ensure that all waste generated during the Chrysaor offshore production and drilling operations are managed according to the Company's Health, Safety and Environment policy and relevant legislation. Prior to beginning its decommissioning activities in the southern North Sea, Chrysaor reviewed the EMS and updated it to ensure that decommissioning-specific impacts and legislative requirements were recorded and assessed. Procedures and processes for waste management are now embedded in the EMS. Furthermore, Chrysaor has prepared waste management plans in support of the VDP1 and LDP1 Decommissioning Programmes and will do the same for LDP2 – LDP5. The Waste Management Plans will record how handling, storage, transfer and treatment of waste will be conducted by contractors/sub-contractors on behalf of Chrysaor using their own waste management system.

Although Chrysaor will not be undertaking the actual physical work associated with waste management, the legal liability (i.e. duty of care) for all waste generated from decommissioning remains with Chrysaor for the duration of the Decommissioning Programmes. To ensure that Chrysaor meets its regulatory and corporate expectation, due diligence audits will take place of waste contractors/sub-contractors to ensure that all necessary handling and reporting measures (including tracking of wastes, accounting and identification of wastes, wastes generated per asset and waste segregation) are taking place. Specific audit/monitoring schedules will be set up as part of the disposal yard contract award and will comply with the Chrysaor Corporate Waste Disposition Standard.

[12] By Drstuey at the English language Wikipedia, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=3518269.

6.0 Socioeconomic Impacts

6.1 Other sea users

6.1.1 Introduction

The LDP2 – LDP5 activities have the potential to impact upon other users of the sea. This may happen during the decommissioning activities themselves or after decommissioning should any infrastructure decommissioned *in situ* interact with activities such as fishing. During the EIA, the following issues were considered as potentially having a significant impact on other sea users:

- Physical presence of subsea infrastructure decommissioned *in situ*; and
- Potential snagging risks on the seabed.

The impacts described in the following sections are similar for both the LDP2 – LDP5 decommissioning areas and, therefore, one assessment was conducted.

6.1.2 Description and quantification of impact

Long-term physical presence of subsea infrastructure decommissioned in situ

The long-term presence of LDP2 – LDP5 subsea infrastructure decommissioned *in situ* has the potential to interfere with other sea users that may use the area. However, the 36" trunk line, 4" methanol pipeline, <16" diameter pipelines, >16" diameter pipelines will all be left within trenches and therefore not exposed to other sea users or fishing gear.

It is estimated that 5 m sections will be removed from the satellite ends of each pipeline/umbilical, leaving some of the infrastructure exposed. Each pipeline/umbilical satellite end(s) will be buried with rock to produce a tapered end (worst case 25 tonnes for each pipeline/umbilical satellite end). The rock will be appropriately graded which will ensure they are overtrawlable.

It should be noted that the proposed decommissioning methods emerging from the Comparative Assessment are not necessarily the finalised methods. It is possible that further work on the status of existing infrastructure may lead Chrysaor to propose slight amendments to the strategy outlined herein. However, such modifications would be limited to leave *in situ* of short sections of lines that this assessment has considered would be removed, and the seabed footprint presented here in terms of temporary disturbance would therefore be an overestimate. Conversely, the long-term footprint would be a slight underestimate, but the lengths of lines involved are so short that the difference against estimates provided in this assessment would be negligible.

Once all decommissioning activities are completed, it is assumed non-intrusive surveys will be undertaken within the 500 m safety exclusion zone of the fourteen platforms (with the potential exception to use overtrawl if needed at the Saturn location only), subsea infrastructure and within a 100 m corridor of pipelines/umbilicals decommissioned *in situ* to verify that the seabed has been left in a condition that does not present a hazard to commercial fishing, discussions are underway with OPRED regarding the level of appropriate coverage for pipeline corridor survey along each existing pipeline and umbilical route. However due to the sensitivity of the area, survey requirements will be discussed with stakeholders. Any subsea infrastructure left *in situ* will not be noticeable at the

seabed surface and Chrysaor will ensure all items will be marked on admiralty charts and notifications and issued to fishermen / other sea users of their exact locations.

The majority of the pipelines/ umbilicals have a low percentage of exposure, with the exception of the 36" trunk line which had 32.3% of the pipeline exposed during a 2014 survey. Of these exposures there were two areas of spanning (total of 32.25 m with a maximum height of spanning of 0.9 m). The maximum length of any individual span was 17.97 m. Currently the proposed approach for these spans is to decommission in their current state to avoid adversely impacting the protected features within the designated sites, however monitoring will be undertaken to observe any change in burial status and should any remediation be required this will be discussed and agreed with OPRED. The project-specific burial study indicates that the location and size of the spans changes over time. Even with the changes in position and size, over time the percentage of exposure is relatively stable (BMT Cordah, 2016).

Chrysaor recognises the requirement to monitor any structures decommissioned *in situ* and therefore intends to set up arrangements for long-term survey monitoring. The frequency of the monitoring that will be required will be agreed with the Regulator and future monitoring will be determined through a risk-based approach based on the findings from each subsequent survey. During the period over which monitoring is required, the status of the infrastructure will continue to be reviewed and any necessary remedial action to ensure it does not pose a risk to other sea users will be identified and agreed with the Regulator.

Snagging risks

The physical presence of the pipelines/umbilicals decommissioned *in situ*, seabed depressions, local rock placement, mattresses and grout bags increases the potential for interaction with fishing gear. This may result in the loss of catch/revenue for fisheries with the potential, in extreme cases, for the destabilisation of the vessel. The Marine Accident Investigation Branch shows there have been 15 sinkings resulting from snagged fishing gear between 1989 and 2014 resulting in 26 fatalities (Anatec, 2017).

Those pipelines/umbilicals that are currently located within trenches (36" trunk line and 4" methanol pipeline, pipelines <16" diameter and >16" diameter) do not pose a snagging risk to fishing, and they will receive additional small volumes of rock placement to ensure that the pipeline/umbilical satellite ends remain overtrawlable and inaccessible to fishing gear.

There is the potential for a number of depressions and berms to be left on the seabed following decommissioning. This may arise from excavation at the platform footings to enable these to be severed below the seabed, if internal cutting is not possible. Based on the dynamic nature of the environment in the vicinity of the LDP2 – LDP5 areas, it is anticipated that these depressions will backfill naturally over time. It is estimated that it can take between 1 and 5 years for natural recovery of similar depressions (e.g. Loe, 2010, Hill *et al*., 2011, Thompson *et al*., 2011). Surveys will be undertaken to ensure there are no berms or snagging issues associated with these depressions.

For the subsea infrastructure decommissioned *in situ* on the seabed, Chrysaor will ensure all LDP2 – LDP5 areas are left overtrawlable without snagging risks and that any rock placement required will be appropriately graded to allow fishing gear to trawl across it without snagging (this will be confirmed by visual inspection). The method of determining snag risk removal will be determined with OPRED. As such, the decommissioning *in situ* of the subsea infrastructure presents no immediate snag risk.

The current 500 m exclusion zone in place at the LDP2 – LDP5 platforms will be removed. This will allow access to areas which fishermen have previously been excluded.

There is the potential for the loss of objects during decommissioning activities. Depending on size, dropped objects may present a hazard to fishing activities. Should objects may pose a snag hazard and in the very unlikely scenario that they cannot be recovered, it is possible that fisheries will be unable to make use of the re-opened areas, resulting in continued, long-term exclusion from the 500 m safety zone (however, see mitigation measures in Section 6.1.3 for proposed recovery strategy).

6.1.3 Mitigation measures

A number of mitigation measures will be employed to reduce the impact on other sea users:

- The LDP2 – LDP5 subsea infrastructure is currently shown on Admiralty Charts and the FishSAFE system. Once decommissioning activities are complete, updated information on the LOGGS subsea area (i.e. which infrastructure remains *in situ* and which has been removed) will be made available to allow the Admiralty Charts and the FishSAFE system to be updated;

- The pipelines will be decommissioned *in situ*;

- Any pipeline that is removed the pipeline/umbilical ends will undergo rock placement to ensure they are overtrawlable to fishing gear. Note, given that non-intrusive means are to be used this will involve the visual removal of all oil and gas debris from the seafloor that could pose a snagging hazard. Additionally low angle rock deposits will be occurred to protect pipeline ends and ensure adequate coverage for any snagging hazards and to allow sand to migrate over them.

