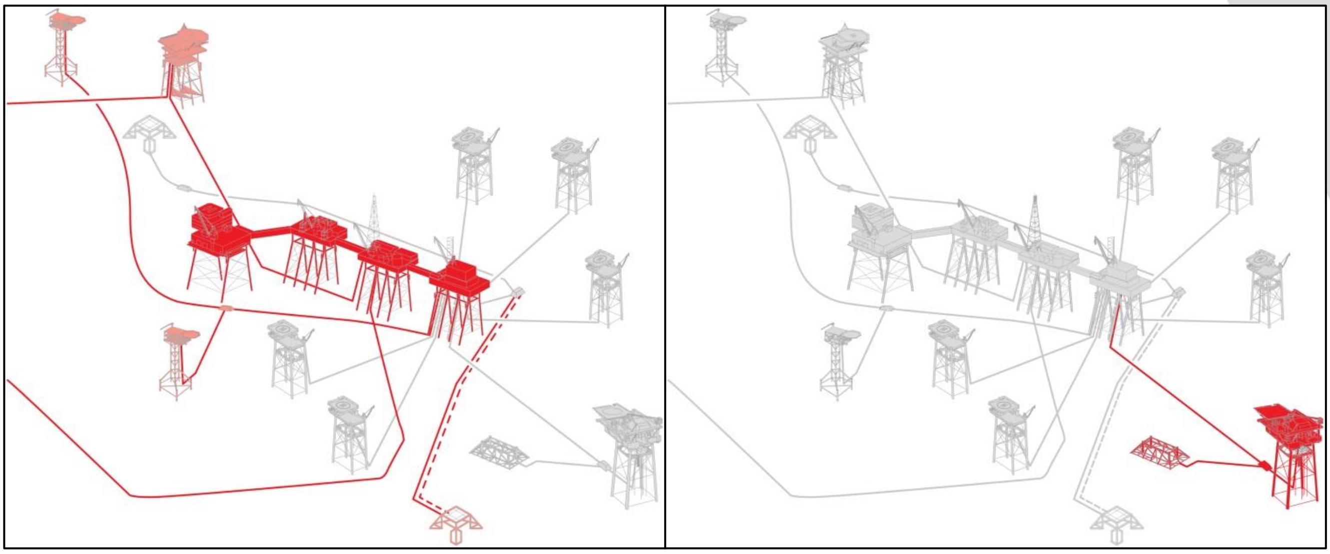
SOUTHERN NORTH SEA (SNS) DECOMMISSIONING PROJECT

SNS DECOMMISSIONING PROGRAMMES ES: VIKING VDP2 AND VDP3



AUGUST 2018

REVISION C1

BMT-SNS-V-XX-X-HS-02-00003

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APPENDICES

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ABBREVIATIONS, ACRONYMS AND UNITS

Definition	
3PLE	3 Layered Polyethylene
%	Percentage
°C	Degrees Celsius
μgg^{-1}	micrograms per gram
µPa	micro Pascal
AA	Appropriate Assessment
A complex	(Viking) Alpha complex
AIS	Automated Identification System
Al	Aluminium
ALARP	As low as reasonably possible
ANIFPO	Anglo-North Irish Fish Producers' Organisation
API	American Petroleum Institute (specific gravity)
As	Arsenic
ASSI	Area of Special Scientific Interest
AWV	Accommodation Work Vessel
Ba	Barium
BEIS	Department for Business, Energy & Industrial Strategy
BOD	Biological Oxygen Demand
BRC	Background/ Reference Concentrations
BTAs	Buoyancy Tank Assemblies
C	Carbon
CA	Comparative Assessment
CCO	Channel Coastal Observatory
CCS	Carbon Capture Storage
Cd	Cadmium
CEFAS	Centre for Environment, Fisheries & Aquaculture Science
CH_4	Methane
cm	Centimetre(s)
CMS	Caister Murdoch System
CO_2	Carbon Dioxide
Cr	Chromium
cSAC	candidate Special Area of Conservation
CSV	Construction Support Vessel
Cu	Copper
dB	Decibel
$dB_{ht\ (species)}$	Sound level in decibels above the hearing threshold of a species
DECC	Department of Energy & Climate Change
Defra	Department of Environment, Food and Rural Affairs
DP	Dynamic Positioning
DSV	Dive Support Vessel
DTI	Department of Trade and Industry (became DECC, presently BEIS)
EA	Environmental Agency

EAC	European Amino-Carboxylate
EBS	Environmental Baseline Survey
EC	European Commission
EDC	Engineering Down and Cleaning
EIA	Environmental Impact Assessment
EPS	European Protected Species
ERL	Effects Range - Low
ES	Environmental Statement
EUNIS	European Nature Information System
FBE	Fusion Bonded Epoxy
FC&D	Final Cleaning and Disconnect
Fe	Iron
FOCI	Features of Conservation Importance
GJ	Gigajoules
GMS	Global Marine Systems Ltd
gS	gravelly Sand
HAZID	Hazard Identification Study
HAZOP	Hazard and Operability
Hg	Mercury
HLV	Heavy Lift Vessel
Hmax	Maximum Mean Wave Height
HRA	Habitats Regulations Assessment
HSE	Health and Safety Executive
Hz	Hertz
ICES	International Council for the Exploration of the Sea
IoP	Institute of Petroleum
IPCC	Intergovernmental Panel on Climate Change
ITOPF	International Tanker Owners Pollution Federation
JNCC	Joint Nature Conservation Committee
kg	kilogram(s)
kHz	kilo Hertz
km	kilometre(s)
km^2	kilometre(s) squared
KP	Kilometre Point
LDP1	LOGGS Decommissioning Program me 1
LOD	Limit of Detection
LOGGS	Lincolnshire Offshore Gas Gathering Systems
m	metre(s) (All water depths are given to Lowest Astronomical Tide)
m/s	metres per second
MALSF	Marine Aggregate Levy Sustainability Fund
MAREA	Marine Aggregate Regional Environmental Assessment
MARPOL (convention)	International Convention for the Prevention of Pollution from Ships
MAT	Master Application Template
MCA	Maritime and Coastguard Agency
MCAA	Marine and Coastal Access Act

MCZs	Marine Conservation Zones
mg/l	milligrams per litre
MMO	Marine Management Organisation
Mn	Manganese
MoD	Ministry of Defence
MODU	Mobile Offshore Drilling Unit
MSFD	Marine Strategy Framework Directive
MSV	Multi-Support Vessel
Nb	Niobium
ND	No Data
NFFO	National Federation of Fishermen's Organisation
Ni	Nickel
NIFPO	Northern Irish Fish Producers' Organisation
nm	Nautical Mile
NOAA	The National Oceanic and Atmospheric Administration
NORM	Naturally Occurring Radioactive Material
NOx	Oxides of Nitrogen
NRC	National Research Council
NSTF	North Sea Task Force
OGA	Oil and Gas Authority
OGP	Oil and Gas Producers (now International Association of Oil and Gas Producers)
OMS	Operating Management System
OPEP	Oil Pollution Emergency Plan
OPOL	Oil Pollution Operator's Liability
OPPC	Oil Pollution Prevention and Control
OSCAR	Oil Spill Contingency and Response
OSPAR	Oslo and Paris Conventions
OSRL	Oil Spill Response Limited
P	Phosphorus
P&A	Plug and Abandonment
PAH	Polycyclic Aromatic Hydrocarbon
PSV	Platform Supply Vessel
Pb	Lead
PETS	Portal Environmental Tracking System
PLONOR	Pose Little or No Risk
ppm	parts per million
ppt	parts per trillion
Ra	Radium
rMCZ	Recommended Marine Conservation Zone
rms	Route Mean Squared
ROV	Remotely Operated Vehicle
ROVSV	ROV Support Vessel
S	Sulphur
SAC	Special Area of Conservation
SCI	Site of Community Interest
SCOS	Special Committee on Seals

SEPA	Scottish Environment Protection Agency
SFF	Scottish Fisherman's Federation
sG	sandy Gravel
SLV	Single Lift Vessel
SMRU	Sea Mammal Research Unit
SNS	Southern North Sea
SO_2	Sulphur Dioxide
SOPEP	Shipboard Oil Pollution Emergency Plan
SOSI	Seabird Oil Sensitivity Index
SOx	Oxides of Sulphur
SPA	Special Protection Area
SPL	Sound Pressure Level
SSA	Site Specific Assessment
SSSI	Site of Special Scientific Interest
Ti	Titanium
TGT	Theddlethorpe Gas Terminal
Th	Thorium
THC	Total Hydrocarbon Concentration
U	Uranium
UK	United Kingdom
UKCS	United Kingdom Continental Shelf
UKDMAP	United Kingdom Digital Marine Atlas
UKOOA	United Kingdom Offshore Operators Association (currently Oil and Gas UK)
V	Vanadium
VDP1	Viking Decommissioning Programme 1
VDP2	Viking Decommissioning Programme 2
VDP3	Viking Decommissioning Programme 3
Viking AR	Viking Alpha Riser
Viking BA	Viking Bravo Accommodation platform, part of Viking Bravo Hub Complex
Viking BC	Viking Bravo Compression platform, part of Viking Bravo Hub Complex
Viking BD	Viking Bravo Drilling platform, part of Viking Bravo Hub Complex
Viking BP	Viking Bravo Production platform, part of Viking Bravo Hub Complex
VisNed	VisNed is the voice of the Dutch cutter fleet, Fish Producer Organisations from Urk, Southwest and North Netherlands
VMS	Vessel Monitoring System
VOC	Volatile Organic Compound(s)
WOW	Wait on Weather
Zn	Zinc

GLOSSARY

Acid rain	Precipitation of acidic pollutants, chiefly sulphur dioxide and nitrogen oxide, released into the atmosphere by the burning of fossil fuels such as oil.
A Complex	A term referring to the five Viking Alpha platforms at the Viking Alpha field. All but one platform (the Viking AR platform) have been decommissioned.
Annex I	Legislation protecting certain habitats under the EC Habitats Directive.
Annex II	Legislation protecting certain organisms under the EC Habitats Directive.
Bathymetry	The measurement of water depth in oceans, sea and lakes.
Benthic Fauna	Organisms that live on, near, or in the bottom sediments of the seabed.
Benthos	See 'Benthic Fauna'.
Bioaccumulation	A general term of the accumulation of substances, such as organic chemicals in an organism or part of an organism.
Biogenic	A substance produced by life processes.
Bivalve	A class of marine and freshwater molluscs with laterally compressed bodies enclosed by a shell in two hinged parts.
Block	A North Sea acreage sub-division measuring approximately 10 km x 20 km forming part of a North Sea quadrant, e.g. Block 21/05 is the 5th block of Quadrant 21.
Coal tar	A viscous black liquid containing numerous organic compounds that is obtained by the destructive distillation of coal. Used for coating pipelines, once cool coal tar sets as a hard impregnable coating.
Condensate	Volatile liquid consisting of the heavier hydrocarbon fractions that condense out of the gas as it leaves the well, a mixture of pentanes and higher hydrocarbons.
Copepods	Small planktonic crustaceans that form a vital part of many marine food webs.
Crude oil	Unprocessed naturally occurring oil.
Crustaceans	A very large group of arthropods usually treated as a subphylum, which includes such animals as crabs, lobsters, crayfish, shrimp, krill and barnacles.
Cuttings	The small chips or flakes of rock retrieved from a well by the circulation of the mud.
Decommissioning	Shutdown of the development with system cleaning and dismantling of facilities.
Decommissioned in situ	Left in its current location
Dinoflagellates	Any of numerous one-celled, aquatic organisms that have characteristics of both plants (algae) and animals (protozoans). Most are microscopic and marine. The group is an important link in the food chain. Dinoflagellates also produce part of the luminescence sometimes seen in the sea.
Dynamic positioning	A system of sensors and thrusters on a vessel which allows it to maintain position using satellite telemetry to adjust thrusters' direction and power.
Echinoderm	Any marine invertebrate animal of the phylum Echinodermata, including starfishes and sea urchins, characterized by a five-part radially symmetrical body and a calcareous endoskeleton.
Ecosystem	The physical environment and associated organisms that interact in a given area. There is no defined size for an ecosystem.
Effects Range – Low (ERL)	Effects Range-Low (ERL) value is the lower tenth percentile of the data set of concentrations in sediments which were associated with biological effects.
Environmental Impact Assessment	A process to identify and assess the impacts associated with a particular activity, plan or project.
Environmental Management System	A formal system which ensures that a company has control of its environmental performance.

Environmental Statement	A report setting out the findings of an assessment of a project's environmental impacts.
Epibenthic	Organisms that live on the surface of sediments at the bottom of the sea.
European Commission	Body made up of commissioners from each EU country, responsible for representing the common European interest, with the power to instigate and apply changes in European law to all EU countries.
European Protected Species	Species that are listed in Annex IV of the Habitats Directive, and are therefore protected from harm or disturbance by European law.
Fauna	Animal life.
Flora	Plant life.
Frond mats	Mattress with buoyant fronds attached installed to reduce scour.
Greenhouse gas	Gas that contributes to the greenhouse effect. Includes gases such as carbon dioxide (CO_2) and methane (CH_4). The greenhouse effect results in a rise in temperature due to incoming solar radiation being trapped by carbon dioxide and water vapour in the Earth's atmosphere.
Hazardous Waste	Hazardous Waste is a term used in England, Wales and Northern Ireland for materials that have one or more of the hazardous properties described in the Hazardous Waste Directive 91/689/EEC.
Infauna	Fauna that lives within sediments.
Inorganic	Not having the structure or characteristics of living matter (not considered organic).
Macrofauna	Benthic or soil organisms which are larger than 0.5mm.
Marine Scotland	A government consultee and a lead marine management organisation in Scotland, bringing together the functions of Marine Scotland Science, Marine Scotland Compliance and the Scottish Government Marine Directorate.
Mattresses	A structure to support, protect and provide stability to pipelines and to give any additional dropped object protection.
Megaripples	Large, sand waves or ripple-like features having wavelengths greater than 1 meter or a ripple height greater than 10 centimetres
Multi-beam echosounder	A multi-beam echosounder used to measure and record seabed bathymetry over a wide strip or area beneath the survey vessel.
Organic	Compounds containing carbon and hydrogen.
Organotin	An organic compound with one or more tin atoms in its molecules.
P&A (Plug and Abandonment)	To seal a well, or part of a well with cement before leaving the well permanently sealed and abandoned.
Pelagic	Any water in the sea that is not close to the bottom or near to the shore. Marine animals that live in the water column of coastal, ocean and lake waters, but not on the bottom of the sea or the lake.
Phytoplankton	Planktonic organisms that obtain energy through photosynthesis.
PLONOR List	The OSPAR List of Substances/ Preparations Used and Discharged Offshore which are Considered to Pose Little or No Risk to the Environment (PLONOR) contains substances whose use and discharge offshore are subject to expert judgement by the competent national authorities or do not need to be strongly regulated.
Polychaete	A class of marine annelid worms.
Protozoans	Protozoa are single celled organisms. They come in different shapes and sizes and live in a wide variety of moist habitats including freshwater, seawater and soil.
Risk	The combination of the probability of an event and a measure of the consequence.
Rock-placement	Deposition of rock onto subsea pipelines, to provide protection against anchors and trawlnets, when burying completely the pipe is impossible.
Salinity	The dissolved salt content of a body of water.

Sound	Sound is a mechanical wave that is an oscillation of pressure transmitted through a solid, liquid, or gas, composed of frequencies within the range of hearing and of a level sufficiently strong to be heard.
Scour pit	The result of the process by which tides and currents carry away loose sediment from around a fixed object on the seabed such as a platform leg or pipeline or rock.
Side-scan sonar	Acoustic survey equipment towed close to the seabed, typically used for surveying pipelines.
Stratification	Separation of a body of water into two or more distinct layers due to differences in density or temperature.
Stochastic model or simulation	A model/simulation involving or containing a random variable or variables; involving chance or probability.
Surge	A rise in water level above that expected due to tidal effects alone; the primary causes are wind action and low atmospheric pressure.
Taxa	Categories in the biological classification system for all living organisms (i.e. kingdom, phylum, class, order, family, genus, species).
THC	Total Hydrocarbon Concentration. The summed concentration of all the resolved/unresolved (i.e. UCM) aliphatic and aromatic hydrocarbons derived from biogenic and petrogenic sources. A petrogenic hydrocarbon is one produced by the incomplete combustion of petroleum.
Thermocline	An area in the water column where there is a rapid temperature change with increasing depth. This is due to stratification between warmer, well mixed, less dense water in the surface layer and deeper, colder water below.
UKCS	Areas of the United Kingdom Continental Shelf waters in which the UK Government has jurisdiction over oil and gas activity.
Viking Bravo Hub Complex	A term referring to the four bridge-linked platforms at the Viking Bravo field: Viking BD, Viking BA, Viking BC, Viking BP.
Wait on Weather (WoW)	When a rig or vessel is “waiting on weather”, this refers to a period of time when no work can be undertaken due to risk to equipment and personnel safety.
Water column	A theoretical column through a body of water from the surface to the sediments. This concept can be helpful when considering the different processes that occur at different depths.
Zooplankton	Broadly defined as heterotrophic (deriving energy from organic matter) planktonic organisms, although some protozoan zooplankton species can derive some energy from sunlight.

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NON-TECHNICAL SUMMARY

This non-technical summary outlines the findings of the Environmental Impact Assessment (EIA) conducted by ConocoPhillips (U.K.) Limited (ConocoPhillips) in support of the two decommissioning Programmes, Viking Decommissioning Programme 2 (VDP2) and Viking Decommissioning Programme 3 (VDP3).

The purpose of the EIA is to understand and communicate the significant environmental impacts associated with the decommissioning options proposed under VDP2 and VDP3 and to inform the decision-making process. The detailed assessment is presented within the Environmental Statement.

The VDP2 and VDP3 infrastructure are located within 14 United Kingdom Continental Shelf licence blocks in the Southern North Sea (Figure i).

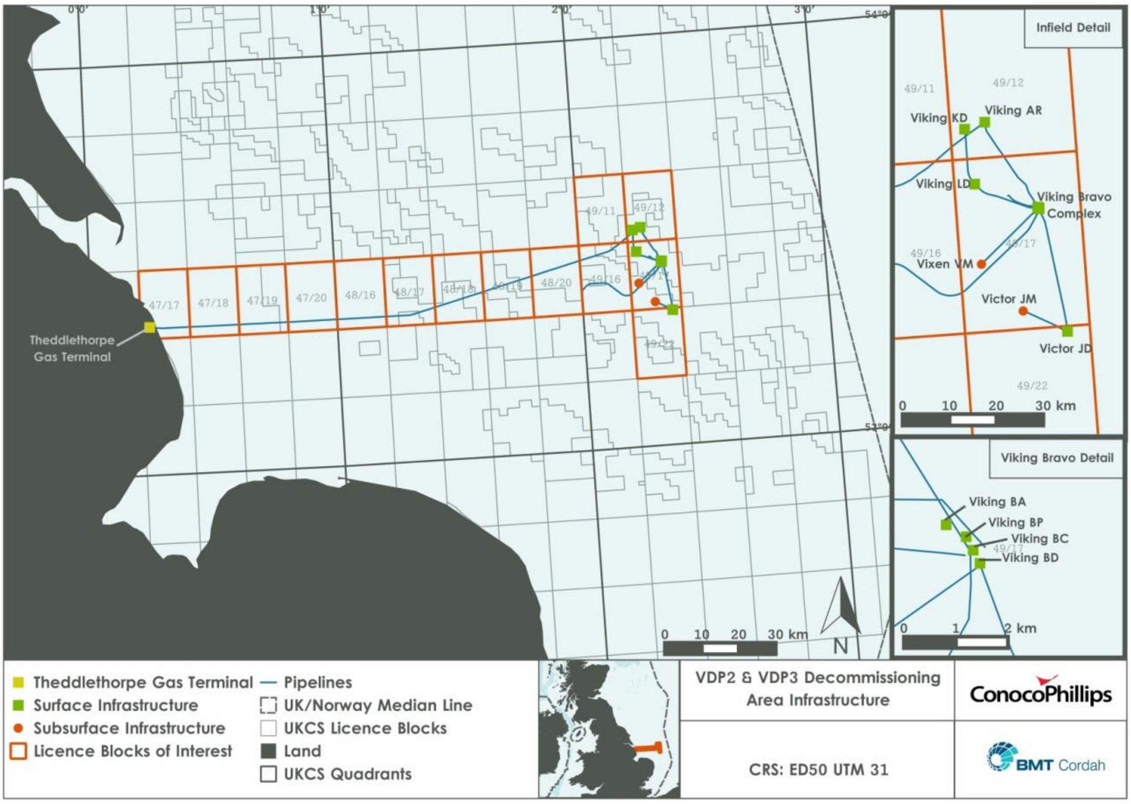

Figure i: Location of the VDP2 and VDP3 infrastructure to be decommissioned

The VDP2 infrastructure is composed of three satellite platforms (Viking KD, LD and AR), the four Viking Bravo Hub Complex platforms (Viking BA, BC, BD and BP), one subsurface installation (Vixen VM), two subsea tees, seven gas pipelines, six methanol pipelines and one control umbilical. The infrastructure to be decommissioned also includes supporting structures and mattress protection.

The VDP3 infrastructure is composed of one satellite platform (Victor JD), one subsurface installation (Victor JM), one subsea pigging skid, two gas pipelines, two methanol pipelines and one umbilical. The infrastructure to be decommissioned also includes supporting structures and mattress protection.

One VDP2 gas pipeline and methanol pipeline connects the VDP2 and VDP3 offshore infrastructure to the onshore Theddlethorpe Gas Terminal.

Regulatory Context

The decommissioning of offshore oil and gas infrastructure in the United Kingdom Continental Shelf is principally governed by the Petroleum Act 1998, as amended by the Energy Act 2008. The Petroleum Act sets out the requirements for a formal Decommissioning Programme which must be approved by the Department for Business, Energy & Industrial Strategy (formerly the Department for Energy and Climate Change) before the owners of an offshore installation or pipeline may proceed with decommissioning.

At present, there is no statutory requirement to prepare an Environmental Statement for decommissioning. However, under the Guidance Notes: Decommissioning of Offshore Oil and Gas Installations and Pipelines under the Petroleum Act 1998 (DECC Guidance Notes, which were applicable prior to the establishment of BEIS and when this document was first written) the Decommissioning Programme must be supported by an EIA.

The Guidance Notes state that an EIA should include an assessment of the following:

- All potential impacts on the marine environment including exposure of biota to contaminants associated with the decommissioning of the installation; other biological impacts arising from physical effects; conflicts with the conservation of species with the protection of their habitats, or with mariculture; and, interference with other legitimate uses of the sea.
- All potential impacts on other environmental compartments, including emissions to the atmosphere, leaching to groundwater, discharges to surface fresh water and effects on the soil.
- Consumption of natural resources and energy associated with reuse and recycling.
- Interference with other legitimate uses of the sea and consequential effects on the physical environment.
- Potential impacts on amenities, the activities of communities and on future uses of the environment.

In addition, BEIS have advised the Oil and Gas Industry that under the Marine and Coastal Access Act 2009 (MCAA) and the Marine (Scotland) Act 2010 an EIA/ Environmental Statement will be required for all licence applications relating to decommissioning operations.

OSPAR Decision 98/3 (the Decision) sets out the United Kingdom's international obligations on the decommissioning of offshore installations. The Decision prohibits the dumping and leaving wholly or partly in place of offshore installations. 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 of cutting is dependent upon the prevailing seabed conditions and currents.

OSPAR Decision 98/3 does not include the decommissioning of pipelines. 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. The Guidance Notes state that "Because of the widely different circumstances of each case, it is not possible to predict with any certainty what may be approved in respect of any class of pipeline". Therefore, all feasible pipeline decommissioning options should be considered and a Comparative Assessment made.

Scope of the Viking Decommissioning Programmes, VDP2 and VDP3

The main elements of VDP2 and VDP3 include the following:

- Plug and abandonment of the wells in accordance with the well abandonment programme (covered in a separate environmental assessment).
- Preparation, final cleaning and removal of mobile hydrocarbons, production chemicals and mobile solids from pipelines and topsides (gas, methanol and corrosion inhibitor) and subsequent flooding of pipelines (decommissioned in situ) with seawater.
- Preparation of infrastructure for removal by specialist contractors to an approved onshore disposal facility.
- Leaving satellite installations (Viking AR, KD and LD) and the Viking Bravo Hub Complex in cold suspension with appropriate navigational aids until topside and jacket removal.
- Removal of infrastructure by heavy lift vessel.
- Dismantling and disposal of infrastructure at an onshore reception facility.

The decommissioned structures will be taken to an appropriate onshore disposal yard located within Europe. Disposal yard selection remains to be made.

Decommissioning Studies

ConocoPhillips have conducted a number of studies in support of the Southern North Sea Decommissioning Program, planning process and option evaluation. These have been used to determine the preferred decommissioning options and optimal engineering solutions. The conclusions from these are included within the Environmental Statement.

Recommended Decommissioning Options

Topsides, jackets, manifolds, tee-pieces and pigging skids will be removed and brought to shore for reuse, recycling or disposal. Specialists' studies, internal reviews and engineering assessments were undertaken to determine the optimum decommissioning options for the VDP2 and VDP3 surface installations, subsea structures, pipelines and wells. ConocoPhillips conducted a Comparative Assessment of the options for decommissioning of the infield pipelines and mattresses for VDP2 and VDP3, as required under the Petroleum Act 1998. Table ii provides an overview of the selected decommissioning options for the VDP2 and VDP3 infrastructure.

Table ii: Overview of selected decommissioning options of the VDP2 and VDP3 infrastructure

VDP2/ VDP3 Infrastructure	Decommissioning Option Selected	Possible Decommissioning Method
Topsides	Full removal	Lift and transportation to shore by a Heavy Lift Vessel for dismantlement, disposal and recycling.
Jacket (and risers)		
Pipelines	Decommissioned in situ	Minimal intervention
Manifolds	Full removal	Cut and lift via a DSV, with a supply vessel on site.
Tee-pieces		
Pigging skid		
Remaining mattresses and grout bags	Current state (decommissioned in suit)	
Wells (and conductors)	Plug and Abandon	In accordance with the Oil and Gas UK Guidelines for the Suspension and Abandonment of Wells (2012)

Environmental Setting and Sensitivities

The VDP2and VDP3 infrastructure is located in the relatively shallow waters of the southern North Sea. Water depths offshore range from approximately 20 to 38 m Lowest Astronomical Tide, with water depth decreasing with proximity to the shoreline and the Theddlethorpe Gas Terminal.

Sediments in the offshore decommissioning area comprise fine to course 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%. Seabed sediments closer to shore are comprised of gravelly Sand and sandy Gravel.

Side-scan sonar images from recent environmental surveys and historic pipeline monitoring surveys show evidence of exposure of the pipelines included in both decommissioning programmes. This exposure is due to the presence of strong currents, relatively shallow water depths and mobile sediments which result in a dynamic seabed environment in the immediate area. These conditions have created seabed features such as sandbanks, megaripples, scour and shoal areas which are all characteristic of this area of the southern North Sea.

A key concern regarding the decommissioning of VDP2 and VDP3 is that the infrastructures to be decommissioned are sited within the North Norfolk Sandbanks and Saturn Reef Special Area of Conservation (SAC) and the Inner Dowsing, Race Bank and

North Ridge SAC and the Southern North Sea cSAC. These SACs have been designated for the protection of two Annex I habitats that have been identified within the SACs. These habitats include: ‘Sandbanks which are slightly covered by sea water all the time’ and ‘Reefs (specifically, the biogenic reef built from the tubes created by the polychaete worm *Sabellaria spinulosa*). The cSAC is designated as an area of importance for harbour porpoise, and mitigation to the disturbance of harbour propose of deterioration of the supporting habitat be considered. The Joint Nature Conservation Committee (JNCC) has classified the SACs as representing good ‘conservation’ examples of these habitats.

Sabellaria spinulosa were identified in several historic survey reports within the Viking area. Analysis of the VDP2 and VDP3 pipeline inspection footage found evidence of large aggregations of *S. spinulosa* along the PL27/ PL161 pipelines, approximately 18 km from Viking AR platform. However more recent surveys suggest that these have been damaged, removed or covered by sediment in some areas. Tables iii highlight the key physical, chemical and biological sensitivities relevant to the VDP2 and VDP3 areas.

Table iii: Summary of environmental characteristics and sensitivities

Aspect	Months of the Year											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Site overview												
The VDP2 and VDP3 infrastructure is located in the southern North Sea Quadrants 47, 48 and 49, within 14 blocks (Blocks 47/17, 47/18, 47/19, 47/20, 48/16, 48/17, 48/18, 48/19, 48/20, 49/11, 49/12, 49/16, 49/17 and 49/22).												
Conservation interests												
Annex I habitats												
North Norfolk Sandbanks and Saturn Reef SAC	All of the platforms and 25 km section of PL27/ PL161 are located within this SAC. The sandbanks typically have fields of sand waves associated with them. The Annex I biogenic reef habitats formed by the polychaete worm (*S. spinulosa*) are also present in the SAC and were recorded along PL27/ PL161.											
Inner Dowsing, Race Bank and North Ridge SAC	A 23 km section of PL27/ PL161 pipelines is located within this SAC. The SAC is designated for its sandbanks which are slightly covered by seawater all the time, and for its *S. spinulosa* reef habitats.											
Southern North Sea cSAC	All of the infield infrastructure included in VDP2 and VDP3 are located within this candidate SAC (cSAC). Approximately 42 km of the VTS pipeline crosses this cSAC. The site is designated due to the populations of harbour porpoise, and Annex II species, in the area											
Annex II species												
Harbour porpoise		M	H	L	H	H	H	VH	H	L	M	L
Bottlenose dolphins								L			L	
Grey seals	Grey seal density along the decommissioning area ranges from 0 to 150 seals per 25 km^2. Haul-out and breeding sites are located within the Humber Estuary SAC.											
Harbour seals	Harbour seal density along the decommissioning area ranges from 0 to 100 seals per 25 km^2. Haul-out and breeding sites are located within The Wash and North Norfolk Coast SAC. This site represents the largest colony of harbour seals in the UK, with approximately 7% of the total UK population.											
Designated areas												
No designated MCZs coincide with the VDP2 and VDP3 infrastructure; however three rMCZs coincide with VDP2 and VDP3 infrastructure: Lincs Belt rMCZ, Silver Pit rMCZ and Wash Approach rMCZ.												

Table iii (Continued): Summary of environmental characteristics and sensitivities

Aspect	Months of the Year											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Plankton												
Plankton in the sea area surrounding the VDP2 and VDP3 is likely to be typical for the southern North Sea. Dominant phytoplankton species are dinoflagellates of the genus Ceratium, including *C. fusus, C. furca* and *C. tripos*. High numbers of the genus Cheaetoceros are also present. Dominant species of zooplankton present include small copepods including *Para-Pseudoclanus spp*., and echinoderm larvae. The larger species of copepods, *Calanus helgolandicus* and *Metridia lucens* are also present.												
Benthic environment												
Sediments in the offshore area comprise 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 %. Seabed sediments closer to shore are comprised of gravelly Sand and sandy Gravel. No cuttings piles have been identified in the study area. Chemical analysis of sediment samples found metals and total hydrocarbons to be within the range of reported background concentrations and below the effects range. The seabed habitat when classified using the EUNIS code is 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 identified during seabed surveys are typical for this area of the southern North Sea. The shallow-water infaunal assemblage is typically characterised by taxa including polychaetes, bivalve molluscs and amphipods and crustaceans. *S.spinulosa* were identified in several historical survey reports within and adjacent to the VDP2 and VDP3 area. Also recent pipeline inspection surveys observed sections of *S. spinulosa* along the PL27/ PL161 pipelines, within the boundaries of North Norfolk Sandbanks and Saturn Reef SAC.												
***Fish* – spawning and nursery areas** for the ICES Rectangles 35F0, 35F1, 35F2 and 36F2												
Anglerfish	N	N	N	N	N	N	N	N	N	N	N	N
Mackerel	N	N	N	N	NS*	NS*	NS*	NS	N	N	N	N
Herring	NS	N	N	N	N	N	N	N	N	N	NS	NS
Cod	NS	NS*	NS*	NS	N	N	N	N	N	N	N	N
Haddock	N	N	N	N	N	N	N	N	N	N	N	N
Whiting	N	N	N	N	N	N	N	N	N	N	N	N
Norway pout	N	N	N	N	N	N	N	N	N	N	N	N
Plaice	NS*	NS*	NS	N	N	N	N	N	N	N	N	N
Lemon sole	N	N	N	NS	NS	NS	NS	NS	NS	N	N	N
Sole	N	N	NS	NS*	NS	N	N	N	N	N	N	N
Sandeel	NS	NS	N	N	N	N	N	N	N	N	NS	NS
Sprat	N	N	N	N	NS*	NS*	NS	NS	N	N	N	N
Nephrops	NS	NS	NS	NS*	NS*	NS*	NS	NS	NS	NS	NS	NS
Tope shark	N	N	N	N	N	N	N	N	N	N	N	N
Spurdog	N	N	N	N	N	N	N	N	N	N	N	N
Thornback ray	N	N	N	N	N	N	N	N	N	N	N	N
Horse mackerel	N	N	N	N	N	N	N	N	N	N	N	N
Key:												
Fish spawning/ nursery	S	spawning			S*	peak spawning			N	nursery		

Table iii (Continued): Summary of environmental characteristics and sensitivities

Seabirds ***(median score for blocks containing infrastructure)***												
The most common species of seabird found in these areas of the SNS include: Fulmar, Gannet, Guillemot, Kittiwake, Razorbill, Puffin, Little Auk; as well as numerous species of gull, tern, and skua.												
Seabird sensitivity to oil pollution within the Blocks of Interest (JNCC, 2017a)												
Block	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
47/17	4	4	3	5	5	5	5	5	5	2	2	2
47/18	4	4	2	5	5	5	5	4	4	1	2	2
47/19	3	3	2	5	5	5	5	4	4	3	1	2
47/20	3	4	2	5	5	5	5	4	4	3	1	2
48/16	3	4	3	3	5	5	5	4	5	4	2	3
48/17	3	3	3	3	5	5	5	3	4	2	1	3
48/18	1	2	3	3	5	5	5	3	3	1	1	1
48/19	1	1	3	3	3	5	5	3	3	1	1	1
48/20	1	1	1	ND	3	5	5	5	5	ND	1	1
49/11	1	1	1	ND	ND	1	1	5	5	ND	ND	1
49/12	ND	1	ND	ND	5	5	1	5	5	5	ND	1
49/16	2	2	2	ND	ND	5	5	5	5	ND	2	1
49/17	ND	1	2	ND	ND	2	2	5	5	5	ND	1
49/22	1	3	3	3	ND	5	5	5	3	3	1	1
Overall the seabird sensitivity in the area is 'high'. A clear seasonality in seabird sensitivity occurs within the decommissioning area, with the highest sensitivities in the winter months (JNCC, 2017g)												

Aspect	Months of the Year											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Marine mammals *(generalised for Quadrants 47, 48 and 49)*												
Harbour porpoise		M	H	L	H	H	H	VH	H	L	M	L
White-beaked dolphin	M		VH	VH	L	H	L	L	M	M	H	L
Minke whale						L	L	L	L	L		
Long-finned pilot whale								L				
Bottlenose dolphin								L			L	
White-sided dolphin								L	L			
Common dolphin		L							M			

Key

Seabird sensitivity	
1	Extremely high
2	Very High
3	High
4	Medium
5	Low
ND	No data
x	Interpolated data (where "x" is the interpolated value)

Marine mammal sightings	
VH	Very high
H	High
M	Moderate
L	Low
	No data

Users of the VDP2 and VDP3 areas are mainly associated with oil and gas exploration and development, aggregate extraction, shipping and fishing. Table iv highlights the key socioeconomic sensitivities relevant to the VDP2 and VDP3 areas.

Table iv: Summary of socioeconomic characteristics and sensitivities

Aspect	Characteristics
Commercial fishing	
Low to high fishing activity occurs within the vicinity of the VDP2 and VDP3 infrastructure. The UK vessel activity is targeted closer inshore and is primarily shellfish species fishery for crab and *Nephrops*. Dutch vessels primarily fish further offshore using trawlers fishing for demersal species, mainly plaice. Vessel monitoring data suggests there is little vessel activity in the immediate vicinity of the offshore pipelines.	
Other users	
Shipping activity	Shipping activity in the VDP2 and VDP3 infrastructure area ranges from very low to very high.
Oil and gas	The nearest non-ConocoPhillips infrastructure is the Shell operated Skiff platform, located in Block 48/20, 0.3 km north from the VDP2 and VDP3.
Telecommunications	The Tampnet Telecom cable passes 2.2 km from Viking BA platform and 2 km from the Vixen VM subsea manifold. This cable also transects pipelines, PL88/ PL134, PL1571/ PL1573, PL1767/ PL1768 and PL2643/ PL2644.
Military activities	Block 47/17 lies within military exercise area.
Aggregate extractions	Aggregate application option areas are located within the VDP2 and VDP3 area.
Windfarms	Three windfarms are located in the vicinity of VDP2 and VDP3 area.
Carbon capture storage	Aquifers with the potential for carbon capture storage in the southern North Sea are located within Blocks 48/19, 48/20, 49/11, 49/16 and 49/17, containing the export pipeline and offshore infrastructure.
Wrecks	No designated historical wrecks have been recorded in the area. There are 52 wrecks classed as dangerous wrecks by the United Kingdom Hydrographic Office in the vicinity of VDP2 and VDP3 infrastructure. East Essex S Trawler is located in Block 49/19, 0.9 km south west from Viking Bravo Hub Complex.

Key Environmental Concerns

A risk assessment of the potential significant environmental impacts, between the proposed decommissioning activities and the local environment, identified a number of potential impacts requiring further assessment. The following summarises the conclusions from detailed assessments of the potential sources of significant impact.

Energy and emissions

Energy use and associated emissions resulting from the proposed decommissioning activities under VDP2 and VDP3 are mainly attributed to the manufacture of new materials to replace recyclable materials decommissioned in situ and sent to landfill. The cutting and lifting of the jacket and topsides will utilise the most number of vessels and therefore result in the next highest energy usage and emissions.

The emissions from the decommissioning activities will have a localised effect on air quality (the emissions being less than the emission profile associated with the installations operations during production). The impact on air quality is unlikely to affect any sensitive receptors within the VDP2 and VDP3 area as the impact is expected to be limited to the immediate vicinity. For this reason, there is unlikely to be a significant transboundary or cumulative impact on air quality.

Underwater noise

Man-made underwater noise has the potential to impact on fish species and marine mammals. Several activities associated with the proposed decommissioning activities will generate underwater noise. Based on the activities proposed, it is estimated that the sound levels would attenuate to ambient levels within a few kilometres of the sound source.

As such, it is unlikely that the sound produced from decommissioning activities would have an effect on fish behaviour that would be noticeable at the population level given the limited spatial extent of the sound generated.

The main marine cetacean species that occur in the VDP2 and VDP3 areas are white-beaked dolphin and harbour porpoise. There are two species of pinniped present, harbour seal and grey seal. Records indicate the seals will be in the study area at the same time as decommissioning activities are taking place. These species are all subject to regulatory protection from injury or disturbance.

Vessel noise is thought to be the main source of persistent noise during the decommissioning activities and a worst-case scenario was modelled using a maximum of eight vessels present at one location. Even with this worst-case approach, subsea noise levels are unlikely to result in physiological damage to marine mammals. Depending on ambient noise levels, sensitive marine mammals may be locally displaced by vessel noise in the immediate vicinity or by any other continuous noise source during the proposed activities. The individual and cumulative impacts from the decommissioning activities at VDP2 and VDP3 were not considered significant.

Seabed impacts

The proposed decommissioning operations at the VDP2 and VDP3 areas will result in work being undertaken at or near the seabed. Therefore, there is the potential for localised long and short term seabed disturbance and habitat loss. Surveys have indicated that there are no cuttings piles associated with the platforms to be removed under the two decommissioning programmes.

The short-term impacts associated with the decommissioning of the VDP2 and VDP3 infrastructure include excavation pits at the jacket piles, anchor pits and excavation work for access to the buried pipework. Studies have shown that any impact from seabed disturbance and anchoring will be transient in this area of the North Sea, and any anchor plough marks and excavation would revert to background seabed conditions in a short timescale. None of these impacts have been assessed as significant.

The decommissioning in situ of the pipelines, mattresses and associated grout bags, rock-placement on pipeline ends and the placement of rock on the seabed to provide stabilisation for the accommodation work vessel will constitute a long-term impact on the seabed. These impacts constitute a change in sediment type within the SACs, however the footprint is small (2.2 km^2) in comparison to the total SAC areas (4,448 km^2) and as such it is not considered to adversely impact the integrity of the SAC. ConocoPhillips has selected current state (in situ decommissioning) for the mattresses and grout bags as their preferred decommissioning option. This option results in reduced impacts to the SACs while maintaining pipeline stability as opposed to the placement of additional rock material which would result in a larger footprint.

The pipelines will release a small volume of contaminants to the marine environment over time as the pipeline degrades. However, these volumes will be small and over a long period (between 100 - 500 years depending on conditions). These levels are not likely to rise significantly above background levels or result in significant long-term toxicity to marine organisms or populations.

Discharges to sea

There are not any significant discharges to sea planned from any of the decommissioning activities proposed under VDP2 and VDP3, with the exception of the contents of the Methanol Pipelines PL134 and PL161 which cannot be successfully flushed and inventories disposed of downhole. Under chemical permits and appropriate risk assessment, the inventories of pipelines PL134 and PL161 are to be discharged to the marine environment. There is potential for some residual hydrocarbons and NORM scale to be present in the pipelines decommissioned in situ and a negligible amount of material during cutting of the pipelines will be discharged to sea. A small volume of material may be released to the environment over many decades as the pipeline degrades over time (100 to 500 years). However, these are not likely to result in any significant impacts on the marine environment.

Societal impacts

The main socioeconomic impacts which may arise as a result of the decommissioning of the VDP2 and VDP3 include interference or disturbance to commercial shipping and/or snagging hazards to fishermen resulting in lost or damaged fishing gear.

The majority of the decommissioning operations will be undertaken within the current safety exclusion zones which are in place around each of the decommissioned platforms. The exception to this is a small number of surveys which will be undertaken along the pipelines decommissioned in situ. As a result there will be negligible impacts to commercial shipping activities in the vicinity.

The decommissioning of pipelines in situ will not result in any additional loss of fishing grounds as these pipelines have been in situ for a number of decades. There is potential for the small footprint of the mattresses and rock-placement left in situ becoming exposed over time and potentially posing a snagging hazard. Based on the level of fishing present in the VDP2 and VDP3 areas this risk is low, with the exception of the shellfish species near shore. ConocoPhillips intends to minimise any potential risk to fishermen by accurately mapping the location of these potential obstructions and making these positions available to fishermen for navigational purposes. Once the decommissioning of the infrastructure is complete, full overtrawlability trials will be conducted in the 500 m safety exclusion zones where stabilisation features predominantly exist, ensuring the infrastructure decommissioned in situ is passible by fishing gear.

Accidental events

Accidental events, such as the release of hydrocarbons and chemicals, can result in a complex and dynamic pattern of pollution distribution and impact on the marine environment. Although the likelihood of such a spill is remote, there is a potential risk to organisms in the immediate marine and coastal environment, and a socioeconomic impact if a spill were to occur.

A worst-case scenario at the VDP2 and VDP3 areas would result from a loss of diesel from on-site vessels or collisions. Diesel spills will disperse and dilute quickly, with a very low probability of hydrocarbons reaching the coastline. The likelihood of a hydrocarbon spill occurring is low and will not contribute to the overall spill risk in the area. The current Oil Pollution Emergency Plans for the southern North Sea Operations and Onshore Operations provide effective spill management in the case of an accidental event.

During the proposed operations, there is the potential for the loss of objects dropped overboard which may present a hazard to shipping, fishing activities and may also impact the seabed community within the drop zone. ConocoPhillips will endeavour to minimise the number of dropped objects and will secure items to prevent loss during the proposed decommissioning operations. The recovery of oil and gas related debris wherever practicable will be undertaken to minimise the impact on the environment and to minimise the risk to other users of the sea.

Environmental Management

ConocoPhillips is committed to conducting activities in compliance with all legislation and operates an ISO14001 certified Environmental Management System (EMS). The EMS covers all aspects of ConocoPhillips's activities including exploration, drilling and production activities. All activities associated with the decommissioning of the VDP2 and VDP3 infrastructure will be covered by this EMS.

Conclusions

Overall, the Environmental Statement has evaluated the potential impacts, their significance and environmental risk reduction measures. Although the intent is to decommission several pieces of infrastructure in situ, this document concludes that ConocoPhillips have, or intend to, put in place sufficient safeguards to mitigate the potential environmental risk and to monitor the implementation of these measures. A summary of the impacts and planned mitigation measures are presented in Table v.

In addition, the Environmental Statement has highlighted the positive impact that the decommissioning of the VDP2 and VDP3 infrastructure will have on commercial fishermen and other users of the sea, with the opening of areas of the sea which have previously been excluded for safety reasons. This will exceed the small area of seabed which may be unavailable from the presence of mattresses decommissioned in situ and rock-placement.

Therefore, it is the conclusion of this Environmental Statement that the recommended options presented for the decommissioning of the VDP2 and VDP3 infrastructure can be completed without causing significant adverse impact to the environment.

Table v: Summary of potential impacts and planned mitigation measures

Potential sources of impact	Planned mitigation measures
Energy and Emissions	
CO_2 Emissions	• Vessels will be audited as part of selection and pre-mobilisation. • All generators and engines will be maintained and operated to the manufacturers' standards to ensure maximum efficiency. • Vessels will use ultra-low sulphur fuel in line with MARPOL requirements. • Work programmes will be planned to optimise vessel time in the field. • Fuel consumption will be minimised by operational practices and power management systems for engines, generators and other combustion plant and maintenance systems.
Underwater Noise	
Underwater noise from decommissioning activities	• Machinery and equipment will be in good working order and well-maintained. • Helicopter maintenance will be undertaken by contractors in line with manufacturers and regulatory requirements. • The number of vessels utilising dynamic positioning would be minimised where possible.
Seabed Disturbance	
Subsea equipment cutting, excavation and lifting	• Cutting and lifting operations will be controlled by a remotely operated vehicle to ensure accurate placement of cutting and lifting equipment and minimise any impact on seabed sediment. • The requirements for excavation of the platform footings will be assessed on a case-by-case basis and will be minimised to provide access only where necessary. Internal cutting will be used preferentially where access is available.
Anchoring activities	• All anchors would be completely removed from the seabed at the end of the decommissioning operations.
Rock-placement	• A rock-placement vessel or remotely operated vehicle 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 fall pipe equipped with cameras, profilers, pipe tracker and other sensors as required. • The profiles of both the rock-placement over the pipeline ends and the accommodation work vessel rock berms will be such as to allow fishing nets to trawl over the rock unobstructed. Suitably graded rock will be used to minimise the risk of snagging of fishing gear. • 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.

Potential sources of impact	Planned mitigation measures
Discharges to Sea	
Residual hydrocarbons or solids in pipelines and subsea pipework	Cleaning of pipelines during the decommissioning process, including: • Flushing pipelines with sea water and gel pigging. • Re-injection of contaminated fluids from the pipelines. • Removal of any mobilised solid wastes for skip and ship. • Release of residual contaminants from the long term degradation of the pipelines decommissioned in situ. • Release of degradation products from the breakdown of the pipelines. Disposal of waste transported onshore for disposal will be provided by an approved waste management contractor, in compliance with ConocoPhillips existing standards, policies and procedures.
Residual fluids in piggybacked methanol lines	• Cleaning of pipelines during the decommissioning process. • Wherever possible recovered clean methanol will be reused during Viking decommissioning operations.
Societal Impacts	
Physical presence of decommissioning vessels causing potential interference to other users of the sea.	• Prior to commencement of operations, the appropriate notifications will be made and maritime notices posted. • A stand-by/ support vessel will monitor shipping traffic during decommissioning operations. • All vessel activities will be in accordance with national and international regulations. • Appropriate navigation aids will be used to ensure other users of the sea are made aware of the presence of vessels.
Damage to or loss of gear as a result of subsea obstructions decommissioned in situ, posing potential snagging risks.	• The use of a fall-pipe on the rock-placement vessel and the use of remotely operated vehicle during rock-placement operations will ensure that the rock was placed in the correct position. • On-going consultation with fisheries representatives • Subsea rock-placement will be included on navigational charts • Post-decommissioning seabed clearance and an overtrawlability survey to ensure that the rock-placement gradient is within acceptable limits.
Long term environmental impacts of the physical presence of the pipelines, mattresses and rock-placement on the seabed.	• Post decommissioning survey to accurately map the location of subsea structures decommissioned in situ. • Post-decommissioning monitoring (for up to10 years) of routes of the buried pipeline routes will be discussed as part of any future monitoring programme agreed with BEIS. • Potential remedial intervention in the event issues arise with the pipeline interacting with other users. These mitigation measures recognise ConocoPhillips' indefinite liability for the pipeline and associated materials decommissioned in situ.
Accidental Events	
Dropped object event from VDP2 and VDP3 decommissioning activities	• All efforts will be made by ConocoPhillips to minimise the number of dropped objects. During the cleaning and preparation for removals programme, items will be secured to prevent loss wherever practicable. • Post-decommissioning surveys will be undertaken to assess the presence and potential recoverability of any lost objects from VDP2 and VDP3 facilities wherever practicable. The recovery of such debris will be undertaken to minimise the impact on the environment and to minimise the risk to other users of the sea wherever possible.