- Any objects dropped during decommissioning activities will be removed from the seabed where appropriate;

- An appropriate vessel will be engaged to carry out survey work within the 500 m safety exclusion zones to evaluate any potential snagging risks. No overtrawl activities will occur within designated sites. Discussions are underway with OPRED regarding the level of appropriate coverage for pipeline corridor survey along each existing pipeline and umbilical route. The actual survey techniques will be discussed with stakeholders and presented in individual Decommissioning Programmes. The total potential worse case impact due to overtrawl survey activities at Saturn platform locations is 0.79 km^2 as this is the only site outside of any designated/ protected areas. Final decommissioning activities will be considered to be complete subject to verification of clear seabed and a statement of clearance and acceptance of the Decommissioning Close-out Report by OPRED. The 500 m safety exclusion zone around the LDP2 – LDP5 platforms will then be removed;

- The post-decommissioning survey will confirm the depth to which the *in situ* decommissioned infrastructure is buried below the seabed. Environmental samples will be acquired to characterise the condition of the sediment chemistry and macrobenthos when decommissioning is complete; and

- Chrysaor recognises its commitment to monitor any infrastructure decommissioned *in situ* and therefore intends to set up arrangements to undertake post-decommissioning monitoring on behalf of the Licence Owners. The frequency of the monitoring that will be required will be agreed with OPRED and future monitoring will be determined through a risk-based approach based on the findings from each subsequent survey. During the period over which monitoring is required, the 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.

6.1.4 Cumulative assessment

In the LOGGS North area, landings were dominated by shellfish species with crabs being the most fished species. UK vessels used demersal towed gears, potting and scallop dredging and the effort was very low in terms of effort and landing values. The Belgian fleet effort was also low for all gear types identified (beam trawling, demersal otter trawling and seine netting). Fleets of other nationalities recorded negligible activity within LOGGS North area. The LOGGS South area was mainly targeted for sole by Dutch beam trawlers with vessels tending to be of the largest type (38 to 42 m). The majority of the LOGGS infrastructure is located in an area of moderate to high activity in terms of effort and value. Considering the wider area provides fishing grounds of highest values within the CNS and SNS, fishing intensity within LOGGS South is moderate.

Considered alongside the relatively low to moderate levels of fishing, shipping activity offshore renewables (operational and consented) and aggregate extraction licences, in the vicinity of the LOGGS area, the wide expanse of water available to navigate in and the overtrawlable decommissioned infrastructure, it is not anticipated that there will be any significant cumulative impacts with respect to the long-term presence of decommissioned subsea infrastructure.

All infrastructure will either be removed or decommissioned *in situ* in an overtrawlable condition, and monitoring will be conducted to ensure the decommissioned *in situ* infrastructure remains overtrawlable. Where decommissioned infrastructure presents an unacceptable risk, Chrysaor will undertake remedial action. There is expected to be no cumulative impact (with regards to exclusion from areas) with other structures decommissioned as part of the Chrysaor Viking VDP1 and LOGGS LDP1 decommissioning project, or indeed with other SNS decommissioning projects such as the Centrica Audrey (Block 49/11a and 48/15a), Annabel (Block 48/10a), Ann (Block 49/6a), Alison (Block 49/11d) and Markham (Block 49/5a) fields.

As the decommissioning activities proceed, new areas of sea will become available to fisheries and other sea users, reducing the overall cumulative impact and resulting in a positive impact to the area. These include removal of safety zones and new overtrawlable areas covering the LDP2 – LDP5 area. In terms of the scale of the decommissioning activities with regards to other sea users, there are estimated to be 457 safety zones in the southern North Sea on the UKCS (UKOilAndGasData, 2017). Since the decommissioning of the LDP2 – LDP5 area will see the removal of safety zones resulting in approximately 237 km^2 of occupied sea area being returned to navigable waters of the North Sea. This will assist in reducing the areas of the North Sea currently unavailable to other sea

users and thus in reducing the potential for cumulative impact from decommissioning of North Sea structures.

There are no negative cumulative impacts expected. The decommissioning of the LDP2 – LDP5 area will result in a positive impact by opening up new fishing grounds previously unavailable due to the ten 500 m safety exclusion zones currently imposed around the Chrysaor installations.

6.1.5 Transboundary impact

As the LDP2 – LDP5 area is beyond the UK's 12 nm limit, EU and non-EU vessels are also permitted to fish in the area, subject to management agreements including, for example, quota allocation and days at sea. Anatec (2017) report vessels of Dutch origin to have the highest levels of activity in the LOGGS area, predominantly larger beam trawlers between 38 – 42 m. A high portion of the fleet operates pulse wing trawls. The Dutch also operate demersal otter trawls and fly seiners in the general area (Anatec, 2017). The intensity of fishing activity with the LOGGS area is low to moderate with principal fishing grounds located far enough away from the LOGGS area. Combined with the removal of infrastructure and the overtrawlable nature of the infrastructure that is decommissioned *in situ*, there is no mechanism by which significant transboundary impacts could occur.

6.1.6 Residual impact

The residual impact to other sea users due to the planned decommissioning activities is summarised in Section 6.1.6.

Table 6-1 Residual impact to other sea users

Receptor	Consequence	Likelihood
Other sea users, excluding fisheries	Negligible	Remote
Fisheries	Low	Rare
Rationale		
Sea users other than fisheries relates to shipping, which is capable of accommodating any short-term interference without changing behaviour, makes limited use of the LOGGS area and will experience only very localised effects. On this basis, the consequence is negligible and the impact not very high. For fisheries, there is some tolerance to short-term interference and given the low to moderate fishing effort in the area, unlikely to be an impact during the decommissioning activities or in terms of longer-term snag risk or exclusion. Although there will be localised exclusion during decommissioning itself, the removal of the ten safety zones will eventually return sea area to the fishing community, which is considered a positive outcome. Combined with the *in situ* decommissioning leaving the seabed in an overtrawlable condition, and the commitment to remediate any snag risks arising during the period of monitoring, the likelihood is considered to be rare relative to complete removal of all seabed structures. Combining these, the risk significance is defined as low and thus not significant.		
Risk significance	**Impact significance**	
Low	Not significant	

7.0 Conclusions

Following review of the project activities, the environmental sensitivities of the project area, industry experience with decommissioning activities and of stakeholder concerns, it was determined that assessment of the following issues was required in order to properly define the potential impact of the LDP2 – LDP5 activities:

- Seabed interaction, particularly with sandbanks;
- Noise emissions on marine mammals;
- Long-term interaction with other sea users; and
- Management of waste.

A review of each of these potentially significant environmental interactions has been completed and, considering the mitigation measures that will be built into the project activities (and will be captured in Chrysaor' Environmental Aspects Register), there is expected to be no significant impact on receptors. As part of this review, cumulative and transboundary impacts were assessed and determined to be not significant.

Given the location of the project activities, consideration of the potential impact on protected sites has been important to the assessment. Of key importance is the potential to impact upon the NNSSR SAC, designated for Annex I habitat reefs and sandbanks which are slightly covered by water all of the time, and the SNS SAC designated for harbour porpoises (the location of project activities within the SNS SAC, designated for harbour porpoise, makes this a key sensitivity). Having reviewed the decommissioning project activities and the cumulative impacts of those activities alongside other developments in the relevant area, there is not expected to be a significant impact on any protected sites.

Finally, this environmental appraisal has considered the objectives and marine planning policies of the East Inshore and East Offshore Marine Plans across the range of policy topics including biodiversity, natural heritage, cumulative impacts and oil and gas. Chrysaor considers that the proposed decommissioning activities are in broad alignment with such objectives and policies.