1.0 INTRODUCTION

Within the southern North Sea (SNS), ConocoPhillips (U.K.) Limited (ConocoPhillips) operates three main gas areas (Viking, Caister Murdoch System [CMS], and Lincolnshire Offshore Gas Gathering Systems [LOGGS]) (Figure 1.1). ConocoPhillips propose to decommission the Viking, CMS and LOGGS fields and facilities over a 10-year period (2014 to 2023).

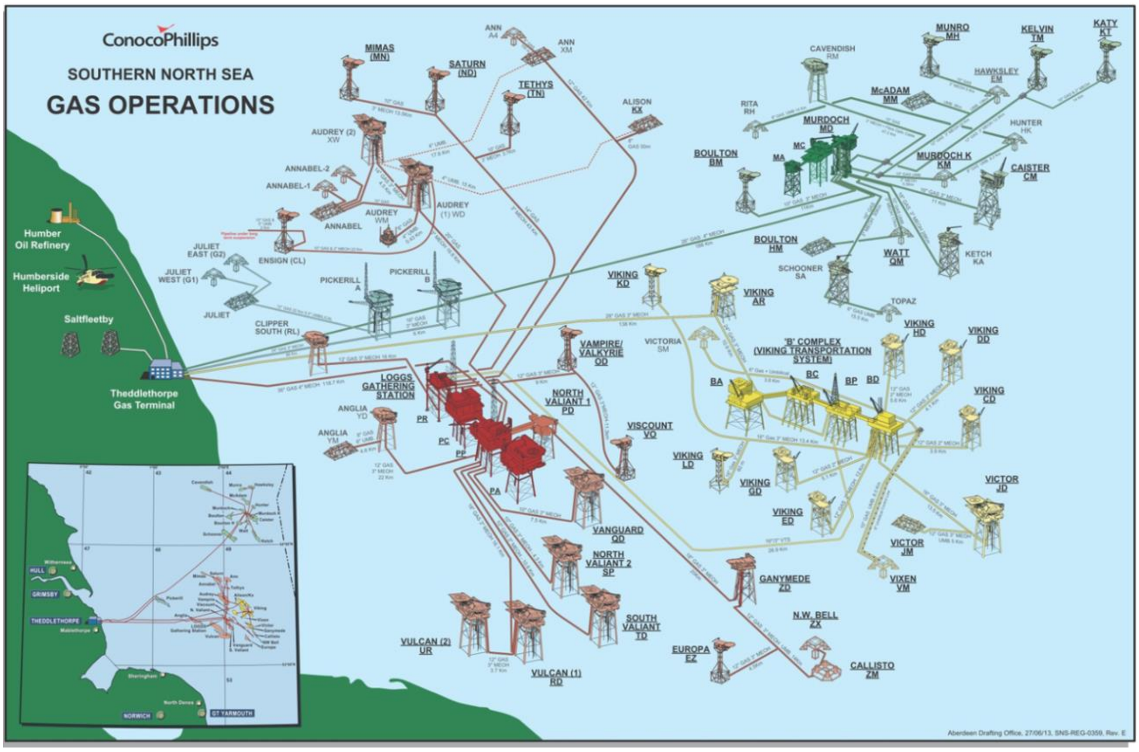

Figure 1.1: ConocoPhillips SNS gas operations

Decommissioning of the SNS hubs and satellites will be carried out in a phased manner. This Environmental Statement (ES) includes the second tranche of the Viking area decommissioning programmes (DPs); Viking Decommissioning Programme 2 and Viking Decommissioning Programme 3 (VDP2 and VDP3).

It should be noted that this ES was originally prepared in 2015, prior to the commencement of any preparatory works. VDP2 and VDP3 were placed on hold whilst consultee comments for the first tranche of the Viking Area Decommissioning Programme (VDP1) were addressed. Since this time approval has been obtained for VDP1 and LOGGS Decommissioning Programme 1 (LDP1). Preparatory works have taken place and the removal of six satellite platforms (five under VDP1 and one under LDP1) is scheduled for later this year (2018). Preparatory work (including cleaning and final disconnect) has also taken place for VDP2 and VDP3 activities and is referred to throughout in this ES. Any work undertaken to date has been carried out under regulatory guidance and all relevant permits and consents for this work have been applied for and approved via the Department for Business, Energy and Industrial Strategy (BEIS) Portal Environmental Tracking System (PETS).

The VDP2 infrastructure is composed of three satellite platforms (Viking KD, LD and AR), the four Viking Bravo Hub Complex platforms (Viking BA, BC, BD and BP), one subsurface installation (Vixen VM), two subsea tees, seven gas pipelines, six methanol pipelines and one control umbilical. The infrastructure to be decommissioned also includes supporting structures and mattress protection.

The VDP3 infrastructure is composed of one satellite platform (Victor JD), one subsurface installation (Victor JM), one subsea pigging skid, two gas pipelines, two methanol pipelines and one umbilical. The infrastructure to be decommissioned also includes supporting structures and mattress protection.

The infrastructure to be decommissioned and included as part of VDP2 and VDP3 are all located in the United Kingdom continental shelf (UKCS) SNS.

1.1 Viking Area Overview

The Viking area comprises eight gas fields (Viking A, Viking B, Viking C, Viking D, Viking E, Victor, Vixen and Victoria). The Viking area blocks were awarded to a Conoco led co-venture in the first North Sea licensing round in 1964. Development of the Viking area commenced in 1971 with installation of the Viking Alpha complex and the 28 inch diameter pipeline ”Viking Transport System” from Viking A field to the onshore facilities at Theddlethorpe Gas Terminal (TGT). Production in the Viking area commenced in 1972. The Viking AD and FD wells were abandoned in 1996 and most of the Alpha complex platforms were removed, leaving only the Viking AR platform and associated pipeline infrastructure (PL88/PL134, PL27/PL161). The Viking FD platform was also removed at this time.

The Viking area infrastructure currently comprises the manned Viking Bravo Complex (four bridge-linked platforms), nine associated outlying wellhead satellite platforms and associated subsea tiebacks (Figure 1.3). Gas from the Viking fields and other fields is tied back to the Viking Bravo Complex and exported to LOGGS, commingled with the gas from LOGGS, and then exported to the TGT via a 118.8 km 36 inch diameter gas export pipeline.

The Victor gas field was produced from five production wells at the Victor JD unmanned satellite platform and a sixth subsea well tied back to the 16 inch pipeline (PL211/PL212). Gas from the Victor field is transported through a 16 inch pipeline to the Viking Bravo Complex and then onto TGT. The field commenced production in September 1984.

1.2 VDP2 Overview

VDP2 includes the Viking Bravo Complex, Viking KD and LD satellite platforms, Vixen VM subsea manifold and the Viking AR platform and all associated pipeline infrastructure. The VDP2 infrastructure comprises:

- Seven surface installations;
- One subsea installation;
- Thirteen pipelines;
- Two subsea tees;
- One umbilical (methanol and control fluids); and
- Associated mattress and grout bag protection.

The surface installations include the unmanned Viking AR, KD and LD satellite platforms, , and the Bravo Platform Complex hubs (Viking BA, BC, BP and BD). A subsea tie-back installation Vixen VM and two pipeline tie-in tee-pieces are also included in VDP2.

Figure 1.3 illustrates the infrastructure to be decommissioned in VDP2.

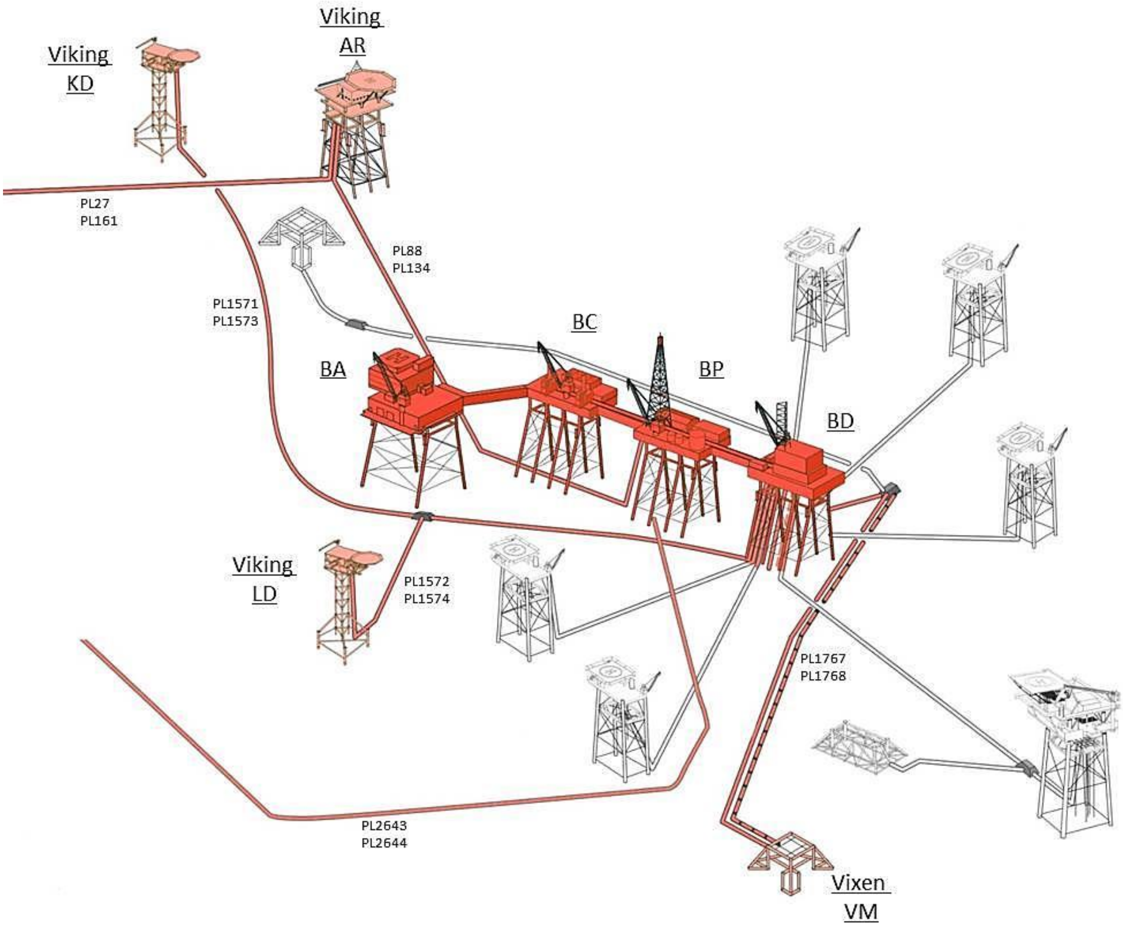

Figure 1.3: VDP2 infrastructure to be decommissioned (highlighted in red)

1.3 VDP3 Overview

VDP3 includes the Victor JD unmanned satellite platform and associated subsea infrastructure. The VDP3 infrastructure comprises:

- One surface installation;
- One subsea installation;
- Four pipelines;
- One umbilical (control fluids);
- One pigging skid; and
- Associated mattress and grout bag protection.

Subsea infrastructure includes the JM pigging skid and the Victor JM subsea well manifold. Figure 1.4 illustrates the infrastructure to be decommissioned in VDP3.

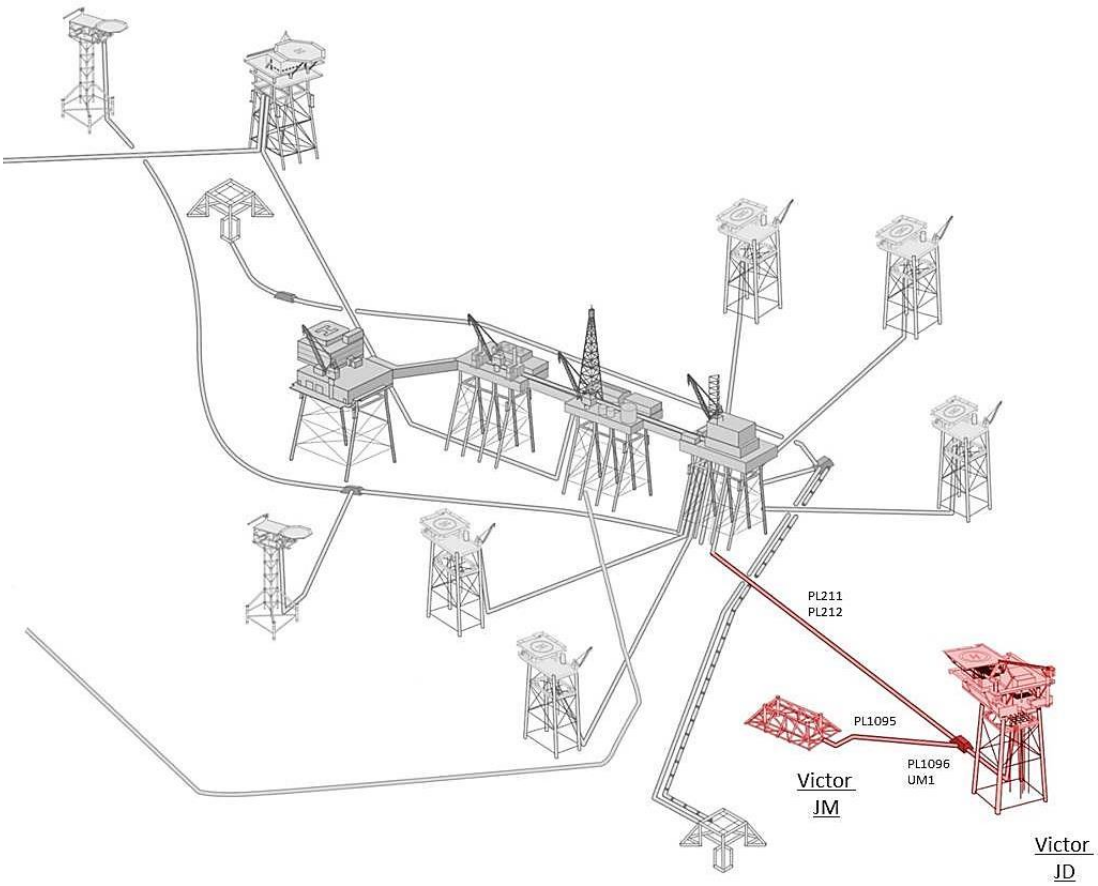

Figure 1.4: VDP3 infrastructure to be decommissioned (highlighted in red)

1.4 Purpose of the Environmental Impact Assessment

Environmental Impact Assessment (EIA) is a systematic process that considers how a project will change existing environmental conditions, and assesses the consequence and significance of such changes (Table 1.1). It is an iterative process that is generally initiated at a project's inception and provides an aid to project decision-making throughout the planning and design phases so that, where practical, potentially significant environmental effects can be mitigated at the source.

The purpose of the EIA process is to understand and communicate the significant environmental impacts associated with the project options to inform the decision making process (Section 2). To support VDP2 and VDP3, the EIA process was conducted in accordance with the Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999 (as amended). The ES presents the findings of the EIA and has been prepared as part of the planning and consents process for the decommissioning of the VDP2 and VDP3 infrastructure.

Table 1.1: Key stages of the EIA process for decommissioning

EIA Stage	Description
Scoping	Allows the study to establish the key issues, data requirements, and impacts to be addressed in the EIA and the framework or boundary of the study.
Consideration of alternatives	Demonstrates that other feasible approaches, including alternative project options, scales, processes, layouts, and operating conditions have been considered.
Description of project actions	Provides clarification of the purpose of the project and an understanding of its various characteristics, including stages of development, location and processes.
Description of environmental baseline	Establishes the current state of the environment on the basis of data from literature and field surveys, and may involve discussions with the authorities and other stakeholders.
Identification of key impacts and prediction of significance	Seeks to identify the nature and magnitude of identified change in the environment as a result of project activities and assesses the relative significance of the predicted impacts.
Impact mitigation and monitoring	Outlines the measures that will be employed to avoid, reduce, remedy or compensate for any significant impacts. Mitigation measures will be developed into a project environmental management plan. Aspects of the project which may give rise to significant impact which cannot be mitigated to an acceptable or tolerable level of impact may need to be redesigned. This stage will feed back into project development activities.
Presentation of the Environmental Statement	Reporting of the EIA process through production of an ES that clearly outlines the above processes. The ES provides a means to communicate the environmental considerations and environmental management plans associated with the project to the public and stakeholders.
Monitoring	Project impacts will be monitored during the operational phase of the project to verify that impact predictions are consistent with the subsequent outcomes.

1.5 Regulatory Context

The decommissioning of offshore oil and gas infrastructure in the UKCS is principally governed by the Petroleum Act 1998, as amended by Energy Act 2008 and 2016. The responsibility for ensuring that the requirements of the Petroleum Act 1998 (as amended) and international obligations are complied with rests with the Offshore Petroleum Regulator for Environment and Decommissioning (OPRED) which sits within the Department of Business, Energy and Industrial Strategy (BEIS), formerly the Department for Energy and Climate Change (DECC). For consistency, the Regulator will be referred to as BEIS throughout this document.

The Petroleum Act 1998 (as amended) sets out the requirements for a formal DP, which must be approved by BEIS, before the owners of an offshore installation or pipeline may proceed. At present there is no statutory requirement to prepare an Environmental Statement for decommissioning. However, under the Guidance Notes: Decommissioning of Offshore Oil and Gas Installations and Pipelines under the Petroleum Act 1998 (DECC, 2011a) the DP had to be supported by an EIA. As this ES was commenced prior to the introduction of the latest BEIS guidelines (BEIS, 2018) for a more streamlined Environmental Appraisal (EA) approach, this ES fulfils these requirements.

The Guidance Notes state that an EIA should include an assessment of the following:

- All potential impacts on the marine environment including: exposure of biota to contaminants associated with the decommissioning of the installation; other biological impacts arising from physical effects; conflicts with the conservation of species with the protection of their habitats, or with mariculture; and interference with other legitimate uses of the sea.
- All potential impacts on other environmental compartments, including emissions to the atmosphere, leaching to groundwater, discharges to surface fresh water and effects on the soil.
- Consumption of natural resources and energy associated with reuse and recycling.
- Interference with other legitimate uses of the sea and consequential effects on the physical environment.
- Potential impacts on amenities, the activities of communities and on future uses of the environment.

In addition, BEIS have advised the Oil and Gas Industry that under the Marine and Coastal Access Act 2009 (MCAA) and the Marine (Scotland) Act 2010, an EIA/ ES will be required for all licence applications relating to decommissioning operations.

OSPAR Decision 98/3 (the Decision) sets out the United Kingdom's (UK's) international obligations on the decommissioning of offshore installations. The Decision prohibits the dumping and leaving wholly or partly in place of offshore installations. 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 of cutting is dependent upon the prevailing seabed conditions and currents (DECC, 2011a).

OSPAR Decision 98/3 does not include the decommissioning of pipelines. 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. The Guidance Notes state that "Because of the widely different circumstances of each case, it is not possible to predict with any certainty what may be approved in respect of any class of pipeline". Therefore, all feasible pipeline decommissioning options should be considered and a comparative assessment (CA) made. Further regulatory drivers relevant to VDP2 and VDP3 are provided in Appendix A.

1.6 Report Structure

Due to the similarities and proximity to each other of the infrastructure within the two DPs, a combined ES covering both VDP2 and VDP3 impacts has been compiled. Where necessary the following sections as detailed in Table 1.2 provide detailed reference to the individual DP elements, however where there is sufficient similarity between the DPs the impacts have been discussed together to help remove duplication and improve efficiency for the reader.

The structure for this VDP2 and VDP3 Decommissioning ES is detailed in Table 1.2.

Table 1.2: The VDP2 and VDP3 decommissioning ES structure

Section	Contents
Non-Technical Summary	A non-technical summary of the ES.
1. Introduction	An introduction to the project and the scope of the ES.
2. Methodology	The methodological approaches used in the EIA process and a summary of the supporting reports and studies undertaken.
3. Project Description	A description of the decommissioning options and the recommended decommissioning option determined by a formal CA process.
4. Environmental Description	A description of the environmental and sensitive receptors in the vicinity of the project area.
5. Consultation	Details of the consultation process.
6. Risk Assessment	A detailed description of the risk assessment approach and findings.
7. Energy and Emissions	Identification of potential sources of impact to environmental and societal receptors, cumulative and transboundary impacts, and details of practicable mitigation strategies.
8. Underwater Noise	
9. Seabed Footprint	
10. Societal Impact	
11. Discharges to Sea	
12. Accidental Events	
13. Waste	Details the waste likely to be generated and the management processes to be implemented during decommissioning activities.
14. Environmental Management	A description of ConocoPhillips environmental management procedures and how these will apply to the decommissioning of the VDP2 and VDP3 facilities. This section also includes a register of commitments made within the ES.
15. Conclusions	Key findings and conclusions.
16. References	Sources of information used to inform the assessment.
Appendix A: Legislation	A summary of relevant environmental legislation.
Appendix C: Non-Significant Impacts	A summary of the non-significant impacts.
Appendix D: Energy Use and Atmospheric Emissions Supporting Information	Additional information to support the Energy Use and Atmospheric Emissions Assessment (Section 7).
Appendix E: Underwater Noise Supporting Information	Additional information to support the Underwater Noise Assessment (Section 8).
Appendix F: Surrounding infrastructure in the North Norfolk Sandbanks and Saturn Reef Special Area of Conservation (SAC).	A summary of the surrounding infrastructure which is situated within the North Norfolk Sandbanks and Saturn Reef SAC. Supports Seabed Footprint assessment (Section 9).

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2.0 METHODOLOGY

The EIA systematically identifies significant environmental impacts and risks (potential impacts) associated with the project and assesses the requirement for impact/ risk mitigation measures. The objective of the EIA process is to incorporate environmental considerations into project planning and design to ensure that best environmental practice is achieved.

This section of the ES describes the methods used to:

- Identify and evaluate the potential environmental (including social) impacts arising from the decommissioning of the VDP2 and VDP3 infrastructure;
- Ensure an appropriate level of assessment is applied to the identified impacts, particularly those impacts identified as being significant; and,
- Identify actions needed, through design or management control, to avoid or mitigate the key anticipated impacts.

2.1 Environmental Impact Assessment Process

An overview of the EIA process to identify and assess the impacts associated with decommissioning the VDP2 and VDP3 facilities is provided within Table 1.1 (Section 1.4). For the EIA the initial evaluation is scoping which provides the context for the project, the options being considered and the environmental and socioeconomic setting. This is followed by risk identification and assessment in order to ascertain potentially significant impacts. The potential impacts then undergo a detailed assessment of the causes and their consequences. Mitigation measures to eliminate or reduce the impacts are considered and a project specific environmental management plan is developed to assure compliance with environmental legislation and ConocoPhillips policy. Throughout the EIA process consultation is conducted with the regulatory bodies and interested parties.

2.1.1 Scoping

Scoping is an integral part of the impact assessment process, the aim of which is to identify potential impacts to be assessed in greater detail within the ES. Scoping is a two-stage process comprising:

- An initial identification of potential impacts, and
- A preliminary evaluation of significance based on available information.

An internal Scoping Assessment was undertaken as part of the EIA and it identified the potential environmental receptors and other considerations which may be impacted by the proposed decommissioning operations (Figure 2.1).

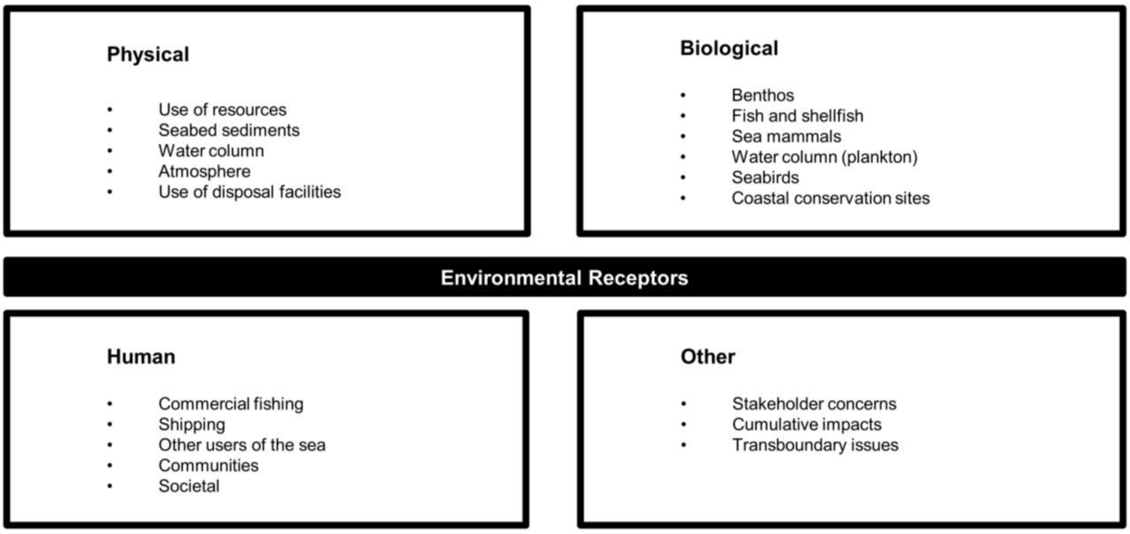

Figure 2.1: Environmental receptors

The activities identified during the scoping exercise as having the potential to give rise to significant environmental impacts and requiring further assessment during the EIA have been grouped into the following potential impacts:

1. Physical presence of vessels;
2. Seabed disturbance and habitat loss;
3. Energy use and atmospheric emissions;
4. Underwater noise;
5. Nearshore and onshore dismantling;
6. Cleaning of marine growth;
7. Landfill disposal;
8. Safety risk to fishing;
9. Socio-economic impact;
10. Non-routine events; and
11. Cumulative impacts.