In summary, the proposed operations have been rigorously assessed through the Comparative Assessment and EIA (both for the LDP2 – LDP5 assets, but also as part of the previous VDP1 and LDP1 work scopes), resulting in a set of selected decommissioning options which are thought to present the least risk of environmental impact whilst satisfying safety risk, technical feasibility, societal impacts and economic requirements. Based on the findings of this EIA and the identification and subsequent application of the mitigation measures identified for each potentially significant environmental impact (which will be managed through Chrysaor' EMS), it is concluded that the proposed activities will result in no significant environmental impact.

8.0 References

ABPmer Ltd (2005). Sand banks, sand transport and offshore wind farms. Report for DTI.

ABPmer Ltd (2010). A Further Review of Sediment Monitoring Data. Commissioned by COWRIE Ltd (project reference ScourSed-09).

Anatec (2017). Navigational Risk Assessment – LOGGS Area Decommissioning. Anatec Report No. A309-CoP-NRA-1. Revision C1 (Final), November 2017.

André, M., Morell, M., Mas, A., Solé, M., van der Schaar, M., Houégnigan, L., Zaugg, S. Castell, J.V.,Baquerizo, C. and Rodríguez Roch, L., (2009). Best Practices in Management, Assessment and Control of Underwater Noise Pollution. CONAT150113NS2008029. Laboratory of Applied Bioacoustics, Technical University of Barcelona.

Anthony, T.G., Wright, N.A. and Evans, M.A. (2017). Review of diver noise exposure. Prepared by QinetiQ for the Health and Safety Executive. Research Report No. RR735.

BEIS (2017). Record of The Habitats Regulations Assessment Undertaken Under Regulation 5 Of the Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 (As Amended). Project Title: Viking and LOGGS Phase 1 decommissioning and Strategic Review of proposed further decommissioning at Viking and LOGGS. ConocoPhillips (U.K.) Limited.

BMT Cordah (2016). Lincolnshire Offshore Gas Gathering System (LDP2, LDP3, LDP4 and LDP5) Pipeline Burial and Stabilisation Material Report. Document Number: BMT-SNS-L-XX-P-HS-02-00001. Revision Control: Rev C1.

Budd, G.C. (2006). *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available at https://www.marlin.ac.uk/habitats/detail/62 [Accessed 12/06/2019].

Cefas (2006). Scroby Sands Offshore Wind Farm – Coastal Processes Monitoring. Client: Department of Trade and Industry. Contract AE0262.

Centrica (2017a). A-Fields Decommissioning. Ann and Alison Fields. Environmental Impact Assessment. Online at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/623813/Ann_and_Alison_Environmental_Impact_Assessment.pdf [Accessed 12/06/2019].

Centrica (2017b). A-Fields Decommissioning. Saturn (Annabel) and Audrey Fields Environmental Impact Assessment. Online at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/642132/Saturn__Annabel__and_Audrey_Fields_EIA.pdf [Accessed 12/06/2019].

Cerniglia, C. E. (1992). Biodegradation of polycyclic aromatic hydrocarbons. *Biodegradation,* 3, 351–368.

Chrysaor (2020) Bird Addendum to support LDP5 Decommissioning Programmes, XOD-SNS-L-XX-X-HS-02-00007;

ConocoPhillips (2017a). LOGGS Satellites Vulcan UR, Viscount VO, Vampire OD & Associated Infield Pipelines. Document No. COP-SNS-L-XX-X-PM-12-00001.

ConocoPhillips (2017b). Commercial Fisheries Baseline Characterisation: LOGGS South, LOGGS North and CMS Areas. Report No. BMM-SNS-P-XX-S-HS-02-00001.

ConocoPhillips (2015). SNS Phase 1 Decommissioning Programme. Environmental Statement for the SNS Decommissioning Project: Viking 1 and LOGGS LDP1. September 2015. Revision C3. Report No. BMT-SNS-P-XX-X-HS-02-00006.

Cooper, W.S., Townend, I.H. and Balson, P.S. (2008). A synthesis of current knowledge on the genesis of the Great Yarmouth and Norfolk Bank Systems. The Crown Estate, 69 pages, February 2008. ISBN: 978-0-9553427-8-3.

Cox, P. and Gerrard, S. (2001). The Environmental Assessment of Southern North Sea Pipeline Decommissioning. Centre for Environmental Risk Report, August, 2001.

DECC (2009). UK Offshore Energy Strategic Environmental Assessment. Future leasing for offshore wind farms and licensing for offshore oil and gas storage. Environmental Report. Online at https://www.gov.uk/government/consultations/uk-offshore-energy-strategic-environmental-assessment-oesea [Accessed 12/06/2019].

DECC (2016). UK Offshore Energy Strategic Environmental Assessment 3. UK offshore waters and territorial waters of England and Wales. Online at https://www.gov.uk/government/consultations/uk-offshore-energy-strategic-environmental-assessment-3-oesea3 [Accessed 05/06/2019].

Decom North Sea (2017). Environmental Appraisal Guidelines. Available at: http://decomnorthsea.com/about-dns/projects-update/environmental-appraisal-guidelines [Accessed 05/06/2019].

Deecke, V.B., Slater, P.J.B. and Ford, J.K.B. (2002). Selective habituation shapes acoustic predator recognition in harbour seals. *Nature*, 420, 171-173.

Defra (2017). Holderness Offshore rMCZ Post-survey Site Report. Contract Reference: MB0120. Report Number: 44, Version 4.

Defra (2019). Holderness Offshore Marine Conservation Zone: factsheet. Available at: https://www.gov.uk/government/publications/marine-conservation-zones-holderness-offshore [Accessed 12/06/2019].

Dernie, K. M., Kaiser, M. J., and Warwick, R. M. (2003) Recovery rates of benthic communities following physical disturbance. *Journal of Animal Ecology*, 72(6), 1043-1056.

DNV (Det Norske Veritas) (2006). Petroleum Safety Authority Norway (PSA), Material risk – aging offshore installations.

Ellis, J.R., Milligan, S., Readdy, L., South, A., Taylor, N. and Brown, M. (2012). Mapping the spawning and nursery grounds of selected fish for spatial planning. Report to the Department of Environment, Food and Rural Affairs from Cefas. Defra Contract No. MB5301.

Finneran J.J., Carder D.A., Schlundt C.E. and Ridgway S.H. (2005). Temporary threshold shift in bottlenose dolphins (Tursiops truncatus) exposed to mid-frequency tones. *Journal of the Acoustical Society of America*, 118(4), 2696-2705.

Foden, J., Rogers, S.I. and Jones, A.P. (2009). Recovery rates of UK seabed habitats after cessation of aggregate extraction. *Marine Ecology Progress Series*, 390, 15-26.

Fugro (2017). Bathymetry survey South Valiant TD. UKCS Block 49/21 B. Survey period 24th – 25th June 2017. ConocoPhillips.

Gardline 2013. Survey report for ConocoPhillips UK Ltd. UKCS Block 49/21b South Valiant TD. Debris clearance survey. August 2013. 2207-0713-COP

Gardline (2015a). SNS Decommissioning Survey LOGGS Gas Fields (LOGGS Hub, Mimas MN, Ganymede ZD, South Valiant TD, Europa EZ). Habitat Assessment Report. August 2015. Report No. 10553.1.

Gardline (2015b). SNS Decommissioning Survey LOGGS Gas Fields (LOGGS Hub, Mimas MN, Ganymede ZD, South Valiant TD, Europa EZ). Pre-decommissioning Survey Report. August 2015. Report No. 10553.2.

Gardline (2016). Survey report for ConocoPhillips (U.K.) Limited, UKCS Block 49/12 Viking. February 2016. CPUK-INT-PR-274

Gardline (2020) Survey report for Chrysaor Production (U.K.) Limited, UKCS Block 49/22 Callisto ZM, SVY-0015-WPK-001

Genesis (2010). Review and assessment of underwater sound produced from oil and gas sound activities and potential reporting requirements under the Marine Strategy Framework Directive.
Hammond, P.S., Lacey, C., Gilles, A., Viquerat, S., Börjesson, P., Herr, H., Macleod, K., Ridoux, V., Santos, M.B., Scheidat, M., Teilmann, J., Vingada, J. and Øien, N. (2017). Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys. Available at: https://synergy.st-andrews.ac.uk/scans3/files/2017/05/SCANS-III-design-based-estimates-2017-05-12-final-revised.pdf [Accessed 12/06/2019].

Heinänen, S. and Skov, H. (2015). The identification of discrete and persistent areas of relatively high harbour porpoise density in the wider UK marine area. Joint Nature Conservation Committee.

Hill, J. M., Marzialetti, S. and Pearce, B. (2011). Recovery of Seabed Resources Following Marine Aggregate Extraction. Marine ALSF Science Monograph Series No. 2. MEPF 10/P148. (Edited by R.C. Newell & J. Measures). 44pp. ISBN: 978 0 907545 45 3.

Hoare, R. and Hoscock, K. (1974). An ecological survey of the rocky coast adjacent to a bromine extraction works. *Estuarine and Coastal Marine Science*, 2(4): 329-336.

Holt, T.J., Rees, E.I., Hawkins, S.J. and Seed, R. (1998). Biogenic Reefs (volume IX). An overview of dynamic and sensitivity characteristics for conservation management of marine SACs. Scottish Association for Marine Science (UK Marine SACs Project), 170 pp.

HSE (Health and Safety Executive) (1997). The abandonment of offshore pipelines: Methods and procedures for abandonment. Offshore technology report. HSE Books, Norwich. ISBN -7176-1421-2.

Hylland, K. and Erikson, D.O. (2013). Naturally occurring radioactive material in North Sea produced water: environmental consequences. Norsk Olje og Gass.

IAMMWG (2015). Management Units for cetaceans in UK waters (January 2015), JNCC Report 547, ISSN 0963-8091.

JNCC (2007). Defining and managing *Sabellaria spinulosa* reefs: Report of an interagency workshop 1-2 May 2007.

JNCC (2010a). UKSeaMap – Predictive mapping of seabed habitats. Online at http://jncc.defra.gov.uk/page-5534 [Accessed 02/05/2017].

JNCC (2010b). The protection of marine European Protected Species from injury and disturbance. Guidance for the marine area in England and Wales and the UK offshore marine area. Prepared by the Joint Nature Conservation Committee, Natural England and Countryside Council for Wales. June, 2010.

JNCC (2010c). Offshore Special Area of Conservation: North Norfolk Sandbanks and Saturn Reef. SAC Selection Assessment. Version 5.0 (20 August 2010)

JNCC (2015). Humber Estuary SAC site description. Available at: http://jncc.defra.gov.uk/protectedsites/sacselection/sac.asp?EUCode=UK0030170 [Accessed 12/06/2019].

JNCC (2016). Seabird Population Trends and Causes of Change: 1986-2015 Report http://www.jncc.defra.gov.uk/page-3201. Joint Nature Conservation Committee. Updated September 2016. [Accessed 10.01.2020]

JNCC (2017a). North Norfolk Sandbanks and Saturn Reef MPA. Online at http://jncc.defra.gov.uk/page-6537 [Accessed 12/06/2019].

JNCC (2017b). The Habitats Directive: selection of Special Areas of Conservation in the UK. Updated 24 November 2017. Available at: http://jncc.defra.gov.uk/protectedsites/sacselection/SAC_searchpage.asp [Accessed 06/12/2017].

JNCC (2019a). Design of a monitoring plan for the Southern North Sea candidate Special Area of Conservation and wider area. Available at: http://data.jncc.gov.uk/data/6b6064c4-5685-49ea-88e1-f6f202b6807e/JNCC-Report-629-FINAL-WEB.pdf [Accessed 09/01/2020]

JNCC (2019b). North Norfolk Sandbanks and Saturn Reef. Available at: https://sac.jncc.gov.uk/site/UK0030358 [Accessed 13/01/2020]

Jones, E., McConnell, B., Sparling, C and Matthiopoulos, J. (2015). Marine Mammal Scientific Support Research Programme MMSS/001/11. At-sea usage and activity. Available at: http://www.smru.st-andrews.ac.uk/files/2015/10/MR5-1_at-sea_usage_and_activity_VF2.pdf [Accessed 12/06/2019].

Kennish, M. J. (1997). Pollution Impacts on Marine Biotic Communities. CRC Press LLC, USA, ISBN 0-8493-8428-1.

Krebs, C.J, (1985). Ecology: The Experimental Analysis of Distribution and Abundance. Third Edition. Harper and Row, New York, 800 pp.

Loe, S.A. (2010). Using natural sedimentation to backfill a dredged pipeline trench. Journal of Marine Engineering and Technology, No. A18, 2010.

MacArthur, R.H. and Wilson, E.O. (1967). The Theory of Island Biogeography. Princeton University Press, Princeton N.J., 203 pp.

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. Online at http://jncc.defra.gov.uk/PDF/jncc446_web.pdf [Accessed 12/06/2019].

Meador, J.P, Stein, J.E, Reichert, W.L, and Varanasi, U. (1995). Bioaccumulation of polycyclic aromatic hydrocarbons by marine organisms. *Rev. Environ. Contam. Toxicol*., 143, 79-165.

MMO (2018). UK sea fisheries annual statistics report 2017. September 2018. Available at: https://www.gov.uk/government/statistics/uk-sea-fisheries-annual-statistics-report-2017 [Accessed 12/06/2019].

MPE (Ministry of Petroleum and Energy) (1999). The Final Disposal of Disused Pipelines and Cables. Summary of the Findings of a Norwegian Assessment Programme. Oslo, December, 1999.

Natural England (2007). Humber Estuary SPA site description. Online at http://publications.naturalengland.org.uk/publication/5382184353398784 [Accessed 12/06/2019].

Nedwell, J.R., Turnpenny, A.W.H., Lovell, J., Parvin, S.J., Workman, R., Spinks, J.A.L. and Howell, D. (2007). A validation of the dBht as a measure of the behavioural and auditory effects of underwater noise. Subacoustech Rep Ref 534R1231 Chevron Ltd Total Explor UK PLC Dep Bus Enterp Regul Reform Shell UK ITF JNCC Subacoustech Southampton UK.

NMPI (2019). Scottish Government Interactive Marine planning tool. Online at https://marinescotland.atkinsgeospatial.com/nmpi/ [Accessed 12/06/2019].

Nowacek, D.P., Thorne, L.H., Johnston, D.W. and Tyack, P.L. (2007). Responses of cetaceans to anthropogenic noise. *Mammal Review*, 37(2), 81-115.

OGUK (2013). Long term Degradation of Offshore Structures and Pipelines Decommissioned and left in Situ, Oil and Gas UK. February 2013.

OGUK (2015a). Guidelines for Comparative Assessment in Decommissioning Programmes. SKU: EN038.

OGUK (2015b). NORM Scale. Online at http://www.oilandgasuk.co.uk/knowledgecentre/normscale.cfm [Accessed 30/11/17].

OGUK (2016a). Decommissioning insight 2016. Online at http://oilandgasuk.co.uk/decommissioninginsight.cfm [Accessed 04/12/17].

OGUK (2016b). Environment Report 2016. Online at http://oilandgasuk.co.uk/wp-content/uploads/2016/11/Environment-Report-2016-Oil-Gas-UK.pdf [Accessed 04/12/17].

OGUK (2019) Environment Report 2018. Online at https://oilandgasuk.cld.bz/Environment-Report-2019/10/19

OPRED (2019a). The Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999 (as amended) – A Guide. February 2019. Revision 5. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/778899/OPRED_EIA_Guidance_2019_Revision_5_-_14Feb19.pdf [Accessed 12/06/2019].