The following issues were further validated and assessed through baseline assessments, modelling studies and stakeholder engagement.

2.1.2 Cumulative and transboundary impacts

The EIA process also includes the identification of any potential cumulative or transboundary impacts that could be caused by the proposed decommissioning programme when considered alongside other activities inclusive of the Company's SNS wide decommissioning programme. Owing to the locality of the infrastructure, within the North Norfolk Sandbanks and Saturn Reef SAC and Southern North Sea cSAC, the impact of other activities in the area including non-oil and gas activities are addressed. Cumulative impacts occur as a result of a number of activities (e.g. discharges or emissions) combining or overlapping and potentially creating new and/ or increased impacts. Under the Habitats Regulations there is a requirement for the competent authority to consider cumulative or 'in-combination' effects. Even where impacts do not overlap, it is important to consider the incremental effect of many small areas of impact on a particular environment or its use. Cumulative impacts, where they can be determined, have been included as part of the VDP2 and VDP3 assessment.

Transboundary impacts are those which could have an impact on the environment and resources beyond the boundary of UK waters. The Convention on Environmental Impact Assessment in a Transboundary Context (United Nations, 1991) addresses the need to enhance international co-operation in assessing transboundary environmental impacts.

2.2 Comparative Assessment

The VDP2 and VDP3 pipelines are subject to a CA to identify the optimal decommissioning solution under the Petroleum Act 1998. In order to determine the recommended decommissioning option for the pipelines, ConocoPhillips conducted a formal CA of possible decommissioning options to establish whether there were significant differences between the options and if so which option performed the best.

Each decommissioning option was assessed against the five BEIS criteria:

- Safety;
- Environment;
- Cost;
- Technical; and
- Societal.

All pipeline decommissioning options, including the subsequent selected option, are described in Section 3. Sections 8 through 13 provide the impact assessment for the decommissioning option as recommended by the CA process.

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3.0 PROJECT DESCRIPTION

This section presents a description of the infrastructure in the Viking area, the scope of the decommissioning operations, infrastructure to be decommissioned and alternatives considered for decommissioning of VDP2 and VDP3, including the selected option and associated activities.

3.1 Overview

Section 3.1.1 describes the infrastructure located in the Viking area. Sections 3.1.2 and 3.1.3 describe the infrastructure to be decommissioned under VDP2 and VDP3.

3.1.1 Viking area

Development of the Viking area gas fields commenced in 1971 with the installation of the Viking Alpha (A) complex and the 28 inch diameter pipeline from Viking A to the onshore TGT. Production commenced in 1972. In 1996, the Viking AD and FD wells were abandoned and the majority of the A complex platforms and the Viking FD platform were removed, leaving only the Viking Alpha Riser (AR) platform. The Viking area currently comprises the following infrastructure illustrated in Figure 3.1 and presented in Table 3.1.

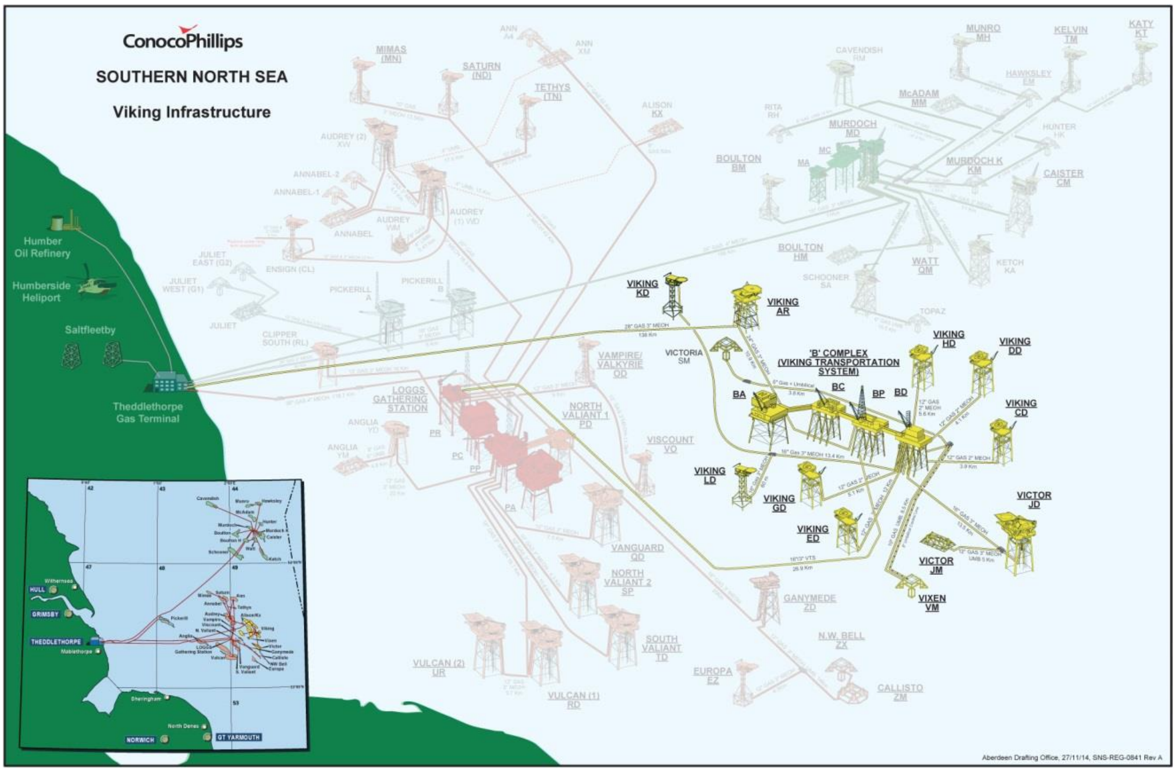


Figure 3.1: Viking area infrastructure

Table 3.1: Viking area infrastructure

Viking Bravo Hub Complex (comprising four bridge-linked platforms)	
• Viking Bravo Drilling (BD) • Viking Bravo Accommodation (BA) • Viking Bravo Compression (BC) • Viking Bravo Production (BP)	
Nine satellite platforms	
• Viking AR • Viking CD • Viking DD • Viking ED • Viking HD	• Viking GD • Viking KD • Viking LD • Victor JD
Three subsea manifolds	
• Vixen VM • Victor JM • Victoria SM	
Twenty nine pipelines	
Forty five wells (including subsea wells)	

3.1.2 VDP2 infrastructure to be decommissioned

VDP2 includes the Viking Bravo Hub Complex, three unmanned satellite platforms, subsea manifold and all associated pipelines. The Viking infrastructure being decommissioned under VDP2 includes the following and is illustrated in Figure 3.2 below:

- Seven surface installations, each comprising a topside and jacket structure:
  - Viking KD;
  - Viking LD;
  - Viking AR;
  - Viking BA;
  - Viking BC;
  - Viking BP; and
  - Viking BD;
- Three subsea structures:
  - Vixen VM manifold;
  - Vixen VM/ Victoria SM pipeline tie-in tee-piece; and
  - Viking KD/ Viking LD pipeline tie-in tee-piece;
- Seven gas pipelines;
- Six methanol pipelines (piggybacked to gas pipelines with the exception of PL134, which is laid separately);
- One methanol and control fluids pipeline (piggybacked to a gas pipeline);
- 24 wells; and
- Associated mattress and grout bag protection.

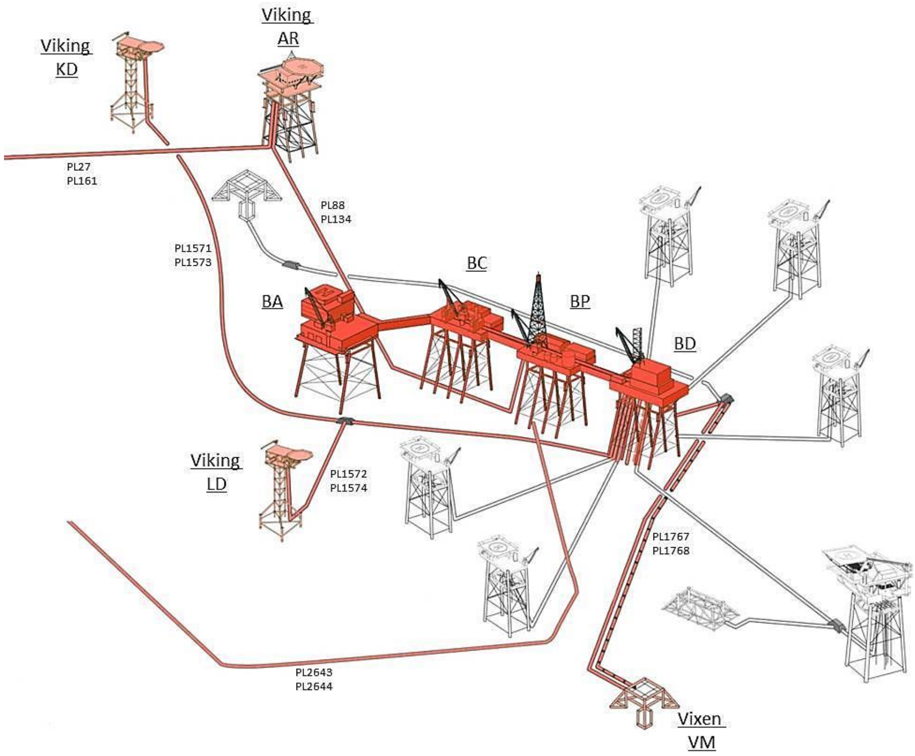


Figure 3.2: VDP2 infrastructure to be decommissioned (highlighted in red)

3.1.3 VDP3 facilities to be decommissioned

The Viking infrastructure being decommissioned under VDP3 includes the following and is illustrated in Figure 3.3 below:

- One surface installation (Victor JD, comprising a topside and jacket structure);
- Two subsea structures:
  – Victor JM manifold; and
  – Victor JM pigging skid;
- Two gas pipelines;
- Two methanol pipelines (piggybacked to gas pipelines);
- One umbilical (control fluids);
- 6 wells; and
- Associated mattress and grout bag protection.

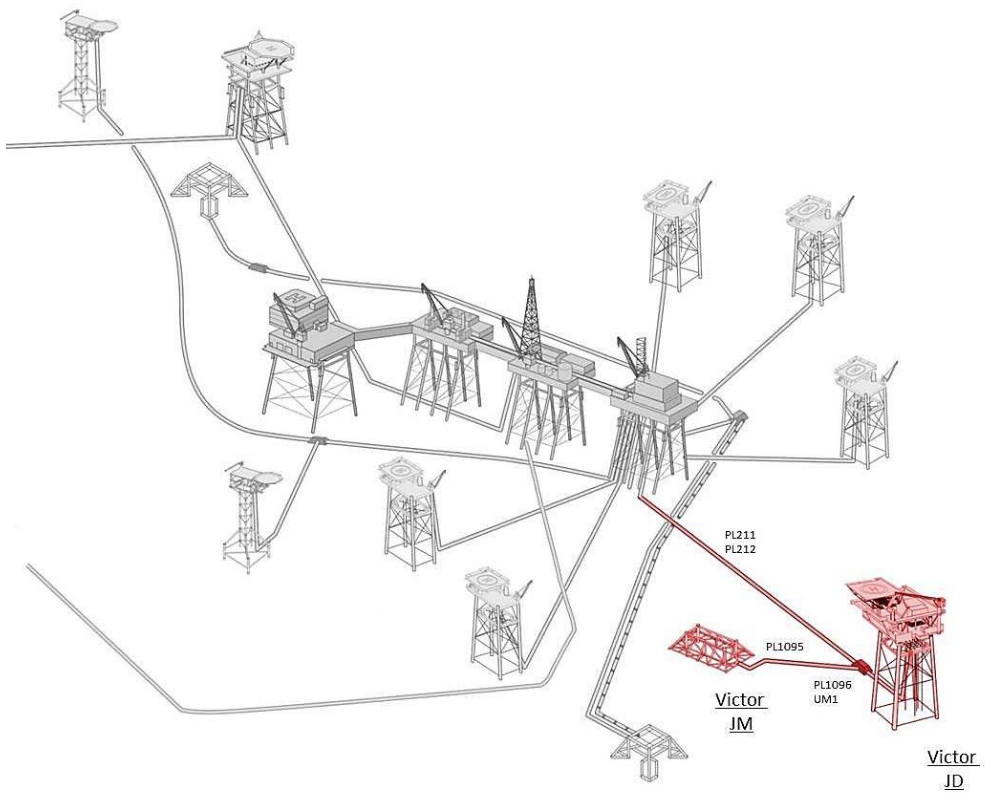


Figure 3.3: VDP3 infrastructure to be decommissioned (highlighted in red)

3.2 Consideration of Alternative Use for the VDP2 and VDP3 Infrastructure

Most of the VDP2 and VDP3 infrastructure being decommissioned is obsolete and/ or in a degraded condition and so not suitable for safe reuse. The dismantling contractor will market any items of platform equipment (e.g., valves) suitable for alternative use.

3.3 Scope of the Proposed Decommissioning Operations

The main elements of VDP2 and VDP3 include the following:

- Plug and abandonment (P&A): P&A of wells in accordance with a well abandonment programme (This is covered by a separate environmental assessment conducted for the Well P&A works).
- Final cleaning and preparation for removal of mobile hydrocarbons and chemicals from pipelines and topsides (gas, methanol and corrosion inhibitor) and subsequent flooding of pipelines with seawater. This includes proposed plans for the management of the PL134 and PL161 pipelines in which blockage anomalies were detected.
- Preparation of infrastructure for removal by specialist contractors to an approved onshore disposal facility.
- Leaving satellite installations (Viking AR, KD and LD) and the Viking Bravo Hub Complex in cold suspension with appropriate navigational aids until topside and jacket removal.
- Removal of infrastructure by heavy lift vessel (HLV).
- Removed infrastructure will be dismantled and disposed of/ recycled at an onshore reception facility. Disposal yard selection remains to be made.

3.4 Description of the VDP2 and VDP3 Infrastructure Being Decommissioned

A description of the surface installations, topsides, jackets, subsea structures, pipelines and umbilicals, and wells to be decommissioned is presented in the sections that follow.

3.4.1 Surface installations

The status and locations of the eight VDP2 and VDP3 platforms, fixed steel surface installations (satellites, riser and hub) are outlined in Table 3.2.

Table 3.2: VDP2 and VDP3 surface installations to be decommissioned

DP	Platform	Installed	Current status	Latitude; Longitude (ED50)	Easting; Northing (m; UTM zone 31 N)
VDP2	Viking KD	1972	Cold suspension	53° 31' 43.95" N; 02° 13' 23.27"E	448 501.28; 5 931 513.19
	Viking LD	1972	Cold suspension	53° 28' 32.42" N; 02° 13' 58.04" E	449 077.86 5 925 587.30
	Viking AR	1971	Cold suspension	53° 32' 03.00" N; 02° 15' 22.24" E	450 698.18 5 932 078.36
	Viking BA	1972	Cold suspension	53° 26' 57.24" N; 02° 19' 51.37" E	455 564.51 5 922 580.26
	Viking BC	1972	Cold suspension	53° 26' 55.15" N; 02° 19' 56.35" E	455 655.77 5 922 514.68
	Viking BP	1972	Cold suspension	53° 26' 52.99" N; 02° 19' 57.89" E	455 683.58 5 922 447.91
	Viking BD	1972	Cold suspension	53° 26' 50.86" N; 02° 19' 59.41 E	455 710.86 5 922 381.73
VDP3	Victor JD	1984	Cold suspension	53° 19' 41.58"N; 02° 21' 49.21"E	457 618.35 5 909 097.00

Notes:
(1) Hub installations are Viking BA, Viking BC, Viking BP and Viking BD and constitute the Viking Bravo Hub Complex; (2) Satellite installations are Viking KD, Viking LD, and Victor JD; (3) Riser installation is the Viking AR platform.

3.4.2 Topsides

Each of the eight surface installations to be decommissioned under VDP2 and VDP3 may require the removal of the topside structure from their jacket structures via reverse installation, piece-small or single lift. However, the decommissioning method will be dependent on the removals contractor selected. The weights for the VDP2 and VDP3 topside structures are presented in Table 3.3. The topside weights are based on net weights provided by the D3 Materials Inventory database (D3 Consulting, 2015).

Table 3.3: Topside details for the VDP2 and VDP3 surface installations to be decommissioned

Decommissioning Programme	Surface installation	Topsides weight (tonnes)
VDP2	Viking KD	445.50
	Viking LD	450.95
	Viking AR	1,394.26
	Viking BA	2,304.65
	Viking BC	3,375.29
	Viking BP	1780.11
	Viking BD	23,001.73
VDP3	Victor JD	751.60

Source: D3 Consulting, 2015

3.4.3 Jackets

Each of the eight installations (and risers) to be decommissioned under VDP2 and VDP3 will require the removal of the jacket structures from the seabed. Each jacket structure is secured to the seabed by piles. All piles securing the eight 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 (DECC, 2011a). ConocoPhillips are estimating this to be in the region of 3 m below the natural seabed level (ConocoPhillips, 2013).

Table 3.4 presents the weights, number of legs and piles, and footing dimensions for the jacket structures to be decommissioned under VDP2 and VPD3, respectively. The weights are based on net weights provided by the D3 Materials Inventory database (D3 Consulting, 2015). Marine growth estimates were derived from a marine growth technical note undertaken by BMT Cordah and the previous marine growth report undertaken for the Viking Decommissioning Programme 1 (VDP1) and the LOGGS Decommissioning Programme 1 (LDP1) (Appendix B; BMT Cordah, 2015a).

Table 3.4: Jacket details for the VDP2 and VDP3 surface installations to be decommissioned

DP	Surface installation	Jacket					
		Jacket weight (tonnes) *	Pile weight *	Estimated weight of marine growth (tonnes)	No of legs	No of piles	Dimensions of footing (m)
VDP2	Viking KD	439.6	147	12.9	3	3	7.0 x 7.0
	Viking LD	422.8	147	13.5	3	3	7.0 x 7.0
	Viking AR	542.0	141	46.9	6	6	21.3 x 12.6
	Viking BA	901.3	486	44.6	4	4	29.4 x 29.4
	Viking BC	707.8	276	37.3	8	8	32.0 x 12.9
	Viking BP	766.3	213	38.5	8	8	32.0 x 12.9
	Viking BD	949.0	216	32.7	8	8	32.0 x 12.9
VDP3	Victor JD	1,240.0	498	45.9	4	4	25.2 x 25.4

*Pile weight below the mudline

Source: D3 Consulting, 2015; BMT Cordah, 2015a, BMT Cordah, 2015b

The marine growth assessment of the platform jackets is presented as an appendix in the ES (Appendix B). This Technical Note provides quantitative estimates of the depth/ thickness profiles of marine growth on the:

- Viking BD platform jacket which forms part of the four bridge-linked Viking Bravo Hub Complex (Viking BA, BC, BD and BP); and
- Victor JD platform jacket, one of the three satellite platforms (Viking KD, Viking LD and Victor JD) which tie back to the Viking Bravo Hub Complex.

The quantitative estimate provides the wet weights in air of the attached marine growth within three depth zones for these two platforms, each delineated by the predominance of characteristic species, and provides a total estimated wet weight for each jacket.

The remaining VDP2 and VDP3 jackets had a qualitative assessment of the marine growth and an estimate of the weight has been provided by depth zone. This has been done on a comparative basis between these jackets and the observations undertaken as part of the quantitative assessments for Viking BD and Victor JD and the previous marine growth assessments undertaken as part of VDP1 and LDP1.

3.4.4 Subsea structures

The subsea structures to be decommissioned under VDP2 and VDP3 comprise:

- Two subsea manifolds;
- Two pipeline tie-in tee-pieces;
- One pigging skid; and
- Associated protective concrete mattresses and grout bags.

Table 3.5 details the subsea structures to be decommissioned under VDP2 and VDP3. Concrete mattresses and grout bags have been installed to maintain stability of the pipelines along their length and at the ends. Details of their locations, where visible, are presented in the pipeline burial report (BMT Cordah, 2015c).

ConocoPhillips commissioned a mattress inventory report to identify the number and where possible the burial status of the mattresses in the VDP2 and VDP3 areas. Table 3.5 also provides an estimate of the dimensions and weights of the mattresses to be decommissioned under VDP2 and VDP3. Exact measurements are not available and therefore estimates have been made based on the results of pipeline surveys (BMT Cordah, 2015c).

The dimensions and weights of the grout bags protecting the tee-pieces and pigging skid are currently unknown.

3.4.5 Pipelines and umbilical

The pipelines to be decommissioned under VDP2 and VDP3 comprise:

- Nine gas pipelines;
- Seven piggybacked methanol pipelines
- One non-piggybacked methanol and control fluids pipeline; and
- One umbilical (control fluids).

Table 3.6 summarises the pipelines to be decommissioned under VDP2 and VDP3. Five of the six VDP2 gas pipelines are piggybacked by methanol lines. The Vixen VM to

Viking BD gas infield pipeline is piggybacked by a methanol and control fluids umbilical. Both the VDP3 gas pipelines are piggybacked by methanol pipelines.

The majority of the VDP2 and VDP3 pipelines will be cut at both ends. The pipelines PL27/ PL161 pipelines will only be cut at the Viking AR installation end, however this is subject to proposed plans to leave 128 km of this pipeline from TGT in situ. The piggybacked pipelines PL211/ PL212 will be cut at the Victor JD satellite installation end under VDP3; however, the ends terminating at the Viking BD platform will be cut under VDP2. Pipelines PL2643 and PL2644 will be cut at the Viking BD platform end however the LOGGS PR end of the pipeline will not be cut as the LOGGS Hub is still live and therefore cutting this pipeline would pose safety issues, this will be addressed at a later date when the LOGGS Hub complex is decommissioned.

In addition, the ten (five gas and five piggybacked methanol) pipelines that were left connected to the Viking BD platform under VDP1, will be cut at the Viking BD platform under VDP2.

A detailed subsea inspection, conducted in 2016 reported a pipeline damage anomaly between KP 3.667 and KP 4.78 of PL134. The pipeline was found to have been displaced at a maximum distance of 96.2 m from its original position. A risk assessment was undertaken at the time of inspection, and it was concluded that the pipeline did not pose a significant risk to the surrounding environment nor the safety of other users of the sea. The damaged section is designated as a “Monitor” item in the anomaly register for future surveys and assessments. ConocoPhillips has taken the appropriate measures, and reported the location and details of the damaged area, including span details, to Kingfisher Information Systems and uploaded the information onto the FishSAFE database. The pipeline cleaning options for PL134 are detailed in Section 3.8.7.

Furthermore, during cleaning operations and subsequent integrity testing, anomalies in the PL161 pipeline were detected, and a suspected loss of pipelines integrity identified on the Viking AR side of the PL161, thought to be a site of pipeline blockage, resulting in the submission of a PON1/5800. Pipeline diagnostics confirmed the presence of a blockage 128 km off TGT (10 km from Viking AR). The proposed decommissioning method for PL161 is to be decommissioned in situ, not flushed. Post operations, no further inventory recovery is planned ahead of pipeline decommissioning, subject to DP approval. Further information about the cleaning and preparation of PL161 is given in Section 3.8.7.

Table 3.7 provides 2006 to 2014 survey findings for exposure and spanning of the VDP2 and VDP3 pipelines. Nineteen pipelines transect the VDP2 and VDP3 pipelines being decommissioned (Table 3.8).

3.4.6 Wells

A total of 30 wells and conductors are to be decommissioned under VDP2 and VDP3 (Table 3.9). At the start of the well P&A campaign, a total of 17 gas/ condensate wells were to be plugged and abandoned under VDP2. These activities have since taken place and the wells have been P&A under two separate environmental direction documents which have been submitted to BEIS.

Drill cuttings

Survey work carried out by Fugro (2014a; 2014b; 2014c and 2014d) found no evidence of cuttings piles on the seabed in the vicinity of the surveyed VDP1 and LDP1 wellheads.

The dynamic marine environment present at the surveyed wellheads is similar to the marine environment at the VDP2 and VDP3 area. A similar redistribution of drill cuttings from around the VDP2 and VDP3 wellheads would be expected. Drill cuttings are therefore not required to be scrutinised under the OSPAR Recommendation 2006/5 Management Regime for Offshore Cuttings Piles and are excluded from further discussion.