OPRED (2019b) The Offshore Petroleum Regulator for Environment and Decommissioning, Portal System

OPRED (2019c) The Offshore Petroleum Regulator for Environment and Decommissioning Programmes. Online at https://www.gov.uk/guidance/oil-and-gas-decommissioning-of-offshore-installations-and-pipelines [Accessed 24/03/2020].

OSPAR (2008). List of threatened and/or declining species & habitats. Online at https://www.ospar.org/work-areas/bdc/species-habitats/list-of-threatened-declining-species-habitats [Accessed 12/06/2019].

Pangerc, T., Robinson, S., Theobald, P., and Galley, L. (2016). Underwater sound measurement data during diamond wire cutting: First description of radiated noise. In *Proceedings of Meetings on Acoustics 4ENAL* (Vol. 27, No. 1, p. 040012). ASA.

Parry, M., Flavell, B., and Davies, J. (2015). The extent of Annex I sandbanks in North Borfolk Sandbanks and Saturn Reef cSAC/SCI (https://jncc.gov.uk/our-work/north-norfolk-sandbanks-and-saturn-reef-mpa/)

Reid, J., Evans, P.G.H. and Northridge, S. (2003). An atlas of cetacean distribution on the northwest European Continental Shelf. Joint Nature Conservation Committee, Peterborough.

Rouse, S., Kafas, A., Catarino, R., Peter, H. and Handling editor: Steven Degraer (2017). Commercial fisheries interactions with oil and gas pipelines in the North Sea: considerations for decommissioning. ICES Journal of Marine Science, 75(1), pp.279-286.

Scottish Government (2018). Scottish Sea Fisheries Statistics, 2017. Scottish Government. Available online at http://www.gov.scot/Topics/marine/marine-environment/species/fish [Accessed 05/06/2019].

Scottish Government (2020). Scottish Sea Fisheries Statistics, 2019. Scottish Government. Available online at https://www.gov.scot/publications/scottish-sea-fisheries-statistics-2019/pages/3/ [Accessed 14/14/2021].

Senergy Floyds (2008). Technical Note to ConocoPhillips: Pipeline Inspection Data Review. February 2008.

Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, R.L., Greene, C.R. and Kastak, D. (2007). Marine Mammal Noise-Exposure Criteria: Initial Scientific Recommendations. *Aquatic Mammals*, 33(4), 411 – 521.

Southall B L, Finneran J J, Reichmuth C, Nachtigall P E, Ketten D R, Bowles A E, Ellison W T, Nowacek D P, Tyack P L (2019). Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. Aquatic Mammals 2019, 45(2), 125-232, DOI 10.1578/AM.45.2.2019.125.

Thompson, C. E. L., Couceiro, F., Fones, G. R., Helsby, R., Amos, C. L., Black, K., Parker, E. R., Greenwood, N., Statham, P. J., and Kelly- Gerreyn, B. A. (2011). In situ flume measurements of resuspension in the North Sea. *Estuarine Coastal and Shelf Science*, 94, 77–88.

Tyler-Walters, H., Lear, D., and Allen, J. H. (2004). Identifying offshore biotope complexes and their sensitivities.

UK Biodiversity Group (1999). UK Biodiversity Group Tranche 2 Action Plans - Volume V: Maritime species and habitats. English Nature, Peterborough, 211 pp.

UKOilandGasData (2017). Online metadata covering UKCS offshore oil and gas wells, 2D and 3D seismic surveys, infrastructure, licences and fields. Available at: https://www.ukoilandgasdata.com [Accessed 08/12/2017].

UKOOA (2001). An analysis of UK Offshore Oil and Gas Environmental Surveys 1975-95. Heriot University.

Walker, A. J. M. and Rees, E. I. S. (1980). Benthic ecology of Dublin Bay in relation to sludge dumping: fauna.

Xodus (2019) Database of publicly available EIA submissions within the UKCS.

Appendix 1. ATMOSPHERIC EMISSIONS

Group	Selected option	Operations CO_2e (te)
1	Leave *in situ*	3,522
2	Leave *in situ*	1,573
3a	Leave *in situ*	1,992
3b	Leave *in situ*	3,902
3c	Leave *in situ*	2,852
4	Leave *in situ*	3,436
7	Leave *in situ*	1,742
	Total	**19,019**

Appendix 2. Bird Addendum

CHRYSAOR

LOGGS Area Decommissioning

BIRD ADDENDUM

Document No: XOD-SNS-L-XX-X-HS-02-00007

4	Rev 4	David Vale	22/09/21	Craig Bloomer	25/09/21	Craig Bloomer	25/09/21
3	Rev 3	Craig Bloomer	18/01/21	Phil Spence	18/01/21	Phil Spence	18/01/21
2	Rev 2	Craig Bloomer	18/01/21	Phil Spence	18/01/21	Phil Spence	18/01/21
1	Rev 1	Craig Bloomer	12/11/20	Phil Spence	13/11/20	Phil Spence	13/11/20
Issue Rev	**Issue or Revision Description**	**Origin By**	**Date**	**Chk'd By**	**Date**	**App'd By**	**Date**
Originator Name:	**Craig Bloomer**		**Originator Position:**	**Environmental Manager**			

REVISION RECORD

Revision	Description of Revision	Date
1	Issued to Regulator	16 Nov 2020
2	Update to reflect CyberHawk Survey December 2020	18 Jan 2021
3	Update to capture Ornithological surveys in May 2021	29th Aug 2021
4	Update to include Section 2.4 future surveys	30th Sep 2021

DISTRIBUTION

Name	Position	Company
Competent Authority	Various	ODU / BEIS

EXECUTIVE SUMMARY

Chrysaor have prepared a Bird Addendum at the request of the Competent Authority. This Addendum covers the Wild Birds Directive (2009/147/EC) Article 1 requirements in relation to Chrysaor Decommissioning operations associated with LDP5 Decommissioning Programmes.

Wild birds, their eggs and nests are protected in UK offshore waters, as they are onshore and in territorial waters, through the transposition of the EU Wild Birds Directive.

Chrysaor will not commence any decommissioning operations on any LOGGS Decommissioning programme LDP2-LDP5 if there are any nests or eggs on any of the installations, unless the specific activities are covered by a Wildlife Licence.

Surveys will always be carried out to ensure that the any birds or eggs have been identified and assessed prior to decommissioning operations being carried out.

1.0 Wild Birds Directive and UK legislation

European Commission Wild Birds Directive (2009/147/EC) relates to the conservation of all species of naturally occurring birds in the European territory of the Member States to which the Treaty applies. It covers the protection, management and control of these species and lays down rules for their exploitation.

Article 5 specifies that "*Member States shall take the requisite measures to establish a general system of protection for all species of birds referred to in Article 1, prohibiting in particular:*

(a) deliberate killing or capture by any method;
(b) deliberate destruction of, or damage to, their nests and eggs or removal of their nests;
(c) taking their eggs in the wild and keeping these eggs even if empty;
(d) deliberate disturbance of these birds particularly during the period of breeding and rearing, in so far as disturbance would be significant having regard to the objectives of this Directive;
(e) keeping birds of species the hunting and capture of which is prohibited."

Requirements of the Wild Birds Directive are written into UK legislation for the offshore industry via the Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 (as amended).

Regulation 11 specifies that "*a person shall not carry out UKCS oil and gas activities in such a way as—*
(a) deliberately to kill or capture any bird in its wild state which is a member of any species referred to in Article 1 of the Wild Birds Directive;
(b) deliberately to disturb any wild bird referred to in Article 1 of the Wild Birds Directive while it is building a nest or is in, on or near a nest containing eggs or young, or the dependent young of such a bird;
(c) deliberately to damage or destroy its nest or eggs or to remove its nest; or
(d) to take or keep its eggs."

Additionally the Wilds Birds Directive is transposed for the UK offshore area by the Conservation of Offshore Marine Habitats and Species Regulations (2017).