Table 3.5: VDP2 and VDP3 subsea structures to be decommissioned

Decommissioning Programme	Subsea structure	Number of structures	Dimensions (length x width) (m)	Estimated weight (tonnes)	Latitude; Longitude (ED50)	Easting; Northing (m; UTM zone 31 N)
VDP2	Vixen VM manifold	1	11.4 x 11.4	46.64	53° 23' 54.78"N; 02° 14' 03.26"E	449 081.934 5 917 006.246
	Vixen VM/ Victoria SM pipeline tie-in tee-piece	1	8.0 x 6.5	38.50	53° 26' 50.93"N; 02° 20' 1.70"E	455 753.160 5 922 383.520
	Viking KD/ Viking LD pipeline tie-in tee-piece	1	5.3 x 1.2	2.00	53° 28' 32.12"N; 02° 14' 1.24"E	449 136.623 5 925 577.261
	Concrete mattresses	139*	6.0 x 3.0	858	Not available	Not available
VDP3	Victor JM manifold	1	21.3 x 12.3	300.66	53° 21' 03.22"N; 02° 17' 43.46"E	453 096.725 5 911 662.637
	Victor JM pigging skid	1	7.3 x 4.6		53° 19' 42.53"N; 02° 21' 48.76"E	457 610.308 5 909 126.354
	Concrete mattresses	35*	6.0 x 3.0	210.00	Not available	Not available

Note:*estimated number based on observations of ROV footage
Source: ConocoPhillips, 2015a; BMT Cordah, 2015c

Table 3.6: VDP2 and VDP3 pipelines to be decommissioned

Decommissioning Programme	From	To	Pipeline number	Installed	Concrete coating	Type	Diameter (inches)	Length (km)
VDP2	Viking AR	TGT	PL27	1971	Yes	Gas	28	134.9
	TGT	Viking AR	PL161	1971	No	Methanol	3	134.9
	Viking BP	Viking AR	PL88	1971	Yes	Gas	24	10.9
	Viking AR	Viking BP	PL134	1971	No	Methanol	3	10.9
	Viking KD	Viking BD	PL1571	1998	Yes	Gas	16	13.6
	Viking BD	Viking KD	PL1573	1998	No	Methanol	3	13.6
	Viking KD	Viking BD	PL1464	1998	No	Gas	16	0.03
	Viking BD	Viking KD	PL1465	1998	No	Methanol	3	0.03
	Viking LD	Viking KD/ Viking LD tee-piece	PL1572	1998	Yes	Gas	16	0.1
	Viking KD/ Viking LD tee-piece	Viking LD	PL1574	1998	No	Methanol	3	0.1
	Viking BP	LOGGS PR	PL2643	2009	Yes	Gas	16	27.5
	LOGGS PR	Viking BP	PL2644	2009	No	Methanol	3	27.5
	Vixen VM	Viking BD	PL1767	2000	No	Gas	10	8.7
	Viking BD	Vixen VM	PL1768	2000	No	Methanol and control fluids*	4.5	8.7
VDP3	Victor JD	Viking BD	PL211	1984	Yes	Gas	16	13.5
	Viking BD	Victor JD	PL212	1984	No	Methanol	3	13.5
	Victor JM	JM pigging skid	PL1095	1995	Yes	Gas	12	5.1
	JM pigging skid	Victor JM	PL1096	1995	No	Methanol	3	5.1
	Victor JD	Victor JM	UM1	1995	No	Umbilical (control fluids)	4	5.4

Note: *umbilical (methanol and control fluids)
Source: ConocoPhillips, 2015a

Table 3.7: VDP2 and VDP3 pipelines exposure status

Decommissioning Programme	Pipelines	Pipeline status						
		Length of pipeline (m)	Length surveyed (m)	Length of surveyed pipeline exposed/ [spanning] (m)*	% of surveyed pipeline exposed/ [spanning]	Maximum height of span (m)	Number of reportable spans**	Survey year (year corresponding to maximum length surveyed)
VDP2	PL27/ PL161	139,200	117,590	12,448	10.6	0.30	0	2008
	PL88/ PL134	10,900	10,900	2,452	22.5	0.45	0	2008
	PL1571/ PL1573	13,600	13,570	175	1.3	0.39	0	2011
	PL1572/ PL1574	100	81	27	33.3	0.59	0	2014
	PL2643/ PL2644	27,500	25,333	50	44.3	-	1	2015
	PL1767/ PL1768	8,700	8,632	7	0.1	0.34	0	2007
VDP3	PL211/ PL212	13,500	12,740/1,145***	15/[126]	0.1/[11.0]	-/0.88	0/1***	2013/2014***
	PL1095/ PL1096	5,100	4,197/1,091***	0/[63]	0.0/[5.7]	-/1.05	0/0	2009/2014***
	UM1	5,400						

* Exposed length refers to any length of the surveyed pipeline where depth of cover is less than 0 cm.
** Reportable span refers to a span >0.8 m in height and >10 m in length (Fish Safe, 2015; *personal communication*)
***No complete survey available in any year so information has been presented from two surveys to provide relevant coverage

Source: ConocoPhillips, 2015a; BMT Cordah, 2015c

Table 3.8: Crossings located in the VDP2 and VDP3 area (Source: BMT Cordah, 2015c)

Pipelines	Crossing number and pipeline descriptions		Pipeline no(s)	Operator
		VDP2 pipelines		
PL27/ PL161	1	Viking KD to Viking BD 16” gas pipeline and piggybacked 3” methanol pipeline	PL1571/ PL1573	ConocoPhillips (U.K.) Limited
	2	Ann XM to LOGGS PR 12”gas pipeline	PL947	Centrica Energy Limited
	3	Saturn ND to LOGGSPR 14” gas pipeline and piggybacked 3” methanol pipeline	PL2107/ PL2108	ConocoPhillips (U.K.) Limited
	4	Audrey WD to LOGGS PP 20” gas pipeline and piggybacked 3” methanol pipeline	PL496/ PL497	ConocoPhillips (U.K.) Limited
	5	Bacton to Clipper PT 3.5” glycol pipeline	PL996	Shell UK Limited
	6	Clipper PT platform to Bacton Terminal 24” gas pipeline	PL632	Shell UK Limited
	7	Trent to Bacton Terminal 24” gas pipeline	PL253	Perenco UK Limited
	8	Valiant North to TGT 36” gas pipeline	PL454	ConocoPhillips (U.K.) Limited
	9	Valiant North to TGT 4” methanol pipeline	PL455	ConocoPhillips (U.K.) Limited
	10	Shearwater to Bacton Terminal 34“ gas pipeline	PL1570	Shell UK Limited
	11	Lancelot A to Bacton Terminal 20” gas pipeline and piggybacked 3” methanol pipeline	PL876/ PL877	Perenco UK Limited
	12	Waveney to Lancelot A 11”gas pipeline	PL1639/ PL1640	Perenco UK Limited
PL88/ PL134	13	Victoria SM to Viking BD 6” gas pipeline and Viking BD to Victoria umbilical	PL2526/ PL2527	ConocoPhillips (U.K.) Limited
PL1571/ PL1573	1	Viking AR to TGT 28” gas pipeline and piggybacked 3” methanol pipeline	PL27/ PL161	ConocoPhillips (U.K.) Limited
	14	Viking BP to LOGGS platform (PR) 16” gas pipeline	PL2643	ConocoPhillips (U.K.) Limited
PL2643/ PL2644	14	Viking KD to Viking BD 16” gas pipeline and piggybacked 3” methanol pipeline	PL1571/ PL1573	ConocoPhillips (U.K.) Limited
	15	Viking BD to Viking GD 12” gas pipeline Montrose to Single Buoy Mooring 12” oil pipeline	PL92 PL68	ConocoPhillips (U.K.) Limited Talisman Sinopec Energy UK
	16	Viking BD to Viking ED 12” gas pipeline and piggybacked 3” methanol pipeline	PL91/ PL133	ConocoPhillips (U.K.) Limited
	17	Vixen VM to Viking BD 10” gas pipeline and piggybacked 4.5” methanol and control fluids umbilical	PL1767/ PL1768	ConocoPhillips (U.K.) Limited
PL1767/ PL1768	18	Victor JD to Viking BD 16” gas pipeline and piggybacked 3” methanol pipeline	PL211/ PL212	ConocoPhillips (U.K.) Limited
VDP3 pipelines				
PL211	18	Vixen VM to Viking BD 10” gas pipeline and piggybacked 4.5” methanol pipeline	PL1767/ PL1768	ConocoPhillips (U.K.) Limited
	19	Victor JM to Victor JD 12” gas pipeline and piggybacked 3” methanol pipeline and umbilical	PL1095/ PL1096/ UM1	ConocoPhillips (U.K.) Limited
PL1095	19	Victor JD to Viking BD 16” gas pipeline and piggybacked 3” methanol pipeline	PL211	ConocoPhillips (U.K.) Limited

Table 3.9: Wells included under VDP2 and VDP3

Decommissioning Programme	Well reference	Date drilled	Current status*	Latitude; Longitude (ED50)	Easting; Northing (m; UTM zone 31 N)
VDP2	49/17-12 (LD1)	08 Dec 1998 – 04 Jan 1999	Completed (abandoned)	53 28' 32.463" N; 2 13' 58.001" E	449 077.100 5 925 588.569
	49/17-L02Z (LD2)	17 Jan 1999 – 10 Feb 1999	Completed (abandoned)	53 28' 32.534" N; 2 13' 57.929" E	449 075.796 5 925 590.77
	49/12a-9 49/12a-K1	18 Oct 1998 – 15 Nov 1998	Completed	53 31' 43.993" N; 2 13' 23.228" E	448 500.522 5 931 514.452
	49/12a-K2	03 Jul 1998 – 02 Aug 1998	Completed	53 31' 43.952" N; 2 13' 23.489" E	448 505.315 5 931 513.133
	49/12a-K3	20 Aug 1998 – 27 Sep 1998	Completed	53 31' 44.066" N; 2 13' 23.161" E	448 499.313 5 931 516.722
	49/12a-K4Z	17 Sep 2000 – 07 Oct 2000	Suspended	53 31' 43.951" N; 2 13' 23.350" E	448 502.755 5 931 513.130
	49/12a-K5	14 Jun 2000 – 01 Jul 2000	Completed	53 31' 43.840" N; 2 13' 23.160" E	448 499.219 5 931 509.738
	KD Conductor Slot 4	-	-	-	-
	49/12-A1	17 June 1971 – 27 July 1971	Plugged and abandoned	53 32' 05.053" N; 2 15' 28.281" E	450 809.977 5 932 140.736
	49/12-A2	01 Mar 1971 – 02 Apr 1971	Plugged and abandoned	53 32' 05.025" N; 2 15' 28.194" E	450 808.366 5 932 139.888
	49/12-A3	06 May 1971 – 06 June 1971	Plugged and abandoned	53 32' 04.996" N; 2 15' 28.107" E	450 806.755 5 932 139.008
	49/12-A4	09 Apr 1971 – 02 May 1971	Plugged and abandoned	53 32' 04.964" N; 2 15' 28.020" E	450 805.143 5 932 138.036

Decommissioning Programme	Well reference	Date drilled	Current status*	Latitude; Longitude (ED50)	Easting; Northing (m; UTM zone 31 N)
VDP2	49/12-A5	22 Jan 1971 – 23 Feb 1971	Plugged and abandoned	53 32' 05.040" N; 2 15' 28.009" E	450 804.965 5 932 140.387
	49/12-A6	30 Jul 1971 – 28 Aug 1971	Plugged and abandoned	53 32' 05.098" N; 2 15' 28.183" E	450 808.187 5 932 142.146
	49/12-A7	05 Sep 1971 – 29 Sep 1971	Plugged and abandoned	53 32' 05.085" N; 2 15' 29.911" E	450 839.997 5 932 141.413
	49/12-A8	02 Dec 1971 – 21 Dec 1971	Plugged and abandoned	53 32' 05.171" N; 2 15' 28.172" E	450 808.008 5 932 144.404
	49/12-A9	21 Oct 1971 – 14 Nov 1971	Plugged and abandoned	53 32' 05.142" N; 2 15' 28.085" E	450 806.397 5 932 143.524
	49/12-A10	30 Sep 1971 – 18 Oct 1971	Plugged and abandoned	53 32' 05.113" N; 2 15' 27.998" E	450 804.786 5 932 142.645
	49/17-13Z (Vixen VM)	18 Apr 2000 – 25 Apr 2000	Completed	53 23' 54.785" N; 2 14' 03.258" E	449 081.899 5 917 006.401
	49/17-B02	22 Oct 1972 – 20 Nov 1972	Suspended	53 26' 51.199" N; 2 19' 59.040" E	455 704.203 5 922 392.21
	49/17-B03	01 Oct 1972 – 27 Nov 1972	Completed	53 26' 51.253" N; 2 19' 59.002" E	455 703.518 5 922 393.886
	49/17-B04A	04 Mar 1973 – 29 Mar 1973	Completed	53 26' 51.308" N; 2 19' 58.965" E	455 702.851 5 922 395.592
	49/17-B05	15 Aug 1972 – 21 Sep 1972	Suspended	53 26' 51.197" N; 2 19' 59.291" E	455 708.833 5 922 392.105
	49/17-B07	24 Dec 1972 – 07 Feb 1973	Suspended	53 26' 51.307" N; 2 19' 59.210" E	455 707.371 5 922 395.519
	49/17-B08	30 Oct 1978 – 16 Dec 1978	Completed	53 26' 51.364" N; 2 19' 59.179" E	455 706.815 5 922 397.285
	BD Conductor 1	-	-	-	-
	BD Conductor 2	-	-	-	-
	BD Conductor 3	-	-	-	-

Decommissioning Programme	Well reference	Date drilled	Current status*	Latitude; Longitude (ED50)	Easting; Northing (m; UTM zone 31 N)
VDP3	49/22-J01	08 Mar 1982 – 07 Jun 1982	Completed	53 19' 41.220" N; 2 21' 49.283" E	457 619.616 5 909 085.924
	49/22-J02	29 Aug 1983 – 18 Oct 1983	Completed	53 19' 41.466" N; 2 21' 49.385" E	457 621.571 5 909 093.509
	49/22-J03Z	29 Dec 1983 – 05 Jan 1984	Completed	53 19' 41.505" N; 2 21' 49.101" E	457 616.328 5 909 094.761
	49/22-J05	28 Feb 1984 – 26 Mar 1984	Completed	53 19' 41.537" N; 2 21' 49.274" E	457 619.537 5 909 095.721
	49/22-J06	05 Sep 1994 – 23 Sep 1994	Completed	53 19' 41.639" N; 2 21' 49.336" E	457 620.712 5 909 098.863
	JD Conductor 1 49/22-4	-	Abandoned below mud line	-	-
	49/17-11 (Victor JM)	18 Jun 1993 – 21 Jul 1993	Completed	53 21' 03.223" N; 2 17' 43.461" E	453 096.745 5 911 662.730

Note: * Well status prior to the commencement of the well P&A campaign.

3.4.7 Proposed schedule for VDP2 and VDP3

The proposed decommissioning of the VDP2 and VDP3 infrastructure will be between 2014 and 2022. The current, schedules for the VDP2 and VDP3 decommissioning activities are presented in Figures 3.4 and 3.5.

The exact timing of events will be decided once contracts have been awarded and may be subject to change depending on the availability of vessels and the possible benefits of co-operation with other offshore activities. ConocoPhillips will inform BEIS of all such proposed changes.

3.5 Inventory of Materials

This section presents an estimate of the mass of different types of material in the various facilities to be decommissioned under VDP2 and VDP3. Based on evidence gathered from surveys and cleaning/ disposal certificates at the TGT and from topside pipework removed during the early well P&A work, it is assumed that Naturally Occurring Radioactive Material (NORM) scale deposits will be present on the interior surface of all the pipework to be decommissioned. As a result, all pieces of infrastructure removed which were exposed to production fluids (pipelines, pipework, vessels, risers, etc.) will be monitored for potential NORM contamination. However, the quantities of NORM within this material are not known and are difficult to estimate, as deposition is not likely to be uniform. Detail regarding weights of NORM found will be documented following treatment.

3.5.1 VDP2 infrastructure

Table 3.10 presents an estimate of the mass of different types of material in the various pieces of infrastructure to be decommissioned under VDP2.

3.5.2 VDP3 infrastructure

Table 3.10 presents an estimate of the mass of different types of material in the various pieces of infrastructure to be decommissioned under VDP3.

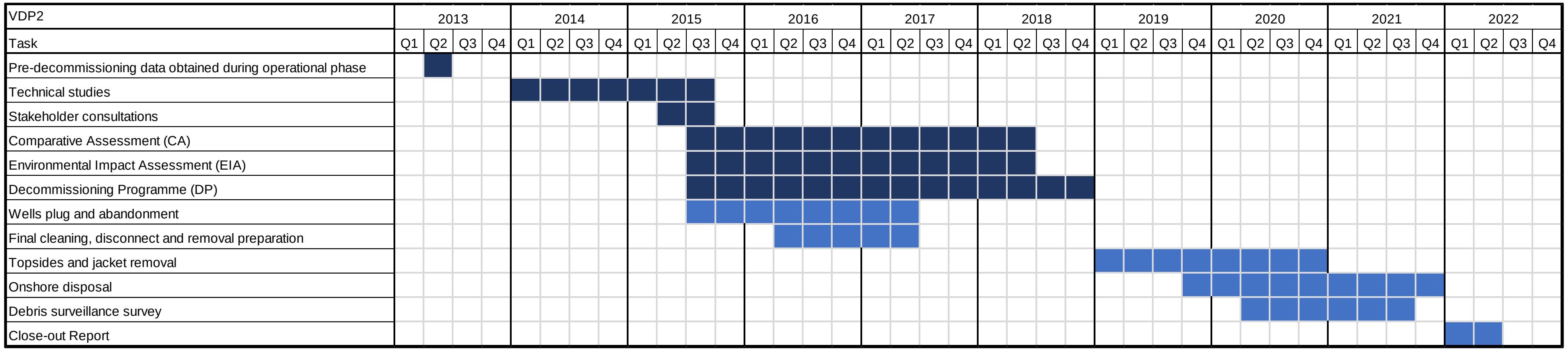


Figure 3.4: Current VDP2 decommissioning schedule

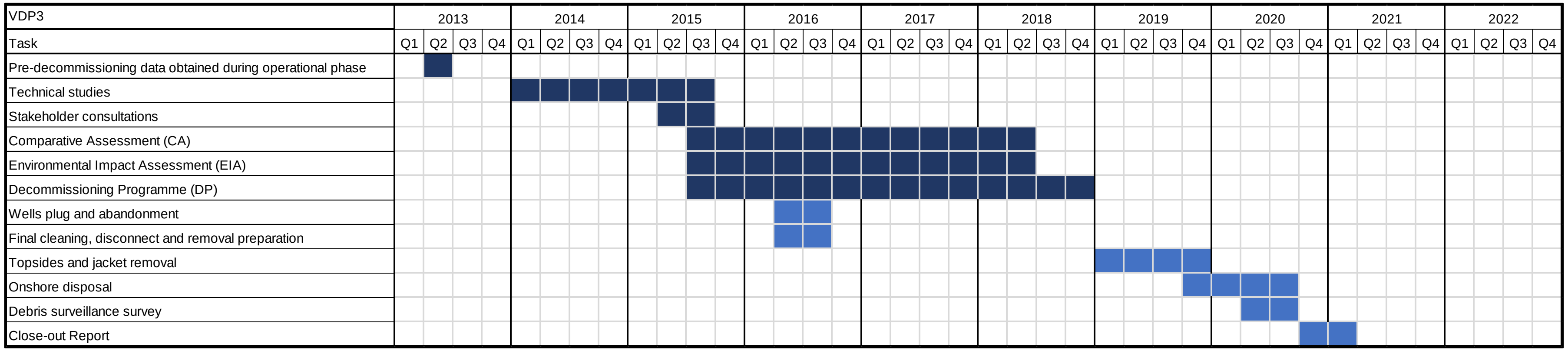


Figure 3.5: Current VDP3 decommissioning schedule

ConocoPhillips

Table 3.10: Inventory of the main materials to be decommissioned under VDP2 and VDP3

Decommissioning programme	Infrastructure	Mass (tonnes)						
		Steel*	Concrete	Hazardous/ NORM	Plastic	Aluminum	Other non-hazardous	Total
VDP2	Viking LD	739.00	18.40	45.00	0.00	27.00	45.00	**874.40**
	Viking KD	743.00	18.40	46.00	0.00	26.00	53.00	**886.40**
	Viking BP	2,101.00	0.80	294.00	0.01	10.00	141.00	**2,546.81**
	Viking BD	3,070.00	1.00	75.00	0.00	12.00	93.00	**3,251.00**
	Viking BC	3,719.00	0.75	296.00	0.20	8.00	59.00	**4,082.95**
	Viking BA	3,103.00	1.00	62.00	0.00	12.00	28.00	**3,206.00**
	Viking AR	1,767.00	0.00	60.00	0.00	0.00	106.00	**1,933.00**
VDP3	Victor JD	1,720.00	166.00	65.00	0.00	10.00	31.00	**1,992.00**
Surface installations total		***16,962.00***	***206.35***	***943.00***	***0.21***	***105.00***	***556.00***	***18,772.56***
VDP2	Vixen VM manifold	46.64	0.00	0.00	0.00	0.00	0.00	46.64
	Vixen VM/ Victoria SM tee-piece	38.50	0.00	0.00	0.00	0.00	0.00	38.50
	Viking KD/ Viking LD tee-piece	2.00	0.00	0.00	0.00	0.00	0.00	2.00
	Concrete mattresses	0.00	834.00	0.00	0.00	0.00	0.00	834.00
VDP3	Victor JM manifold	85.50	0.00	0.00	0.00	0.00	0.00	85.50.00
	Victor JM pigging skid		0.00	0.00	0.00	0.00	0.00	
	Concrete mattresses	0.00	210.00	0.00	0.00	0.00	0.00	210.00
Subsea structures total		***172.64***	***1,044.00***	***0.00***	***0.00***	***0.00***	***0.00***	***1,216.64***

Decommissioning Programme	Infrastructure	Mass (tonnes)					
		Steel*	Concrete	Coal tar	Plastic	Misc**	Total
VDP2	PL1571	1,745.53	2,354.28	0.00	0.00	0.00	**4,099.81**
	PL1573	321.58	0.00	0.00	0.00	0.00	**321.58**
	PL1464	6.00	0.00	0.00	0.00	0.00	**6.00**
	PL1465	1.00	0.00	0.00	0.00	0.00	**1.00**
	PL1572	7.82	10.54	0.00	0.00	0.00	**18.36**
	PL1574	1.44	0.00	0.00	0.00	0.00	**1.44**
	PL0027	40,289.55	93,020.62	2,164.84	0.00	0.00	**135,475.02**
	PL0161	2,058.96	0.00	0.00	30.11	0.00	**2,089.07**
	PL0088	2,532.86	6,784.32	2,668.27	0.00	0.00	**11,985.44**
	PL0134	166.49	0.00	0.00	2.43	0.00	**168.92**
	PL1767	857.00	0.00	1.00	15.00	0.00	**873.00**
	PL2643	3,355.00	0.00	1.00	78.00	0.00	**3,434.00**
	PL2644	572.89	0.00	0.00	0.00	0.00	**572.89**
	PL1768	115.00	0.00	0.00	44.00	0.00	**159.00**
VDP3	PL0211	2,262.00	2,911.34	167.00	0.00	0.00	**5,340.34**
	PL0212	319.74	0.00	2.00	0.00	0.00	**321.74**
	PL1095	636.07	921.26	46.63	0.00	0.00	**1,603.96**
	PL1096	117.76	0.00	0.00	0.00	0.28	**118.04**
	PLU4039	72.00	0.00	0.00	25.00	0.00	**97.00**
Pipelines total		***55,438.69***	***106,002.36***	***5,050.74***	***194.54***	***0.28***	***166,686.61***

*Steel comprises all steel and stainless steel.

**Miscellaneous contains a list of mixed items such as electrical/ electronic items and fittings, paints, safety equipment and some plant equipment not defined under the other sub-headings

Source: D3 Consulting, 2015

3.6 Overview of the Options Available for VDP2 and VDP3 Activities

This section describes the options that ConocoPhillips considered for the VDP2 and VDP3 decommissioning activities. Table 3.11 provides a summary of the VDP2 and VDP3 decommissioning options. The vessel contract(s) for the decommissioning of the surface installations were not known at the time of the original assessment. Therefore, for the purpose of this assessment, the worst case assumption for the removal of the satellite jacket and topside was one lift for the topside and one lift for the jacket, whereas for the removal of the Hub jackets and topsides, between three to five lifts for the topside and one lift for the jacket. All activities related to the decommissioning of the VDP2 and VDP3 platform infrastructure will be detailed in a single decommissioning Master Application Template (MAT) document for each installation and submitted to BEIS via the UK oil portal.