Regulation 40 covers the Protection of wild birds, their eggs and nests. Specifically stating that:

"40.(1) Subject to regulations 41 and 55, a person who deliberately—
(a) captures, injures, or kills any wild bird,
(b) takes, damages or destroys the nest of any wild bird while that nest is in use or being built, or
(c) takes or destroys an egg of any wild bird, is guilty of an offence".

Chrysaor understands the legal basis for the protection of wild birds and the applicability of this to decommissioning activities. In addition, it is recognised that OPRED has the power to grant Licences providing that the specific licence tests have been met. Should this avenue be explored further Chrysaor will engage with OPRED to discuss options and the requirements needed to prepare the Disturbance Licence via the portal application system.

2.0 Establishing likelihood for nesting seabirds

2.1 Evidence from Chrysaor Installations

Chrysaor recognise that birds are attracted to offshore installations both as foraging opportunity (Fowler *et al*. 2018) and as resting and roosting site (Ronconi *et al*. 2015). Seabirds were frequently seen at the LDP5 installations, however the types and species present were not documented via any formal methods. The species assemblages present are therefore assumed to be reflective of the wider geographical area as described in Section 2.2.

All the Chrysaor installations that form part of the LDP2-LDP5 Decommissioning Programme are currently unmanned. The evidence base for demonstrating that there has been no evidence of nesting seabirds was derived when the installations were manned and a subsequent dedicated survey campaign. Anecdotal information via former crew at LOGGS confirmed no nesting birds or eggs have been observed, this information was collected verbally in October 2020. It is recognised that the activity levels of human presence on the installations and associated noise of an operational facility may have limited bird activity, or nesting attempts during that time.

Chrysaor commissioned Cyberhawk in December 2020 to carry out a complete survey via Unmanned Aerial Vehicle (UAV) of the LOGGS complex (Chrysaor, 2020). The timing of the survey in December was out with the breeding season and no active nests were anticipated. The purpose of the survey was to inspect all 5 jackets for signs of nesting or bird activity. Example photographs and evidence of bird nests that have been observed on oil and gas infrastructure were provided to the crews undertaking the study.

The UAV was mounted with high resolution and video photography equipment and able to inspect all areas of the LOGGS installation. The survey was carried out from the 14th to 18th December 2020 and all UAV operators mobilised on a dedicated vessel. Chrysaor had a dedicated client representative on the vessel who was the previous LOGGS Offshore Installation Manager, they had a complete knowledge of the platform and were able to guide and direct the drone operators.

All 5 jackets were successfully inspected with video and photography. Additional summarised information has been presented in Section 2.2.1. The full survey report provided will be provided to the Department (Chrysaor Cyberhawk survey, 2020).

In May 2021 an ornithological survey covering the LOGGS installation and surrounding satellite platforms was undertaken (Chrysaor, 2021). A Joint Nature Conservation Committee (JNCC) approved ESAS surveyor was onboard supply vessel Bailey Sentinel and activites were carried out between the 5th-10th May 2021 at the LOGGS complex and nearby satellites. This included coverage of the Vulcan RD, South Valiant TD, North Valiant SP, Vanguard QD, Mimas MN, Saturn ND, Tethys TN. The surveyors role was to identify seabird nests and to assist with the implementation of JNCC guidelines for nesting birds.

2.2 Evidence of Bird Activity

Offshore platforms provide resting and roosting opportunities for many species of birds. Gulls frequently use platforms for roosting at night and during the day and also rest on the sea surface below platform lights at night (Christensen-Dalsgaard, 2019; Tasker *et al*., 1986).

A detailed description of seabird presence in the LDP2-LDP5 area is provided in XOD-SNS-L-XX-X-HS-02-00005. According to the seabird density maps provided in Kober *et al*. (2010), the following species have been recorded within the area, throughout the year; northern fulmar *Fulmarus glacialis* (all year), sooty shearwater *Puffinus griseus* (July-November), Manx shearwater *Puffinus puffinus* (May-September), northern gannet *Morus bassanus* (all year), pomarine skua *Stercorarius pomarinus* (all year), Artic skua *Stercorarius parasiticus* (all year), great skua *Stercorarius skua* (May- August), black-legged kittiwake Rissa tridactyla (all year), little gull *Larus minutes* (August-November), great black-backed gull *Larus marinus* (all year), common gull *Larus canus* (all year), lesser black-backed gull *Larus fuscus* (May- August), herring gull *Larus argentatus* (September-March), Sandwich tern *Sterna sandvicensis* (May- August), common tern *Sterna hirundo* (May-September), common guillemot *Uria aalge* (all year), razorbill *Alca torda* (all year), little auk *Alle alle* (November- March) and Atlantic puffin *Fratercula artica* (all year).

The evidence of seabird nesting on oil and gas installations is relatively limited (Christensen-Dalsgaard, 2019). Of the seabirds that have been found in the wider area their nesting behaviour, geographical range, seasonal migrations and evidence of past nesting have been considered when determining if there was a risk of the species nesting on the SNS installations.

Due to their preference for nesting in burrows these species are not expected to nest on a decommissioned platform in the SNS:

- Atlantic puffin *Fratercula artica,*
- sooty shearwater *Puffinus griseus (also a visitor to the area post breeding season) and*
- Manx shearwater *Puffinus puffinus*

Due to their preference for nesting at higher geographical latitudes, these species are not expected to nest on a decommissioned platform in the SNS.

- little gull *Larus minutes*, it is a winter visitor to the waters around the UK in small numbers each year.
- Artic skua *Stercorarius parasiticus* – Nesting areas in UK are predominantly Orkney and Shetland islands and West Coast islands Scotland.

There was no available literature which suggests offshore installations would be a suitable nest location for the following species:

- Sandwich tern *Sterna sandvicensis*, this species breeds in very dense colonies on coasts and islands,
- common tern *Sterna hirundo*, the common tern breeds along coasts with shingle beaches and rocky islands, on rivers with shingle bars, and at inland gravel pits and reservoirs, feeding along rivers and over freshwater,
- northern gannet *Morus bassanus*, nests on coastal cliffs around the north of the UK, and
- razorbill *Alca torda*, nests on coastal locations with nests out of sight.

Gulls are a common occurrence on offshore installations and therefore nesting during the breeding season on a SNS installation cannot be ruled out, although Chrysaor are not aware of any installations in the SNS where nesting has occurred for the following species:

- great black-backed gull *Larus marinus*,
- common gull *Larus canus,*
- lesser black-backed gull *Larus fuscus, and*
- herring gull *Larus argentatus.*

These species are understood to have nested on oil and gas installations in the UKCS (Christensen-Dalsgaard, 2019).

- black-legged kittiwake *Rissa tridactyla – UK (SNS, Irish Sea and Norway), and*
- guillemot *Uria aalge* (Chrysaor have an anecdotal account of this species nesting on an Irish Sea installation – note no evidence available to qualify).

Chrysaor understand that a nearby operator in the SNS has experienced nesting from black legged kittiwakes *Rissa tridactyla* on one of their platforms, specifics relating to numbers of birds or further information related to this was not available in the public domain.

2.2.1 Results from the Cyberhawk Survey December 2020

During the survey all 5 platform jacket areas and associated bridges of the LOGGS installation were covered, with high resolution and video footage being successfully collected across the survey area. Drone flight time due to payload, camera weight, battery weight etc is between 6 and 10 minutes per flight. The UAV is limited to flying when the windspeed is <25m.

The survey area covered the full entirety of the platform and all steel structure elevations during the survey period of 14th -18th December (Figure 2-1).

On arrival at the LOGGS accommodation end of the asset, Gulls were seen to be roosting on the lower bracings of the PR Riser platform, as soon as the UAV was in flight, they were observed to take flight. The Chrysaor client representative is of the opinion that the UAV noise and visual appearance was sufficient to startle them and cause them to take flight. The gulls seen on the PR Riser lower bracings were Greater Black Back and Lesser Black Back Gulls, approximately 20 to 30 of them. No birds were noted on any of the other jackets or assets. Given the UAV caused the gulls that were roosting to take flight no images of any seabirds were obtained.