3.6.1 Topside removal options

ConocoPhillips plan to fully remove the topsides of all eight platforms under VDP2 and VDP3. The topsides will be removed and returned to shore for recycling and disposal. The three removal options considered for decommissioning the eight topsides were the following.

1. Reverse installation (multiple lifts)

For reverse installation, the topsides modules would be separated by deconstruction of the module interfaces and then removed individually by a dedicated crane vessel. The modules would be back-loaded to the deck of the crane vessel or to a cargo barge, and then transported in batches to an onshore disposal yard. They would be offloaded either directly from the vessel to the quayside or via a cargo barge towed to the quayside. The modules may then be assigned for reuse or broken down for recycling or disposal.

2. Piece-small offshore deconstruction

In the piece-small option, the topsides modules and other facilities would be dismantled offshore using mechanical excavators equipped with cutting tools. Manual hot and cold cutting techniques would be used to breakdown the facilities into small manageable sections, which would then be sorted and loaded into containers for transportation to shore on supply vessels. The work would be supported by the accommodation work vessel (AWV) stationed at the unmanned satellite platforms. In the case of the Bravo Hub Complex the platform accommodation would be used in place of an AWV. There would be two main phases to this option.

- ***Stage 1.*** All cables and hazardous waste would be removed from the topsides' modules in turn. Module internals (vessels, pipes and secondary structures) would then be removed. The remaining module structures would then be cut into container sized sections. The accommodation, life support and utility systems would also be removed piece small.
- ***Stage 2.*** After removal of all the modules and facilities, the module support frame would be removed by reverse installation, using a HLV.

Once materials had been sorted into the relevant groups, it would be loaded into separate containers and shipped to an onshore disposal/ recycling facility.

Table 3.11: Decommissioning options considered and likely to be selected for VDP2 and VDP3

<table>
<tr><th>VDP2/ VDP3 infrastructure</th><th>Decommissioning option</th><th>Method</th><th colspan="8">Proposed decommissioning method for VDP2 and VDP3 infrastructure</th></tr>
<tr><td colspan="3">Surface installations</td><td>KD</td><td>LD</td><td>AR</td><td>BA</td><td>BC</td><td>BP</td><td>BD</td><td>JD</td></tr>
<tr><td rowspan="3">Topsides</td><td rowspan="3">Full removal</td><td>1. Reverse installation (multiple lifts)</td><td></td><td></td><td></td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>2. Piece-small offshore deconstruction</td><td>✓*</td><td>✓*</td><td>✓*</td><td></td><td></td><td></td><td></td><td>✓*</td></tr>
<tr><td>3. Single lift</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td><td></td><td></td><td>✓</td></tr>
<tr><td rowspan="3">Jacket (and risers)</td><td rowspan="3">Full removal</td><td>1. Single lift</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>2. Cut and lift</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>3. Flotation</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="11">Subsea installations</td></tr>
<tr><td>Tee-pieces</td><td>Full removal</td><td>Cut and lift via a DSV with a supply vessel on site</td><td colspan="8">✓</td></tr>
<tr><td>Pigging skid</td><td>Full removal</td><td>Cut and lift via a DSV with a supply vessel on site</td><td colspan="8">✓</td></tr>
<tr><td rowspan="3">Mattresses</td><td colspan="2">Full removal</td><td colspan="8"></td></tr>
<tr><td colspan="2">Burial</td><td colspan="8"></td></tr>
<tr><td colspan="2">Current state (decommission in situ)</td><td colspan="8">✓</td></tr>
<tr><td colspan="11">Pipelines</td></tr>
<tr><td rowspan="5">Pipelines</td><td rowspan="2">Full removal</td><td>1. Reverse S-Lay/ Reverse Reel</td><td colspan="8"></td></tr>
<tr><td>2. Cut and lift</td><td colspan="8"></td></tr>
<tr><td>Partial removal</td><td>Cut and lift</td><td colspan="8"></td></tr>
<tr><td rowspan="2">Decommission in situ</td><td>1. Minor intervention</td><td colspan="8"></td></tr>
<tr><td>2. Minimum intervention</td><td colspan="8">✓</td></tr>
</table>

*Piece-small removal of some aspects of the topsides by AWV during the EDC activities. This will allow clear sight of navigational aids until full removal of the remaining topside structure and deck by single lift.

3. Single lift

In the single lift option, a HLV capable of lifting the entire topsides in one lift would be utilised. The topsides would be prepared for this by a combination of engineering down and cleaning (EDC); module sea-fastening; and structural strengthening. The topsides would then be transported to the designated disposal yard by HLV or cargo barge where they would be transferred to the quayside for dismantling.

3.6.2 Jacket removal options

As the weights (in air) of the jackets (Table 3.4) 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 the platforms is complete removal. The planned high level process for the removal of each of the eight jackets is:

- Completion of the platform removal preparations;
- Cutting of the risers;
- Remove soil plug from leg piles;
- Remove spool section from pipeline;
- Cutting of the jacket piles to a suitable depth below the natural seabed level (depth to be determined based on prevailing hydrodynamic conditions), currently estimated at 3 m;
- HLV removal of each platform jacket (including risers); and
- Removal of additional subsea infrastructure if required.

The preferred methodology of ConocoPhillips for cutting the piles is to use internal cuts which will not require external dredging of the jacket legs. External cutting will only be undertaken in the event of debris prohibiting access within the jacket legs.

The three removal options considered by ConocoPhillips for the complete removal of the eight jackets are described below.

1. Single lift

In the single lift option, a HLV capable of lifting the entire jacket in one lift would be utilised. The jacket would be prepared for lifting by a combination of engineering down and cleaning; sea fastening and structural strengthening. The jacket would then be transported by the HLV or cargo barge to the quayside.

2. Cutting and lifting

In the cutting and lifting option, the jacket members would be cut into sections using a combination of diamond-wire cutting, abrasive water jetting and hydraulic shear. Each jacket section would be held in place on the end of a lifting strop from a crane during cutting operations, and, after separation from the remainder of the jacket, would be lifted by an HLV. Once the jacket sections have been separated and lifted to the surface, they would be sea-fastened and transported to an onshore disposal yard, either on dedicated transportation barges or on the HLV.

The upper section of the jacket, above the jacket footings, would be removed in several sections. The jacket footings would then be cut into sections and removed down to the seabed. The piles in the seabed would be cut at a suitable depth below the natural seabed so that the seabed is left clear of obstructions. Depending on hydrodynamic conditions at each site this may be to a depth of 3 m (DECC, 2011a; ConocoPhillips, 2013).

3. Flotation

In the flotation option, the jackets would be completely removed using buoyancy tank assemblies (BTAs). Initial preparatory work would involve cutting the majority of the structural members at the section of jacket to be separated, leaving enough in place to secure the jacket during installation of the BTAs. Support brackets would be fitted to each of the corner legs to secure the BTA units. Once the BTAs have been installed, the BTAs would be deballasted. Two tugs would keep the jacket on station while the remaining piles were cut, allowing the jacket to float free. It would then be towed to an inshore location close to the onshore yard for dismantling. On arrival at the inshore grounding location, the BTAs would be ballasted until the jacket rested on the seabed. The BTAs would then be removed, the inshore spread mobilised and the jacket cut into manageable sections. These would be transported to the demolition quay for further dismantling and then recycling.

3.6.3 Pipeline decommissioning options

Pipeline decommissioning is governed by the Petroleum Act 1998 and the requirements are set out within the BEIS Guidance Notes. The Guidance Notes state that there are no prescribed options for pipeline decommissioning; all feasible options must be considered and a CA undertaken to determine which decommissioning option provides the most acceptable outcome on the basis of the criteria outlined in the guidance.

The options considered by ConocoPhillips for the decommissioning of the VDP2 and VDP3 pipelines were the following:

- **Reverse Reel:** Pipelines would be exposed (if required) using jetting methods and would be removed by reverse reel prior to transport to shore. This method would be used for pipelines composed of flexible plastic coating and could be used for the full or partial removal of longer lengths of pipeline. This method would not be suitable for the removal of concrete coated pipelines.

- **Reverse S-lay:** Lengths of buried pipeline would be exposed where required using jetting methods and would be removed by reverse S-lay and would be cut on board the vessel prior to transportation to shore. This method could be used for pipelines with a concrete coating and may be suitable for the full or partial removal of pipelines.
- **Cut and Lift:** Pipelines would be exposed using jetting methods (where required) and would be removed by cutting with an underwater pipe cutter and lifting the cut pipeline sections onto a vessel for transportation to shore. This method may be suitable for the full or partial removal of short sections of plastic and concrete coated pipelines.
- **Decommission in situ:** The following options have been adapted from the Oil and Gas UK document Decommissioning of Pipelines in the North Sea Region 2013 (OGUK, 2013).
    - **Minor intervention:** Pipelines decommissioned in situ would be left in such a manner that they do not pose a risk to other users of the sea, including fisheries. This would involve reburial or rock-placement on exposed or at risk sections or pipeline ends. Reasonable attempts will be made to remove all visible

mattresses where safe to do so. Pipelines would be left open and flooded with seawater.

- **Minimum intervention:** Rock-placement will be placed on the cut pipeline ends only, to make them safe to fishermen. The remaining pipeline would be left in its current state, marked on sea charts and notifications issued to fishermen/ other users of the sea. Pipelines would be left open and flooded with seawater.

The first three options include reasonable attempts to remove mattresses, where safe to do so. However, with decommissioning in situ*,* mattresses will be left in-place where possible. When gaining access to the pipeline ends to sever the connection with the satellite platform, there is potential for the need to remove a small number of mattresses under the minimum intervention option. However this will only be determined upon inspection at the time of decommissioning.

In all options, the crossings would be decommissioned in situ*.* Under the full and partial removal options, the pipeline will be cut at a safe distance (approximately 250 m each side of the crossing) from the crossing and the cut ends either covered with rock-placement or re-trenched as required.

3.6.4 Manifold removal options

ConocoPhillips plan to fully remove the Vixen VM and Victor JM manifolds from the seabed, under VDP2 and VDP3. Mattresses and grout bags moved to gain access to the manifolds will be removed for onshore disposal. One method of removal has been considered by ConocoPhillips. The manifolds will be removed by cutting it from the attached pipelines with an underwater cutter, the securing pin piles will be excavated to a suitable depth based on the hydrodynamic conditions present (approximately 3 m) and these will then be cut (DECC, 2011a; ConocoPhillips, 2013). The manifolds and associated mattresses and grout bags which are to be removed, will then be lifted from the seabed onto a DSV and returned to shore for recycling and/ or disposal.

3.6.5 Tee removal options

ConocoPhillips plan to fully remove two tees and their protective structures from the seabed, under VDP2. Mattresses and grout bags moved to gain access to the tees and protective structures will be removed for onshore disposal. Currently the preferred removal method involves cutting the tees from the attached pipelines with an underwater cutter. Then the securing pin piles will be excavated to a suitable depth based on the hydrodynamic conditions present (approximately 3 m) and these will then be cut (DECC, 2011a; ConocoPhillips, 2013). The tees, protective structures and associated mattresses and grout bags which are to be removed, will then be lifted from the seabed onto a DSV and returned to shore for recycling and disposal. Due to the degradation of the mattresses at the tees, following removal ConocoPhillips propose to use rock-placement over the tee location and pipeline cut ends to minimise snagging hazards to other users of the sea.

3.6.6 Pigging skid removal options

Under VDP3, ConocoPhillips plan to fully remove the Victor JM pigging skid and protective structure from the seabed. Mattresses and grout bags moved to gain access to the pigging skid will be removed for onshore disposal. One method of removal has been considered by ConocoPhillips. The pigging skid will be removed by cutting it from the attached pipelines with an underwater cutter, the securing pin piles will be excavated to a suitable depth based on the hydrodynamic conditions present (approximately 3.0 m) and these will then be cut (DECC, 2011a; ConocoPhillips, 2013). The pigging skid and associated mattresses and grout bags which are to be removed, will then be lifted from the seabed onto a DSV and returned to shore for recycling and disposal. Due to mattress degradation at the pigging skid, rock-placement will be placed over the pigging skid location and pipeline cut ends to minimise snagging hazards to other users of the sea.

3.6.7 Mattress removal options

VDP2 and VDP3 include the decommissioning of mattresses placed on the seabed for protection or stabilisation purposes. Three options were considered by ConocoPhillips for the decommissioning of the mattresses associated with the pipelines:

- **Full removal –** the mattresses would be completely removed from the seabed onto a vessel for transportation to shore.
- **Burial –** the mattresses may be trenched to a pre-determined depth and back-filled.
- **Minimum disposal option (decommission in situ*)* –** mattresses would be decommissioned in situ in their current state to maintain pipeline stability, minimise seabed disturbance and reduce the requirements for the introduction of new material to the seabed. There may still be a requirement to remove some mattresses under minimum disposal where these need to be moved to gain access to make cuts to the pipelines being decommissioned.

3.6.8 Well P&A

The VDP2 and VDP3 involves the permanent abandonment of the designated wells.

The well abandonment operations began in Q3 2015 using the *Ensco 92* jack-up rig. Seventeen wells are included within VDP2 and six wells are included within VDP3.

All hazardous zones (hydrocarbon bearing, over-pressured and/ or porous, and permeable) have been isolated from the surface and where necessary from each other. The wellheads were removed following well P&A.

There were two abandonment options for the P&A of the wells, depending on the well conditions:

- **Cut & Pull Tubing** – the production tubing and/ or casings strings are removed from the well before the cement barriers can be put in place.
- **Through Tubing** – the production tubing and casing strings remain in the well and cement is circulated through the tubing, isolating hazardous zones.

ConocoPhillips have been collaborating with industry including counterparts in Norway and Houston, partners, and the Oil and Gas UK Well Life Cycle Practices Forum, to ensure knowledge sharing and best practice with respect to well abandonments. The removal of the production tubing is considered by ConocoPhillips to be the Best Practicable Environmental Option, in order to establish the quality and quantity of the cement behind the casing. A new technology study is also being carried out by consultants to identify new abandonment technologies and techniques.

The abandonment of the wells will be carried out in accordance with the ConocoPhillips SNS Abandonment approach which complies with the intent of following UK legislation, industry guidelines and internal ConocoPhillips standards listed below:

- Offshore Installations and Wells (Design and Construction) Regulations 1996.
- Offshore Installations (Safety Case) Regulations 2005 (SI 2005/ 3117).
- Oil and Gas UK Guidelines for Suspension and Abandonment of Wells, Issue 4, July 2012.
- ConocoPhillips UK-00529 UK Wells Technical Standards Manual.
- ConocoPhillips UK-00586 UK Well Examination Scheme.

The P&A of these wells and the associated impacts are detailed within two separate environmental direction documents submitted to BEIS.

3.7 Overview of the VDP2 and VDP3 CA Process

ConocoPhillips carried out a CA of the pipeline decommissioning options, as required by the Petroleum Act 1998, to determine which option was most suitable in view of the status, condition and environmental setting of the infrastructure being decommissioned (BMT Cordah, 2015d).

The individual decommissioning options for the pipelines were assessed against the five criteria provided in BEIS's Guidance Notes (DECC, 2011a) and are presented in Table 3.12.

Table 3.12: Five assessment criteria from the BEIS Guidance Notes

Technical Feasibility A qualitative assessment of Technical Feasibility and Recoverability from Major Project Failure.
Safety A qualitative assessment of Potential Safety Risk to personnel working on the decommissioning activities and 3rd parties using the areas in proximity to these decommissioning activities. This is assessed using a modified ConocoPhillips risk assessment matrix.
Environmental Impact (a) Qualitative assessment of Environmental Risks onshore and offshore using a ConocoPhillips risk assessment matrix; and (b) Quantitative estimation of Energy Usage and CO_2 Emissions using the method given in IoP (2000).
Societal Impact A qualitative assessment of Societal Risks to other users of the sea and to those onshore. This is assessed using a ConocoPhillips risk assessment matrix.
Cost A quantitative comparison of the estimated Cost for each option.

Source: BMT Cordah, 2015d

The scores from each of the assessments were expressed in their respective quantitative and qualitative units. Justification for the scores assigned during the assessments, as well as assumptions and limitations were noted.

To enable a comparison of the options to be made, the results were then collated and compared using a normalised/ weighted scoring system, where the results of each of the assessments were expressed in common units and ranked in order of performance from best to worst, based on the percentage weighting assigned by ConocoPhillips (Table 3.13).

Table 3.13: Weightings of options

Criteria/ sub-criteria	Weighting (percentage)
Technical Feasibility	10
Safety	30
Environmental/ Environmental Risk	15
Environmental/ Energy Usage	5
Environmental/ Emissions	5
Societal/ Socioeconomic Risk	10
Cost	25
Total	**100**

Source: BMT Cordah, 2015b

The maximum percentage weighting value for each criterion was assigned to the best performing (and therefore most preferable) option. All subsequent options were assigned a normalised weighting in proportion to the best performing option. The output was a matrix presenting normalised/ weighted scores for the criteria/ sub-criteria for every option.

An overall score was established by totalling the normalised/ weighted scores of the assessments and comparing the totals. The output from the CA was used to select the ConocoPhillips preferred decommissioning option. A CA report documented the justification for the selection (BMT Cordah, 2015d).

The Guidance Notes (DECC, 2011a) make provision for weightings to be assigned to the scoring for the individual assessments to transparently reflect the proportionality or balancing of the options from the viewpoint of the operator or its stakeholders. The outcome of the CA process for decommissioning the pipelines is summarised in Section 3.9 below. The outcomes for decommissioning the remaining VDP2 and VDP3 infrastructure (platforms, wells and subsea infrastructure) are also summarised in Section 3.9.

3.8 Initial Work for Removal of the VDP2 and VDP3 Infrastructure

The initial decommissioning operations will be undertaken using the *Ensco 92* drilling rig. However, a bridge-linked, jack-up AWV may be stationed at the unmanned Viking KD, LD, AR and Victor JD platforms for EDC. As part of the AWV EDC activities the topside modules and facilities will be removed with a navigational aid placed on the topside decks at the four satellite platforms. This will enable clear sight and navigational aid. The remaining infrastructure will be removed at a later stage of the VDP2 and VDP3 decommissioning activities via single lift.

An AWV will not be required at the Viking Bravo Hub Complex, as the accommodation unit on Viking BA will be used. There will be an option to implement a helicopter flying campaign from one of the main offshore complexes to the platforms. The two vessels will attend each installation on separate occasions and will not be present at the same target location.

ConocoPhillips are undertaking site specific assessments (SSAs) for Viking KD, LD, AR and Victor JD to determine the requirement for the placement of rock on the seabed at the four possible AWV locations. Rock-placement may be needed to protect against:

- Punch-through, whereby the AWV spud-cans suddenly penetrate through the seabed resulting in the uneven distribution of the vessels weight and ultimate destabilisation and or listing of the vessel.
- Hang-up, whereby the vessels spud-cans penetrate through the seabed to a depth which prevents the uniform removal of the four legs, resulting in the potential for the destabilisation of the vessel or the lowering of the vessel within the water below safe depths and possible capsize.
- Seabed scour at the AWV spud cans.

The SSAs are ongoing, however, initial assessments for VDP1 and LDP1 have indicated rock-placement (rock berms) are required at four (Viking KD, LD, AR and Victor JD) of the eight platform locations. Historic rock-placement applications made by ConocoPhillips and other operators are presented in Table 3.14.

Based on the SSA results for the VDP1 and LDP1 decommissioning operations, if an AWV is utilised, an estimated 34,000 tonnes of rock may be required at the Viking KD, LD, AR and Victor JD platform locations. Assuming this rock estimate will be required at the four locations, a total worst case mass of 136,000 tonnes of rock will be required.

The berm designs for each location will be similar to those applied for in VDP1 and LDP1, but will vary in height and surface area. Rock will be placed in four adjoining locations on the seabed as a rock berm, to support each of the four AWV jack-up legs. The associated area of impact with the largest predicted berm design for VDP1 and LDP1 was 7,884 m^2 (0.00788 km^2).

The SSAs for VDP1 and LDP1 estimate that each leg location will require at least 4 m of rock depth to provide sufficient resistance against punch-through. A slope gradient of 1 in 5 will be applied to the berm to provide adequate stability. A contractor for the placement of rock on the seabed has been selected. ConocoPhillips has previously used a fall pipe vessel for rock-placement work in the southern North Sea and intends to utilise this same method for VDP2 and VDP3 as it provides the most accurate deployment in high energy environments.

A direction for deposits application will be submitted to the BEIS to seek approval to commence the rock-placement operations at each platform location. ConocoPhillips envision the placement of rock to have been undertaken prior to the arrival of the AWV. The volume of rock, method of installation and the site specific berm design will be detailed within each application, and will be based on the final SSA results. The rock requirement presented here is deemed to be a worst case and in reality, the quantities stated for VDP2 and VDP3 are anticipated to be less than the worst case required at VDP1 and LDP1.

Table 3.14: Historic rock placement at platforms in the southern North Sea

Platform/ block visited	Operator	Date on location	Deposition details
Vanguard QD	ConocoPhillips	February to June 2013	Seabed stabilisation required for soils support and safety of personnel and vessel. 8,000 tonnes of rock/ gravel. Rock/ gravel ranged from 5 to 20 cm.
South Valiant TD		April to August 2014	Seabed stabilisation required for soils support and safety of personnel and vessel. 30,000 tonnes of rock/ gravel. Rock/ gravel ranged from 11 to 22 mm.
North Valiant 1 PD platforms		December 2014 - September 2015	Consent was granted to deposit 11,000 tonnes of rock/ gravel for seabed stabilisation to prevent scour. 4,100 tonnes of rock/ gravel. Rock/ gravel ranged from 11 to 22 mm. 6,850 tonnes of rock/ gravel. Rock/ gravel ranged from 22 to 95 mm.
Block 49/27a	Perenco UK Limited	March 2014	3,000 tonnes of rock material.
Block 48/8	Shell UK Limited	April 2014	2,200 tonnes of rock material.
Block 48/19	Shell UK Limited	May 2015	No details available.
Block 49/26	Perenco (Gas) Limited	July 2014	No details available.
Block 49/27	Perenco UK Limited	October 2014	1,350 tonnes of rock material.
Block 48/7b	Perenco UK Limited	November 2014	3,500 tonnes of rock material.
Block 48/14	Shell UK Limited	November 2014	400 tonnes of gravel.
Viking DD	ConocoPhillips	December 2015 - January 2016	22,479 tonnes of rock deposited for AWV support
Viking ED		February – May 2016	18,222 tonnes of rock deposited for AWV support
Viking GD		November – December 2015	20,388 tonnes of rock deposited for AWV support
Viking HD		December 2015	32,353 tonnes of rock deposited for AWV support

3.8.1 Topsides

ConocoPhillips will purge the topside systems to ensure that minimal hydrocarbons remain in the system prior to the final cleaning and disconnect (FC&D).

During the FC&D works all the systems will be progressively depressurised, purged and rendered safe for removal operations. Pipework and tanks may then be cleaned to remove sources of potential spills of oils and other fluids. Some FC&D operations, which do not compromise the well P&A activities or interfere with the life support systems, may begin during the well P&A programme. It is envisaged that much of the surface structure will be dismantled and removed from the satellite and riser platforms (Viking KD, LD, AR and Victor JD) by the AWV. This is to enable clear sight of the solar navigational aids installed on the platforms until final removal of the remaining topside structure by single lift in a targeted platform removal campaign.

Table 3.15 summarises the methods that are used to flush, purge and clean the topsides offshore prior to removal to shore.

Table 3.15: Cleaning of topsides for removal

Waste Type	Composition of Waste	Disposal Route
Onboard hydrocarbons	Process fluids.	Initial nitrogen purge with any fluids flushed downhole or skipped and shipped to shore. Any mobilised solids will be filtered and skipped to shore for onshore disposal.
Produced solids	Contaminated sand*, NORM.	Bulk produced solids will be removed, treated and disposed of onshore. Scale adhered to the internals of pipework and vessels will remain in situ and be treated and disposed of during the dismantling of the topside onshore.
Diesel	Bunkered diesel fuel.	Bunkered diesel will be drained and returned onshore for disposal.
Chemicals and lubricating oils	Production chemicals and lubricants for equipment, e.g., gearboxes, pumps, pedestal compressor skid.	Chemicals and lubricating oils will be drained and returned onshore for disposal.

*the contaminated sand may contain hydrocarbons, heavy metals and NORM.
Source: ConocoPhillips, 2014a

3.8.2 Jackets

The appointed lifting contractor will assess suitable locations for, and attachment of any new lifting points on the jacket structure.

3.8.3 Mattresses

ConocoPhillips commissioned a mattress inventory report to identify the number and where possible, the burial status of the mattresses in the VDP2 and VDP3 areas (BMT Cordah, 2015c). There will be no additional preparatory work undertaken for the decommissioning of the concrete mattresses under VDP2 and VDP3.

3.8.4 Manifolds

The Vixen VM and Victor JM manifolds were flushed during the cleaning operations for the pipelines as they were integral in the pipeline infrastructure. There will be no additional preparatory work undertaken for the decommissioning of the tees under VDP2 and VDP3.

3.8.5 Tees

The two tees were flushed during the cleaning operations for the pipelines as they were integral in the pipeline infrastructure. There will be no additional preparatory work undertaken for the decommissioning of the tee-pieces under VDP2 and VDP3.

3.8.6 Pigging skid

The Victor JM pigging skid was flushed during the cleaning operations for the pipelines as this was integral in the pipeline infrastructure. There will be no additional preparatory work undertaken for the decommissioning of the Victor JM pigging skid under VDP3.

3.8.7 Pipelines

Prior to cleaning, an internal analysis was undertaken to review feasible pipeline cleaning options for the VDP1 and LDP1 pipelines, this analysis was used to inform the VDP2 and VDP3 decision on cleaning options.

ConocoPhillips decided that the pipelines should be pigged (gel/ foam) and flushed with seawater. The direction of flushing was from the satellite/ platform/ manifold to the Viking Bravo Hub Complex. The pipelines were flushed with seawater and use gel/ foam pigs to remove mobile hydrocarbons with minimal removal of solids. The flushing fluids were filtered and mobile solids separated offshore. These solids were collected for onward shipment to shore for treatment and disposal. With the exception of gas pipelines (and piggybacked methanol lines) PL88 and PL27, the pipeline flushing fluids were re-injected downhole, via well BD03. The seawater flushes and gel-runs did not remove all of the solids from the pipelines. These solids are in the form of contaminated sands and NORM scale, and as a result there will be some residual contaminated solids left in the pipelines. The pipelines were left flooded with seawater following the cleaning operations.

The gas pipeline between Viking AR and Viking BP (PL88) was purged with nitrogen back to Viking AR, with the pipeline contents fed into the Viking AR to TGT gas pipeline (PL27). The gas pipeline PL88 was then be flushed with seawater with the pipeline flushing contents filtered (hydrocarbon content at or below 30 ppm) at Viking AR before being discharged to sea.

The PL27 gas pipeline was flushed back to TGT for discharge via the effluent pipe. Prior to discharge, the flushed PL27 pipeline contents was treated at TGT to pass current effluent discharge permit limits.

To safely undertake pipeline riser disconnect and removal of PL134, having identified the presence of an anomaly. the remaining inventory of PL134 was pumped from the Viking AR platform with untreated seawater, to be discharged at the anomaly site, 96.2 m east of KP 3.842. No further inventory recovery is planned ahead of pipeline decommissioning, subject to DP approvals.

Due to the anomilies identified in PL161, ConocoPhillips and BEIS have agreed on the proposal that the remaining MeOH and inhibitor (CI) contents of PL161 between the

Viking AR platform and identified blockage location was to be displaced down the Viking AR riser, using untreated seawater pumped from the Viking AR platform. Sufficient volumes of seawater were pumped down PL161, with the contents being discharged from the leak location between the Viking AR platform and the pipeline blockage (128 km from TGT and 10 km from Viking AR platform). The remaining inventory between the pipeline blockage and TGT remains in situ, on the basis that this remaining pipeline is of sound integrity, leaks of damage assessed. It is proposed that the remaining inventory will be discharged to the marine environment under a chemical permit and appropriate risk assessment.

3.9 Selected Decommissioning Options for the VDP2 and VDP3 Infrastructure

As discussed, ConocoPhillips undertook a formal CA of the VDP2 and VDP3 pipelines to determine a preferred decommissioning option. In addition, internal engineering studies, reviews and assessments were undertaken for surface installations, subsea structures, pipelines and wells to determine the selected decommissioning options and methods for VDP2 and VDP3. Table 3.16 provides an overview of the selected decommissioning option and methods for VDP2 and VDP3 infrastructure.

Table 3.16: Overview of selected decommissioning options by infrastructure type

<table>
<tr><th>VDP2/ VDP3 Facility</th><th>Selected Decommissioning Option</th><th>Possible Decommissioning Methods</th></tr>
<tr><td>Topsides</td><td rowspan="2">Full removal</td><td rowspan="2">Lift and transportation to shore by a HLV, monohull crane vessel or a HLV for dismantlement, disposal and recycling.</td></tr>
<tr><td>Jacket (and risers)</td></tr>
<tr><td>Manifolds</td><td rowspan="3">Full removal</td><td rowspan="3">Cut and lift via a DSV, with a supply vessel on site.</td></tr>
<tr><td>Tee-pieces</td></tr>
<tr><td>Pigging skid</td></tr>
<tr><td>Pipelines</td><td>Decommissioned in situ</td><td>Minimum intervention.</td></tr>
<tr><td>Remaining mattresses</td><td colspan="2">Current state (decommissioned in situ)</td></tr>
</table>

3.10 Debris Clearance at the VDP2 and VDP3 Decommissioned Areas

ConocoPhillips plan to fully remove the eight surface installations and associated subsea structures from the VDP2 and VDP3 areas, while the remainder of the infrastructure (pipelines, mattresses and grout bags) will be decommissioned in situ with minimum intervention.

Any major piece of equipment or material that is accidentally lost overboard during the proposed decommissioning programme will be located and retrieved where safe to do so.

3.10.1 Seabed clearance survey

On completion of the planned offshore programme of work, the seabed will be surveyed using side-scan sonar to ensure that it is clear of items or obstructions that might pose a safety risk to fisheries or other users of the sea.

Any significant oil and gas related seabed debris will be recovered for onshore disposal or recycling in line with existing disposal methods.

3.10.2 Verification of seabed clearance

After the removal of any oil and gas related debris, these areas will be subject to an overtrawl survey sweep. The sweeps will be carried out by an independent contractor, using specially-designed trawling equipment. The results of the sweeps, pipeline survey and a copy of the seabed clearance certificate issued by the verifier will be submitted to BEIS.

3.10.3 Final condition of the offshore sites

Pipelines will be decommissioned in situ in their current location. Overtrawl surveys will determine whether any additional remedial work is required to ensure the pipelines are in a suitable state of burial at the point of decommissioning which allows fishing gear to pass over these pipelines unobstructed and without the potential of becoming snagged. These overtrawl surveys will be undertaken at each end of the pipeline within the current 500 m safety exclusion zones.

Existing concrete mattresses will remain in situ along the pipeline routes to maximise the reuse of existing stabilisation materials and minimise the introduction of new material (i.e. rock-placement). Over time, it is likely that these would be partially or fully covered by a layer of natural seabed sediment. Along the former route of the spools, the seabed will be free of significant oil and gas related debris.

Rock berms associated with the AWV will be left in situ following the completion of the decommissioning activities. A proportion of rock placed on the seabed under the AWV at the four platform locations will be pressed into the seabed with the weight of the AWV during the proposed operations. ConocoPhillips estimate each spud may penetrate approximately 1.5 m of a 4.0 m high rock berm, with the main bearing area fully embedded. Areas of rock berm will remain on the seabed surface. Over time, it is likely that rock berm on the seabed surface would be partially or fully covered by a layer of natural seabed sediment. Overtrawlability surveys will be undertaken over the rock berms as part of the post decommissioning survey programme agreed with BEIS.

The severed jacket piles will be located at a suitable depth below the natural level of the seabed as determined by the hydrodynamics present, currently estimated at 3 m below the seabed.

Any seabed depressions from anchors, jack-up legs or excavations will be surveyed to ensure these do not pose a snagging hazard to other users of the sea; this may also involve overtrawl trials. These depressions will then be left to infill naturally as a result of the dynamic seabed conditions present across the VDP2 and VDP3 areas.

4.0 ENVIRONMENTAL BASELINE

This section describes the baseline environmental setting of the proposed area to be decommissioned and identifies those components of the physical, chemical and biological environments that might be sensitive to the potential impacts arising as a result of the proposed activities. An understanding of the environmental sensitivities at the local and regional level informs the assessment of the environmental impacts and risks associated with decommissioning activities.

The infrastructure associated with VDP2 and VPD3 are located within fourteen licence blocks situated with the Quadrants 47, 48 and 49 of the UKCS SNS (Figure 4.1).

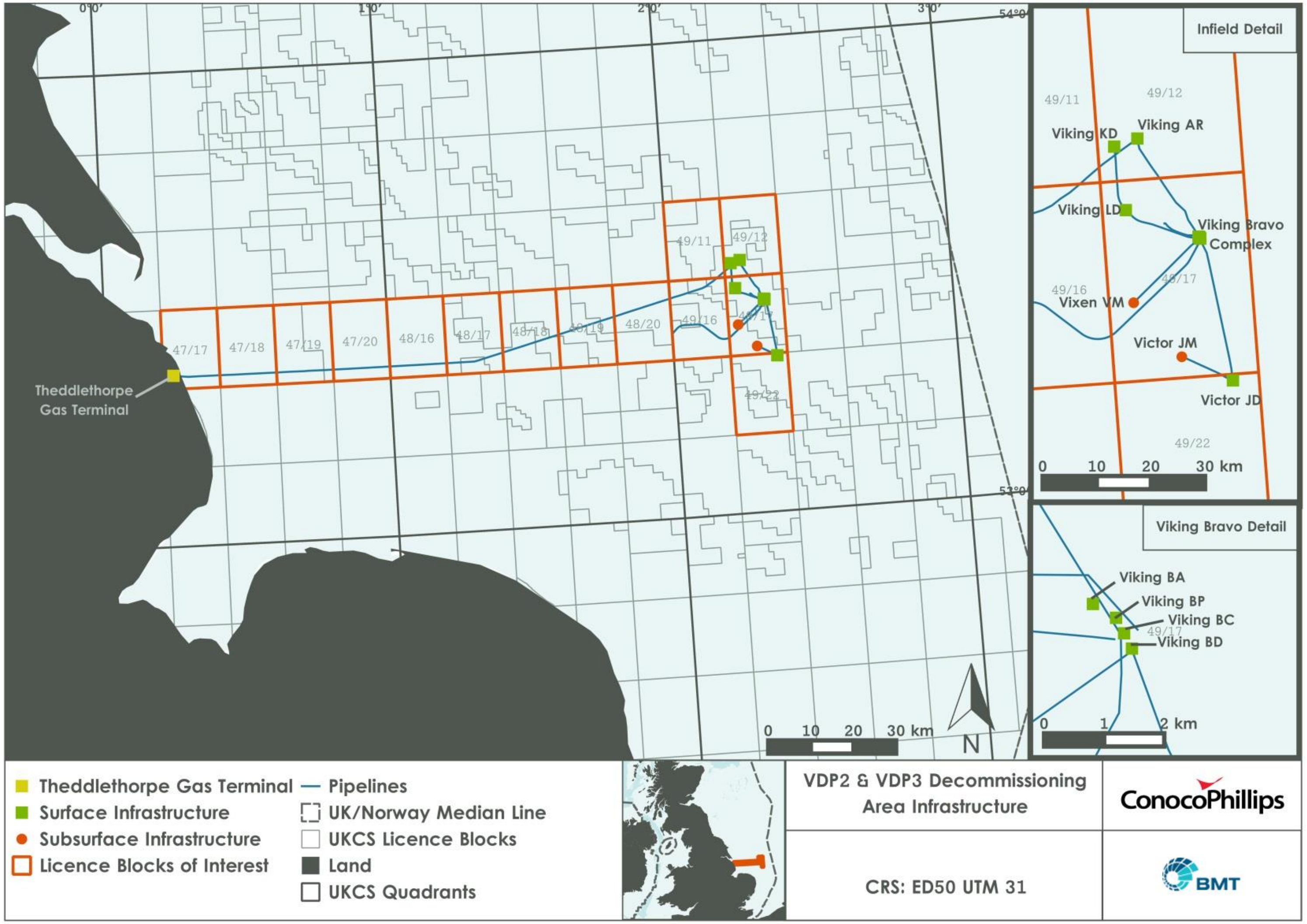
ConocoPhillips have undertaken environmental baseline surveys (EBS) and habitat surveys at the VDP1 and LDP1 platform locations (Figure 4.2) and the VDP2 Viking AR platform location (Figure 4.3), all located within Quadrants 48 and 49 (Table 4.1). The surveys were undertaken over a 2 x 2 km grid centred around each of the surveyed platforms. Geophysical data (side scan and multi-beam data) were undertaken at each location, with sediment sample retrieval/ analysis and video/ stills imagery of the seabed (for ground truthing) also undertaken. The results from these surveys provide an indication of the expected sediments and benthic fauna at the VDP2 and VDP3 offshore locations.

Additional surveys commissioned by ConocoPhillips for VDP2 and VDP3 are listed in Table 4.1. These surveys have been used to inform the VDP2 and VDP3 environmental baseline section, where applicable.

ConocoPhillips have recently undertaken a pipeline route survey along the PL27/ PL161 pipelines. Multi-beam echo-sounder and grab samples data were retrieved. The survey results will not be available until after the ES has been submitted to BEIS, however, they will be incorporated into future permits and consent applications.

Table 4.1: Surveys commissioned by ConocoPhillips in the VDP2 and VDP3 area

Survey	Survey Title
BMT Cordah, 2015c	SNS Decommissioning Programme VDP2 and VDP3 Pipeline Burial and Mattress Inventory Report
Fugro, 2014a	ConocoPhillips (U.K.) Limited SNS decommissioning survey. UKCS 48 and 49. Viking AR, CD, DD, ED, GD, and HD. Habitat Assessment Report J/1/20/2342-3
Fugro, 2014b	ConocoPhillips (U.K.) Limited SNS decommissioning survey. UKCS 48 and 49. Viscount VO, Vulcan UR and Vampire/ Valkyrie OD (LOGGS). Habitat Assessment Report J/1/20/2342-2
Fugro, 2014c	ConocoPhillips (U.K.) Limited SNS decommissioning survey. UKCS 48 and 49. Viking AR, Viking CD and Viking GD. Decommissioning Environmental Report J/1/20/2342
Fugro, 2014d	ConocoPhillips (U.K.) Limited SNS decommissioning survey. UKCS 48 and 49. Viscount VO, Vulcan UR and Vampire/ Valkyrie OD (LOGGS). Decommissioning Environmental Report J/1/20/2342
Gardline Environmental, 2006	Gardline Environmental, 2006. SNS 2006 pipeline inspection inshore survey, June / July 2006 survey
Titan, 2014	ConocoPhillips (U.K.) Limited 2014 Theddlethorpe Pipeline Survey. Titan Report Reference CS0446A/R1/V1
ERT, 2010	ConocoPhillips Theddlethorpe Environmental Survey. September 2010. Summary of survey and results.



Sources: OGA, 2017; UK oil and gas data, 2017

Figure 4.1: Location of the SNS VDP2 and VDP3 infrastructure to be decommissioned

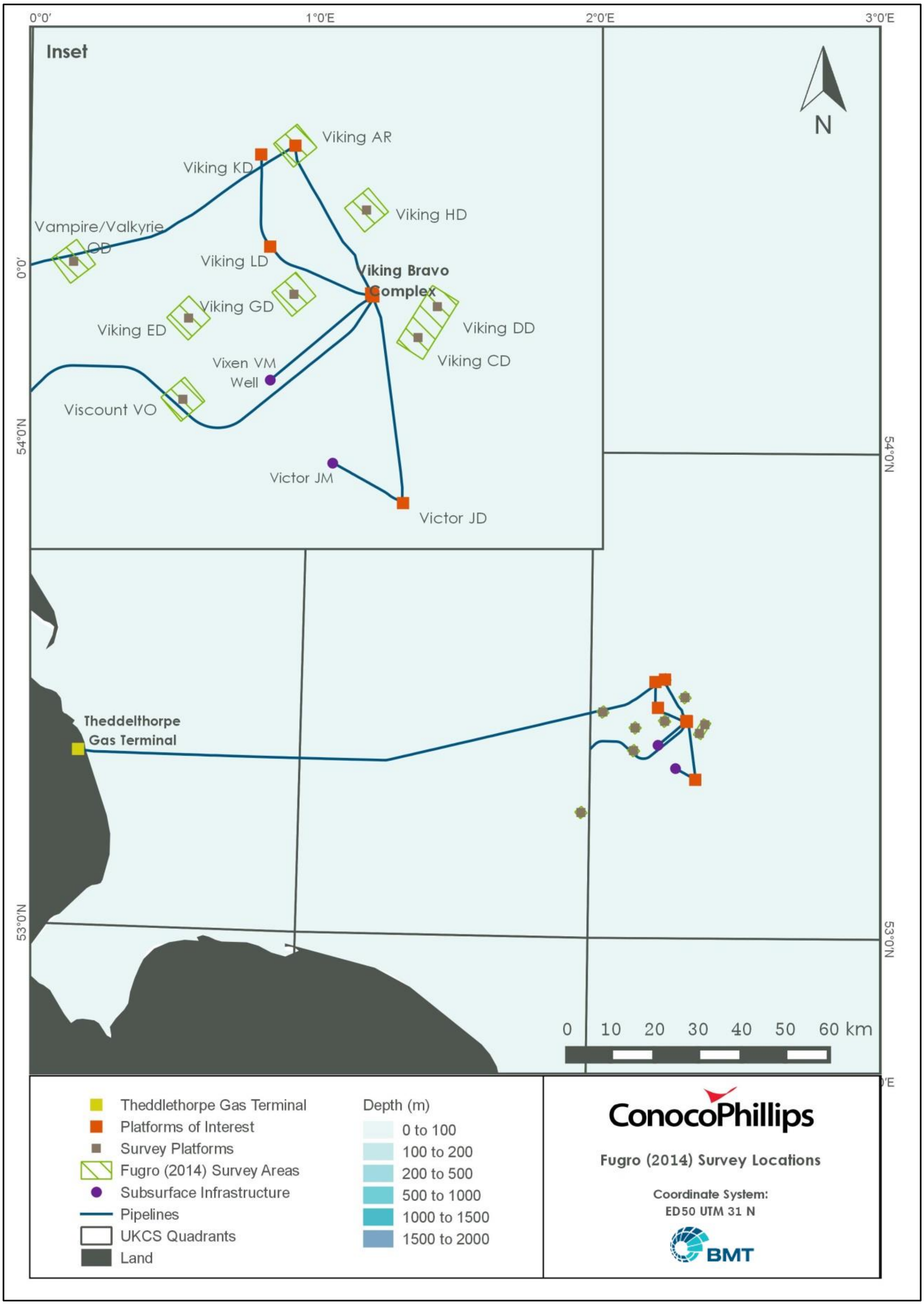
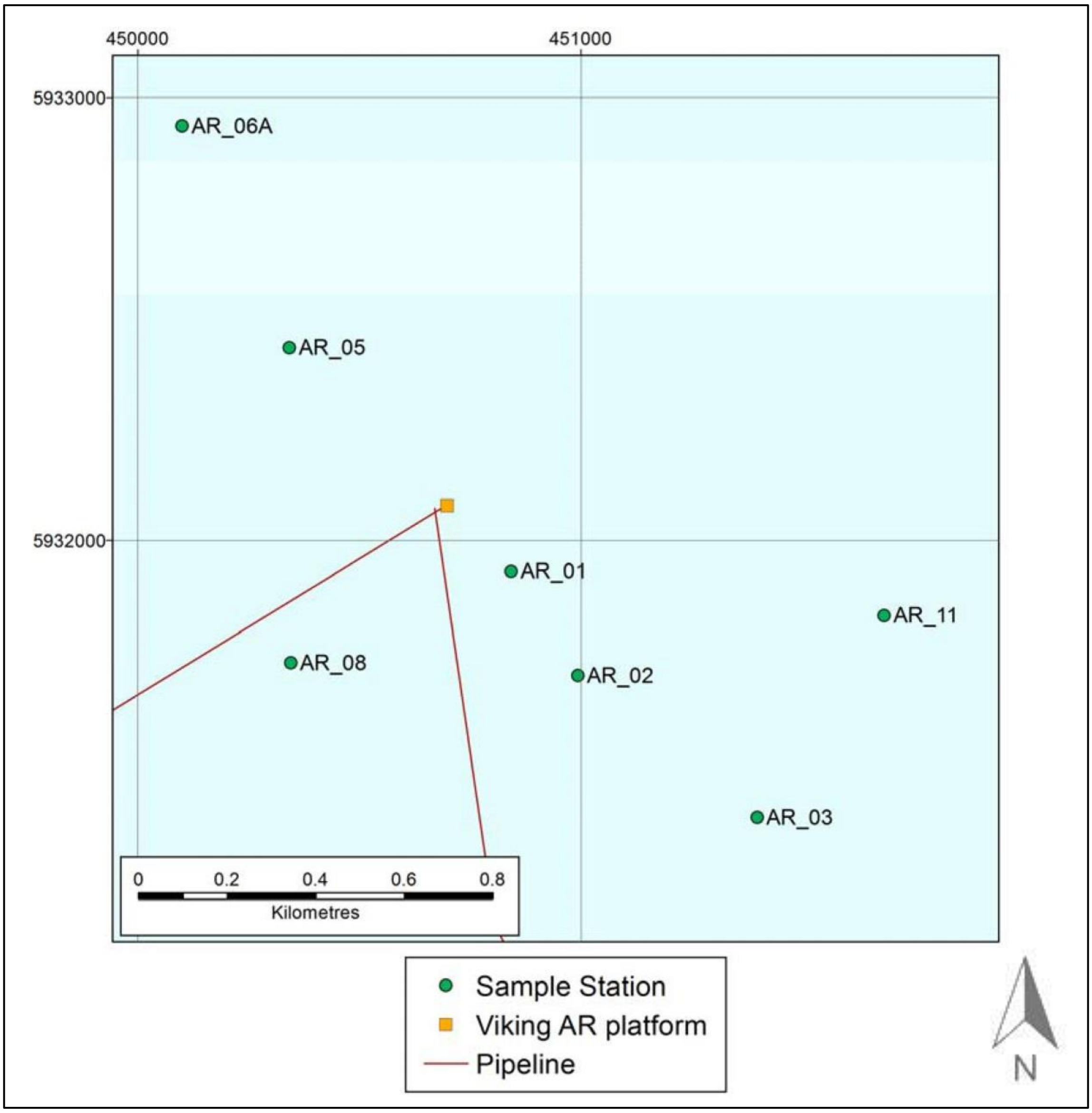


Figure 4.2: Location of the ConocoPhillips surveys undertaken in the immediate vicinity of VDP2 and VDP3



Source: Fugro, 2014a

Figure 4.3: Sample locations around Viking AR

4.1 Physical Environment

4.1.1 Bathymetry

Site specific surveys undertaken within 2 x 2 km areas surrounding ConocoPhillips assets have previously been undertaken (Fugro, 2014a and 2014b). Only the survey around Viking AR is specific to the VDP2 and VDP3 programme. However, given the proximity (0.5 – 4.5 km) of all the surveys to the present concern, the associated geophysical information remains relevant here.

Water depths at the VDP2 and VDP3 offshore installation locations range from approximately 20 to 38 m Lowest Astronomical Tide (Table 4.2). The seabed surrounding Viking AR has depths ranging from 21 to 30 m, with an associated seabed gradient of 0.96º (Fugro, 2014c). At Viking CD (VDP1), 4 km SE of Viking BD, a similar depth range, 21 m, is observed within the 4 km^2 surrounding the installation. Here the depth range extends from 15 to 36 m with a mean gradient of 1.6º (Fugro, 2014c).

Further, 5 km, to the west of Viking BD, there is a smaller depth variation, 11 m, within the Viking GD survey area. Here the depth range is between 19 and 30 m with an associated mean gradient of 2.03º (Fugro, 2014c).

The depth variation within the survey areas is considered to be directly related to the presence and location of bathymetric features, such as sandbanks, sandwaves and sandbars.

Table 4.2: Water depths at the VDP2 and VDP3 offshore installation locations

Decommissioning programme	Surface/ subsea installation	Approximate water depth (LAT) (m)
VDP2	Viking KD	25.0
	Viking LD	20.0
	Viking AR	25.0
	Viking BA	24.0
	Viking BC	24.0
	Viking BP	24.0
	Viking BD	24.0
	Vixen VM manifold	32.1
	Vixen VM/ Victoria SM tee-piece	23.7
	Viking KD/ Viking LD tee-piece	19.9
VDP3	Victor JD	38.0
	Victor JM manifold	30.1
	Victor JM pigging skid	36.0

The water depth along the PL27/ PL161 pipelines connecting the Viking AR platform (approximately 25 m) to TGT decreases with proximity to the shoreline (ConocoPhillips, 2014d). The decrease in water depth along the pipeline route is not gradual and exhibits some sudden changes, with distinct variations in water depth resulting from the presence of large and medium scale features, for example sand waves, megaripples, sand ripples (Gardline Environmental, 2006; ConocoPhillips pipeline surveys; Environment Agency, 2008, 2012 and 2013). These are all evidence of the highly dynamic nature of the seabed present across the southern North Sea area (Fugro, 2014a and 2014b). These variations may also be attributed to the pipeline crossing the tail of Silver Pit, a bathymetric depression which reaches depths of up to 100 m (Proctor *et al*., 2001).