No nests or signs of nesting were found during this survey. This included a complete absence of any residual kittiwake nests or any evidence of broken eggs or shell fragments. Representative images that illustrate that the UAV was able to photograph in close proximity to the installation and provide detailed high resolution images suitable to identify any nests have been provided in Figure 2-2, Figure 2-3 and Figure 2-4.

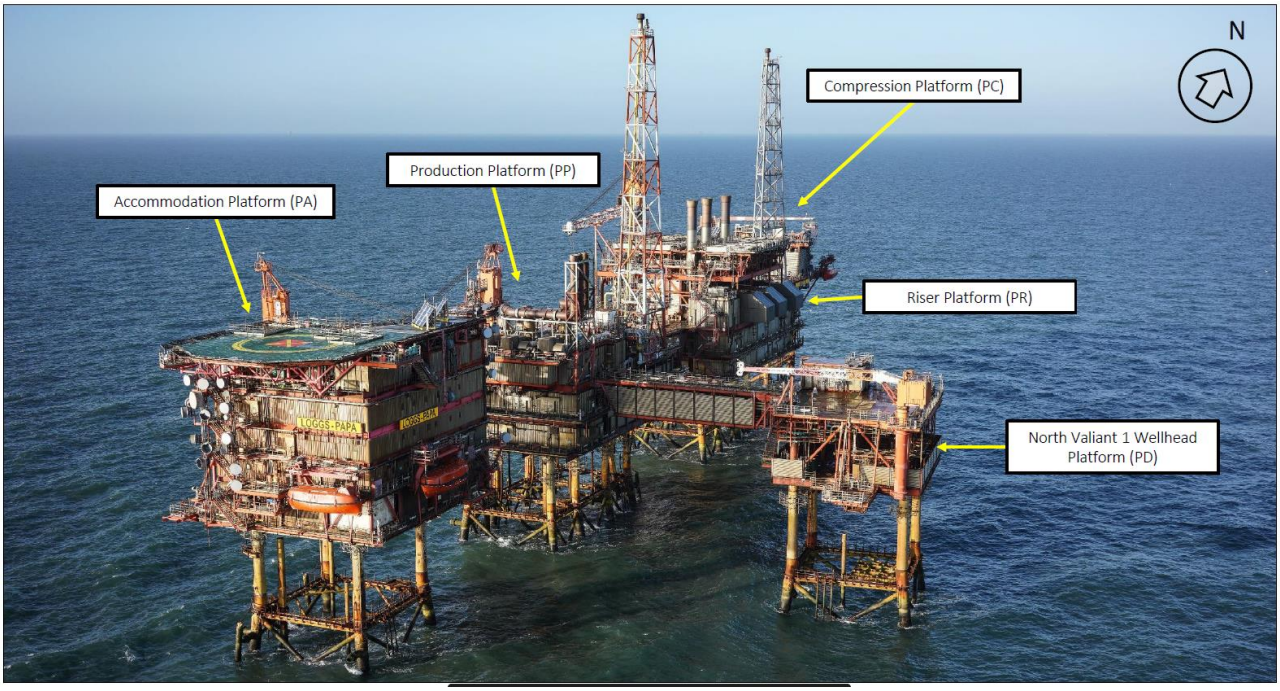


Figure 2-1 Overview of the LOGGS platform captured by UAV

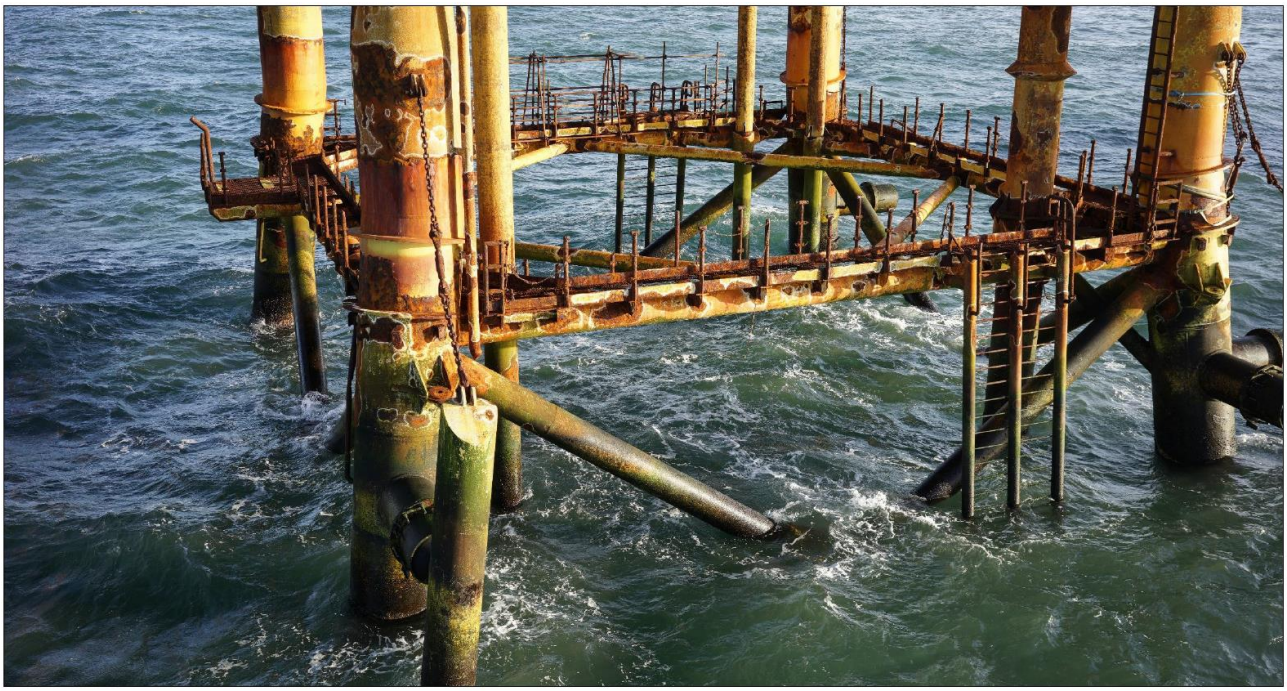


Figure 2-2 Accommodation Platform – no evidence of any seabird activity

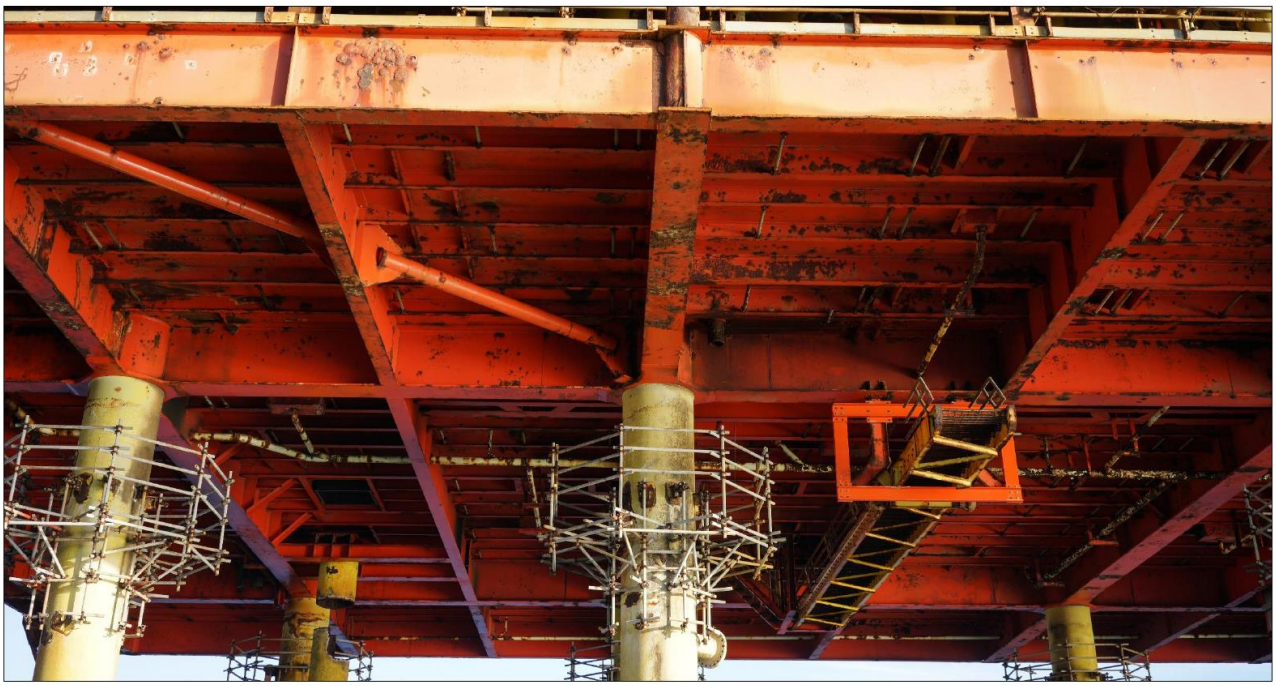


Figure 2-3 Compression Platform - West Elevation – no evidence of any seabird activity

On the riser platform a large amount of guano deposit was noted to the bracing members around the spider deck (Figure 2-4). This guano deposit was found on steel structures that are rounded in shape and relatively close to the sea surface, which would suggest that these areas are more likely roosting areas utilised by seabirds in the wider area, rather than a nesting location.

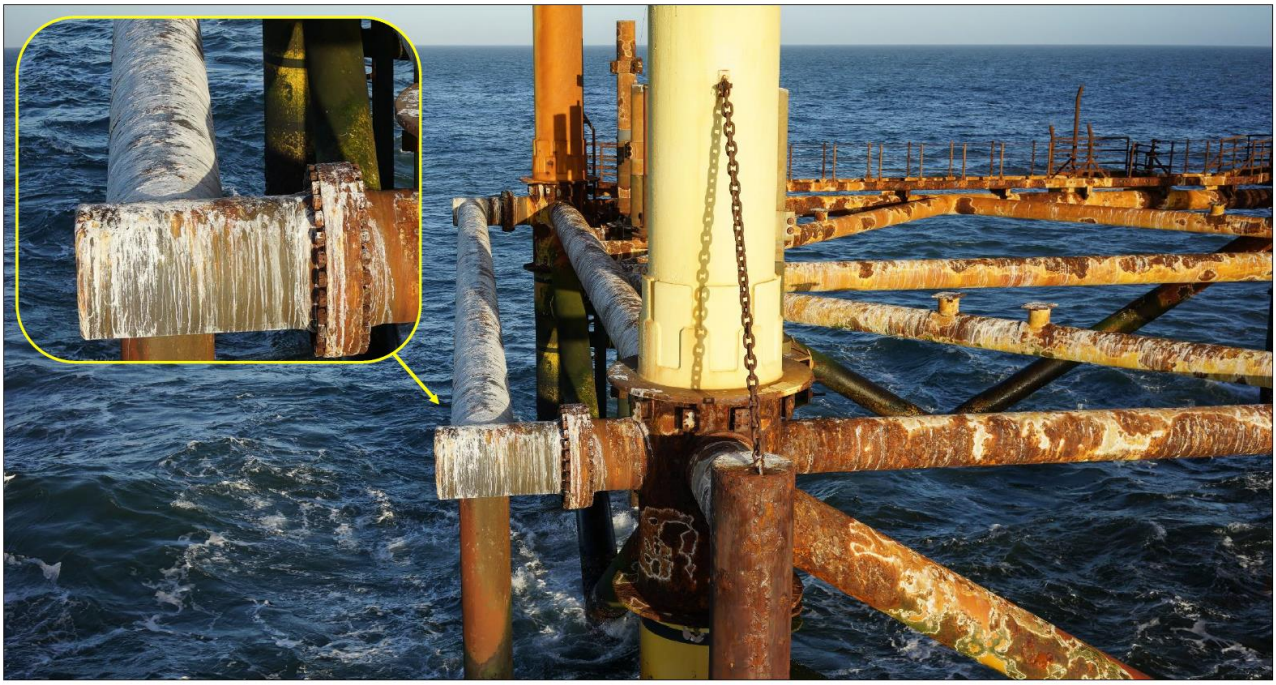


Figure 2-4 Riser Platform – no evidence of any nesting, guano and height from sea surface would suggest a roosting area.

2.3 Results from the Ornithological survey results in May 2021

No nesting birds or chicks were recorded LOGGS complex and nearby satellites: Vulcan RD, South Valiant TD, North Valiant SP, Vanguard QD, Mimas MN, Saturn ND, Tethys TN (Chrysaor, 2021). The survey results were sent to OPRED and confirmed no nesting birds were present prior to the removal of the LOGGS main platform complex in August 2021.

2.4 Future ornithological surveys planned in subsequent years

Chrysaor recognise the importance of ensuring all decommissioning activities are carried out with respect for the environment and with an understanding of all impacts that any offshore activity can generate.

The use of installations for seabird nesting is a key issue for Chrysaor a workgroup has been set up internally to meet and discuss the most suitable preparation for identification and mitigation of any nesting risks to the assets.

Additional ornithological surveys will be timed to identify seabirds or nests on any of the installations that are to be removed in subsequent removal years.

3.0 Conclusion

Chrysaor have no evidence of birds nesting on any of the applicable installations to be decommissioned. On the basis of the current available information no anticipated harm or impact to seabird populations either alone or in combination with other activities are anticipated to be realised from the planned decommissioning activities.

Should there be a need for Wildlife licencing then the species in question will be assessed against the licencing criteria making reference to relevant threats and pressures and their population status.

Wildlife licencing options are to be explored with OPRED in advance of removal options. The purpose of this is to mitigate the risk of a delay to the planned lifting operations as a result of unidentified nest(s).

Chrysaor will not commence any decommissioning operations on LDP2-LDP5 if there are any nests or eggs on any of the installations, unless the specific activities are covered by a Wildlife Licence.

4.0 References

Christensen-Dalsgaard, S., Dehnhard, N., Børge M., Systad, G H R & Follestad, A. Installations and birds A desktop study on how to minimize area of conflict. NINA. 2019

Chrysaor, 2020. Cyberhawk survey of the LOGGS platform December 14th to 18th. Report reference: CHR202343_LOGGS_NSTING_SRVY_NF_V1.

Chrysaor, 2021. Seabird survey of Lincolnshire offshore gas gathering system (LOGGS) complex and nearby satellite installations, Southern North Sea 05th – 10th May 2021.

Fowler, A.M., Jørgensen, A.M., Svendsen, J.C., Macreadie, P.I., Jones, D.O., Boon, A.R., Booth, D.J., Brabant, R., Callahan, E., Claisse, J.T., Dahlgren, T.G., Degraer, S., Dokken, Q.R., Gill, A.B., NINA Report 1731 46 Johns, D.G., Leewis, R.J., Lindeboom, H.J., Linden, O., May, R., Murk, A.J., Ottersen, G., Schroeder, D.M., Shastri, S.M., Teilmann, J., Todd, V., Van Hoey, G., Vanaverbeke, J. & Coolen J.W. 2018. Environmental benefits of leaving offshore infrastructure in the ocean. Frontiers in Ecology and the Environment 16: 571-578.

Kober, K., Webb, A., Win, I., Lewis, M., O'Brien, S., Wilson, L., and Reid, J. (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

Ronconi, R, Allard K, Taylor, P. Bird interactions with offshore oil and gas platforms: Review of impacts and monitoring techniques. Journal of Environmental Management. 147 (2015) 34-45

Tasker, M., Jones, P., Barry, F., Blake, T., Dixon, T & Wallis, A. (1986) Seabirds associated with oil production platforms in the North Sea, Ringing & Migration, 7:1, 7-14.