The landfall of the PL27/ PL161 pipelines at Theddlethorpe lie within the tidal ramparts of the Humber Estuary where a wide, sandy intertidal zone merges with the subtidal Haile Sands (ABPmer, 2012). Much of the beach between Mean High Water Springs and Mean High Water Neaps is covered by saltmarsh, protected from wave action by the nearshore bar system (ABPmer, 2012). The coastal extent between Donna Nook to the north and Mablethorpe to the south can be characterised as accreting, with a net accretion rate of 2.3 m/ year over the last 200 years (Halcrow, 2004). A detailed coastal characterisation undertaken for the Humber Marine Aggregate Regional Environmental Assessment (MAREA) indicates that sediment exchanges occur between the coast and nearshore banks (ABPmer, 2012). Further, the coast is vulnerable to changes in both the wave height and sediment supply.

4.1.2 Seabed sediments

The VDP2 and VDP3 offshore infrastructure lie in an area of the SNS where sediment comprises 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% (Fugro, 2014a and 2014b). The dynamic marine environment is thought to have resulted in the redistribution of drill cuttings piles from around wellheads in the vicinity of the VDP2 and VDP3 installations.

Sediments around Viking AR, in the vicinity of the offshore section of PL27/ PL161 pipelines, are very poorly to moderately well sorted, medium sand to very fine gravel. Levels of clay and organic matter around Viking AR were low, 0.3% and 0.5%, respectively.

Results from the Fugro surveys conducted around other platforms in close proximity to VDP2 and VDP3 locations provide an indication of the expected sediments in that area (Fugro, 2014a, 2014b, 2014c and 2014d). The seabed characteristics at the sampling stations were consistent with the wider region. The survey results indicate that the sediments offshore are expected to be very poorly to moderately well sorted, fine sand to fine gravel, with low silt/ clay and organic matter content (Fugro, 2014a and 2014b).

Surficial seabed sediments at the TGT approaches of the PL27/ PL161 pipelines are comprised of gravelly sand (gS) and sandy gravel (sG), with the latter being located towards the 12 nm limit off TGT (BGS, 2015). These Holocene derived sediments overlay bedrock primarily composed of chalk (BGS, 2015). Site specific surveys concur with this regional synopsis, indicating that the sediment type is moderately sorted fine sand (ERT, 2010).

4.1.3 Sediment chemistry

Gas chromatographic profiles of the surface sediments were found to be similar across the wider Viking survey areas, and indicated that the hydrocarbons present in the sediments were derived from a combination of weathered petroleum residues and a range of biogenic hydrocarbons typical of background southern North Sea sediments (Fugro, 2014a).

The total hydrocarbon concentrations (THC) at Viking AR were low, with exception of station AR_05, were higher level of THC indicated diesel-like input to the sediment (Table 4.3). The THC values were also lower than the average background concentrations calculated from the environmental survey data collected between 1975 and 1995 in the southern North Sea (Fugro, 2014a).

Total organotin (Mono/Di/Tributyltin) levels were below the limit of detection for all Viking samples analysed. The concentration of metals in the sediments at stations around Viking AR showed relatively high variation (Fugro, 2014a). The highest levels for the most elements were detected at station AR_01, the closest to the Viking AR platform.

The concentrations of metals in the sediments across wider Viking area were relatively constant, except one sampling station at Viking GD (located approximately 3.5 km south of Viking LD) which showed elevated levels of several metals (arsenic, barium, lead, vanadium, copper and zinc) analysed compared to other GD samples (Table 4.3). This may be related to previous drilling related discharges at this location; however, no obvious cuttings piles were evident on the seabed (Fugro, 2014a).

Comparison of the metals concentrations with the cited data (e.g. UKOOA (2001); OSPAR, (2005)) indicates that the survey data are within the range of natural background concentrations for the region and well below the lowest effects range (ERL, Table 4.3) (Fugro, 2014a).

Current (2010) THC levels at the TGT approaches of the PL27/ PL161 pipelines remain comparable both to levels measured in 1997 and also background concentrations cited for the North Sea (ERT, 2010). Both the levels and hydrocarbon profiles are not considered to indicate that the TGT has contributed any contaminants to the marine sediments. Further, total phenol content was assessed to be below the methodology's limit of detection (LOD).

With respect to heavy metals, concentrations are typically comparable to those previously measured around TGT. Further, the ERT (2010) study concluded that the concentrations were less than, or comparable to, the mean southern North Sea values for:

- All studies undertaken between 1975 and 1995;
- Upper European Amino-Carboxylate (EAC) levels; and
- Background/ Reference Concentrations (BRC) and North Sea Task Force (NSTF) 1993 levels.

The Uranium 238 (^{238}U) and Thorium 232 (^{232}Th) decay chain radionuclides are representative of natural environmental levels, and as such it is considered that there is no impact from an accumulation of either produced water or scale discharges (ERT, 2010).

4.1.4 Waves

Offshore, significant wave heights in the vicinity of the VDP2 and VDP3 infrastructure exceed 2.5 m for only 10% of the year. However, there is evidence of considerable seasonal variation between sea states, with waves in excess of 4 m recorded for 15% of the time in autumn and winter, but only 2% of the time in summer. Wave direction is variable throughout the year, but in the later part of the year these are predominantly from the southwest (ConocoPhillips, 2005).

Close to shore where TGT is located, the metocean regime is strongly influenced by the presence of the North Norfolk and Lincolnshire coastlines which act to limit fetch distances. The annual significant wave height close to TGT is of the order of 0.59 m, with a maximum mean wave height (Hmax) of 0.92 m (Environment Agency, 2012). In the coastal waters surrounding TGT, the predominant wave direction is from the north-east and easterly directions, resulting in a net southerly sediment transport (Environment Agency, 2012; Brampton and Bevan, 1987).

Table 4.3: Specific chemistry information from sediment grabs from offshore platform locations

Reference	THC	As	Cr	Ni	Cu	Zn	Cd	Hg	Ba	Pb
Central North Sea (µgg^{-1} dry weight) (Min- Max range)										
Offshore (CEFAS, 2001)	17 - 120	-	-	9.5	3.96	20.87	0.43	0.16	-	-
Oil and Gas Installations (CEFAS, 2001)	10 - 450	-	-	17.79	17.45	129.74	0.85	0.36	-	-
Background Concentration (UKOOA, 2001)	9.41 (40.10)	-	9.1 (31)	11.46 (21.75)	6.32 (18.00)	21.28 (43.40)	0.76 (1.00)	0.76 (1.00)	348.47 (720.00)	
Background Concentration (OSPAR, 2005)	-	15	60 - 81	30 - 36	20	90	0.2	0.06	-	-
Effects Range – Low (ERL)	-	-	81	-	34	150	1.20	0.15	-	47
VDP2 and VDP3 offshore infrastructure										
Viking AR (Block 49/12)	0.6 -2.8	10.2 -15.9	4.01 -5.90	2.89 - 5.48	0.83 - 4.85	10.4 - 58.7	0.01	<0.02 - 0.12	4.79 - 54.3	4.13 - 8.84
VDP1 and LDP1 offshore infrastructure located in close vicinity to VDP2 and VDP3 infrastructure										
Viking CD (Block 49/17)	0.5 - 2.0	11.13 - 15.9	4.33 - 5.03	2.28 - 2.91	0.57 - 0.91	8.87 - 10	0.01	<0.02	2.49 - 4.83	3.44 - 4.15
Viking GD (Block 49/17)	0.5 - 3.3	14.1 - 32.3	3.64 - 4.62	1.97 - 2.71	0.46 - 2.31	7.33 - 20.2	0.01	<0.02	3.17 - 10.8	3.39 - 6.55
Vampire/ Valkyrie OD (Block 49/16)	2.1 -5.5	14 - 43.2	3.88 - 6.23	2.20 - 4.23	0.77 - 1.92	9.43 - 20	0.01 - 0.02	<0.02	3.31 - 5.46	3.42 - 7.78
Notes: (-) means no data currently available. UKOOA (2001) values are mean with the 95th percentile shown in parenthesis.										

Source: Fugro, 2014a; Fugro, 2014d; CEFAS, 2001; UKOOA, 2001; OSPAR, 2005

4.1.5 Water circulation and tides

The VDP2 and VDP3 offshore infrastructure is located in an area influenced by southern North Sea current and the Channel current. The cyclonic, counter current created from the ingress of water through the channel drives the near surface current towards a more easterly direction. The shallower waters of the southern North Sea remain permanently mixed throughout the year due to the influence of tidal currents (OSPAR, 2000). This prevents the formation of a thermocline and results in a highly dynamic marine environment (Lee and Ramster, 1981).

Tidal current velocities over the VDP2 and VDP3 offshore area are stronger than those in the northern (0.11 to 0.25 m/s) and central (0.18 to 0.36 m/s) North Sea, at between 0.39 m/s (neap tides) and 0.86 m/s (spring tides) (ABPmer, 2008).

Currents in the vicinity of the sandbanks can be highly affected by their presence. Indeed, residual currents near the seabed have been shown to be strongest towards the crest of a sandbank and in opposing directions on either side of the bank running in a clockwise direction, i.e. from southwest on the southern side and from the northwest on the north residual circulation around the bank. Episodic currents, induced by wave action and storm surges, also influence sandbank development (ConocoPhillips, 2005).

Spring tidal ranges close to shore are of the order of 5.2 m, indicating a macro-tidal regime (Environment Agency, 2012). Approximately rectilinear tidal currents are southerly on the flood and northerly on the ebb, with associated tidal speeds of 0.5 to 0.75 m/s (ABPmer, 2008). These tidal currents can be characterised as moderate, with the relative strength increasing offshore (ABPmer, 2012). The net flood tidal currents to the south also contribute to the net southerly sediment transport (ABPmer, 2012).

4.1.6 Suspended sediments

The level of suspended sediments within the water column is directly related to the availability of material to be suspended, and the ability of the metocean (wave and tide) regime to mobilise and transport the sediment. When combined with the energetic wave and tide conditions (Section 4.1.4 and 4.1.5), the sandy sediments of the VDP2 and VDP3 area are susceptible to suspension and mobilisation. Storm surges will further enhance sediment transport, resulting in considerable increases in suspended sediments (ABPmer, 2011).

The Humber Plume, a natural phenomenon primarily comprised of fluvial sediments and influenced directly by the energetic metocean conditions, originates from the Humber and travels south, past TGT, far as the Wash and the North Norfolk coast. The plume is largely confined to within 20 km of the shoreline exhibiting seasonal variability such that high suspended sediment concentrations (> 40 mg/l) could occur during the winter, with much lower value concentrations (<7 mg/l) occurring in the summer period (Eggleton *et al*., 2011; ABPmer, 2011).

4.1.7 Water quality

The Environment Agency routinely assesses water quality at designated English bathing water sites. The latest (2014) annual rating for the bathing water sites located on the coast to the north and south of TGT is ‘excellent’ and has been assessed against the new 2015 Bathing Water Directive which has been in implementation since 24 March 2015 (Environment Agency, 2015).

4.1.8 Sea temperature and salinity

Sea temperature and salinity affects both the properties of the seawater and the fate of spills or discharges into the environment. Generally, areas south of 54º N remain vertically mixed all year round with little evidence of thermal stratification often seen in deeper water to the north. This is a result of the shallower water in the southern North Sea being susceptible to tidal stirring which is sufficient to overcome the inputs of thermal energy (ConocoPhillips, 2003 and 2005). Due to the mixing at these shallow depths there is little variation in salinity with depth.

Mean sea surface temperature across the VDP2 and VDP3 offshore areas is around 14.5 to 15°C in summer and 5°C in winter. Mean bottom sea temperature is approximately 15°C in summer and 5°C in winter (UKDMAP, 1998). Regional datasets indicate that seawater temperatures within the coastal waters exhibit little variation throughout the water column (UKDMAP, 1998). Published values indicate mean sea temperatures vary with season, ranging from 15°C in summer to 5°C in winter (UKDMAP, 1998). The Channel Coastal Observatory (CCO) network of wave buoys records sea temperature information around the English coastline. A CCO buoy positioned in a 5 m water depth off the Theddlethorpe coast has recorded seasonal variability in sea surface temperature (Table 4.4).

The mean sea surface salinity across the VDP2 and VDP3 offshore areas during winter is around 34.5 ppt decreasing to 34.25 ppt closer to shore (UKDMAP, 1998). In summer, the mean sea surface salinity decreases from 34.75 ppt offshore to 34.25 ppt closer to shore (UKDMAP, 1998).

Table 4.4: Monthly mean sea surface temperatures at a buoy in five metre water depth offshore from Theddlethorpe for the period October 2008 to September 2009

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Temperature (°C)	3.9	4	6.3	9.1	12.2	15.3	17.4	17.7	15.5	11.8	8.4	5.1

Source: Environment Agency, 2012

4.1.9 Wind

Figures 4.4a and 4.4b illustrate the seasonal wind roses for the VDP2 and VDP3 offshore area. These are derived from data presented in the ConocoPhillips Valkyrie extension ES (ConocoPhillips, 2003), which is located within the Viking offshore area.

Although there is some seasonal variation in wind direction the predominant wind direction is south-westerly. From April to July the prevailing wind directions are north-northeast (ConocoPhillips, 2003).

Regional assessments indicate that the annual wind speeds in the VDP2 and VDP3 coastal area are <8.5 m/s, with seasonal variability ranging such that winter wind speeds are approximately 9.5 m/s (ABPmer, 2012). Along the coast, offshore winds prevail from the southwest/ west and are typically <7.5 m/s. Whilst onshore winds originating from the northeast are stronger (often >13.9 m/s), they are less frequent than those from the offshore area (Montreuil and Bullard, 2011).

The wind regime has the potential to greatly influence the tidal regime through the generation of storm surges. These may be generated through either changes in atmospheric pressure and/ or increased wind stress upon the sea surface. The southern North Sea is regularly exposed (Heaps, 1983) to storm surge events during which current speeds will increase with subsequent increases in sediment transport. During a typical 1 m surge, there can be a doubling of normal current speeds accompanied with a 10-fold increase in suspended sediment transport rates (HR Wallingford, 2002).

4.1.10 Air quality

An understanding of the existing air quality in the area of a development is useful when assessing the potential future impact upon air quality from the proposed operations. However, data on air quality offshore is limited. Emissions of CO_2, oxides of nitrogen (NO_x) and oxides of sulphur (SO_x) will result from power generation from vessels during operations. Further information on air quality and energy and emissions is provided in Section 8.

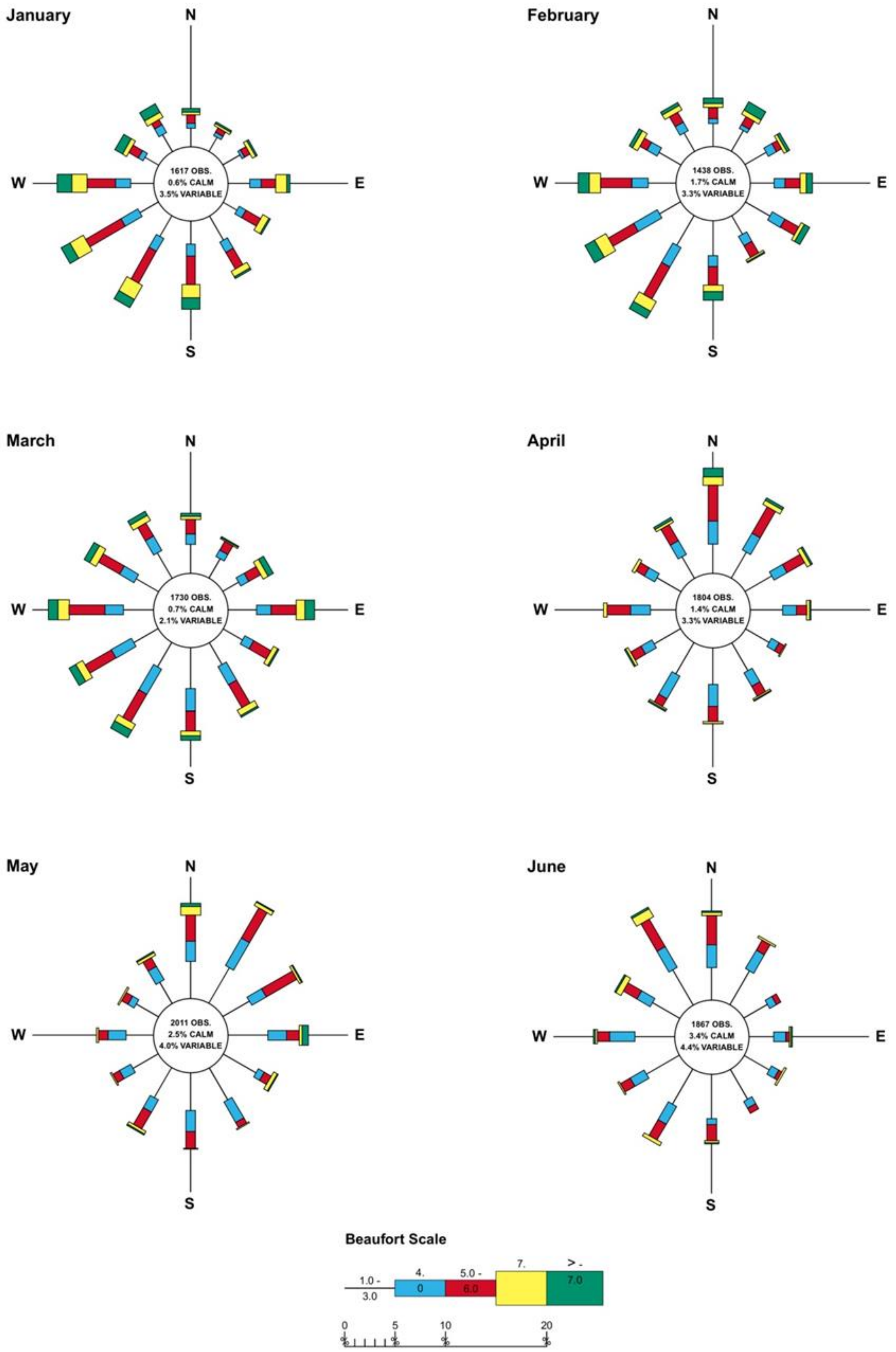


Figure 4.4a: Seasonal wind roses for the Viking offshore area (January to June)

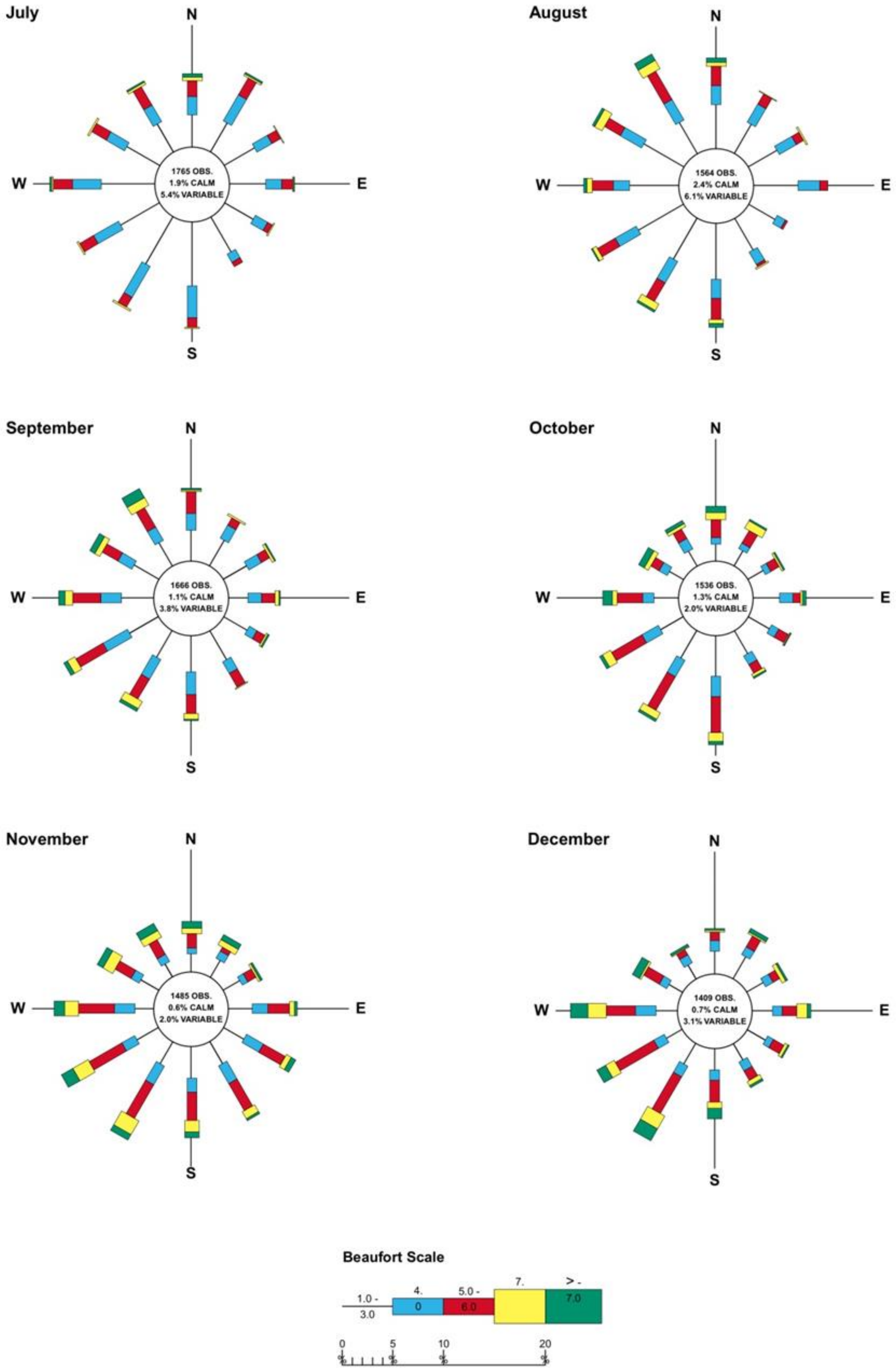


Figure 4.4b: Seasonal wind roses for the Viking offshore area (July to December)

4.2 Biological Environment

4.2.1 Benthic fauna

The seabed habitat around Viking AR and of the wider Viking area adjacent to the VDP2 and VDP3 offshore areas is classified using the European Nature Information System (EUNIS) code A5.2: “Sublittoral, clean medium to fine or non-cohesive slightly muddy sands on open coasts, offshore or in estuaries and marine inlets”. This shallow-water infaunal assemblage is typically characterised by taxa including polychaetes, bivalve molluscs and amphipods and crustaceans (Fugro 2014a and 2014b).

Macrofaunal analysis across the Viking AR area identified sub-biotopes of the habitat classification A5.252: “*Abra prismatica, Bathyporeia elegans* and polychaetes in circalittoral fine sand” and A5.26: “Circalittoral muddy sand” (Fugro, 2014b).

Numbers of taxa, individuals and diversity across the sampling locations of the 2013 surveys (Fugro 2014a and 2014b) were low to moderate. Dominant taxa across the Viking AR and wider Viking area adjacent to VDP2 and VDP3 offshore area, were typical of the mobile sand and coarser sediments present across the decommissioning area, namely the polychaetes *Ophelia borealis*, *Nephtys cirrosa*, several species of *Spio* and crustacean from the genera *Bathyporeia* and *Urothoe*. All species identified are representative of the general area, sediment type and water depth.

The EUNIS classification of the seabed habitat along the PL27/ PL161 pipelines, including the coastal extent is infralittoral coarse sediment (Classification A5.13).

Sabellaria spinulosa were identified in several historical survey reports within and adjacent to the areas containing VDP2 and VDP3 infrastructure (Conoco, 1998 and 2002; ConocoPhillips, 2005 and 2008; Venture, 2006). There was evidence in the Fugro (2014a and 2014b) reports of *S. spinulosa*; however, this was sparse and fragmented. Indications from the reviewed reports show that there is a high probability of *S. spinulosa* across the region. JNCC Report No. 405 provides definitions for the classification of *S. spinulosa* “reef”. These are based on the spatial extent (must be greater than 25 m^2) and patchiness (greater than 10% coverage in an area), elevation above seabed level (greater than 2 cm in height), density of *S. spinulosa* present, biodiversity and longevity/ restoration potential (JNCC, 2007). Based on these definitions the small fragmented patches of *S. spinulosa* would not constitute a reef. However, analysis of the ROV pipeline inspection footage for all VDP2 and VDP3 pipelines, carried out for the purposed of the pipelines and mattress status report (BMT Cordah, 2015c), identified large aggregations of *S. spinulosa* especially along KP18 of the pipeline PL27 within North Norfolk Sandbanks and Saturn Reef SAC. Initial indications from the 2015 survey footage for this are that these areas of *S. spinulosa* are no longer present or are buried by sediment.

4.2.2 Fish and shellfish

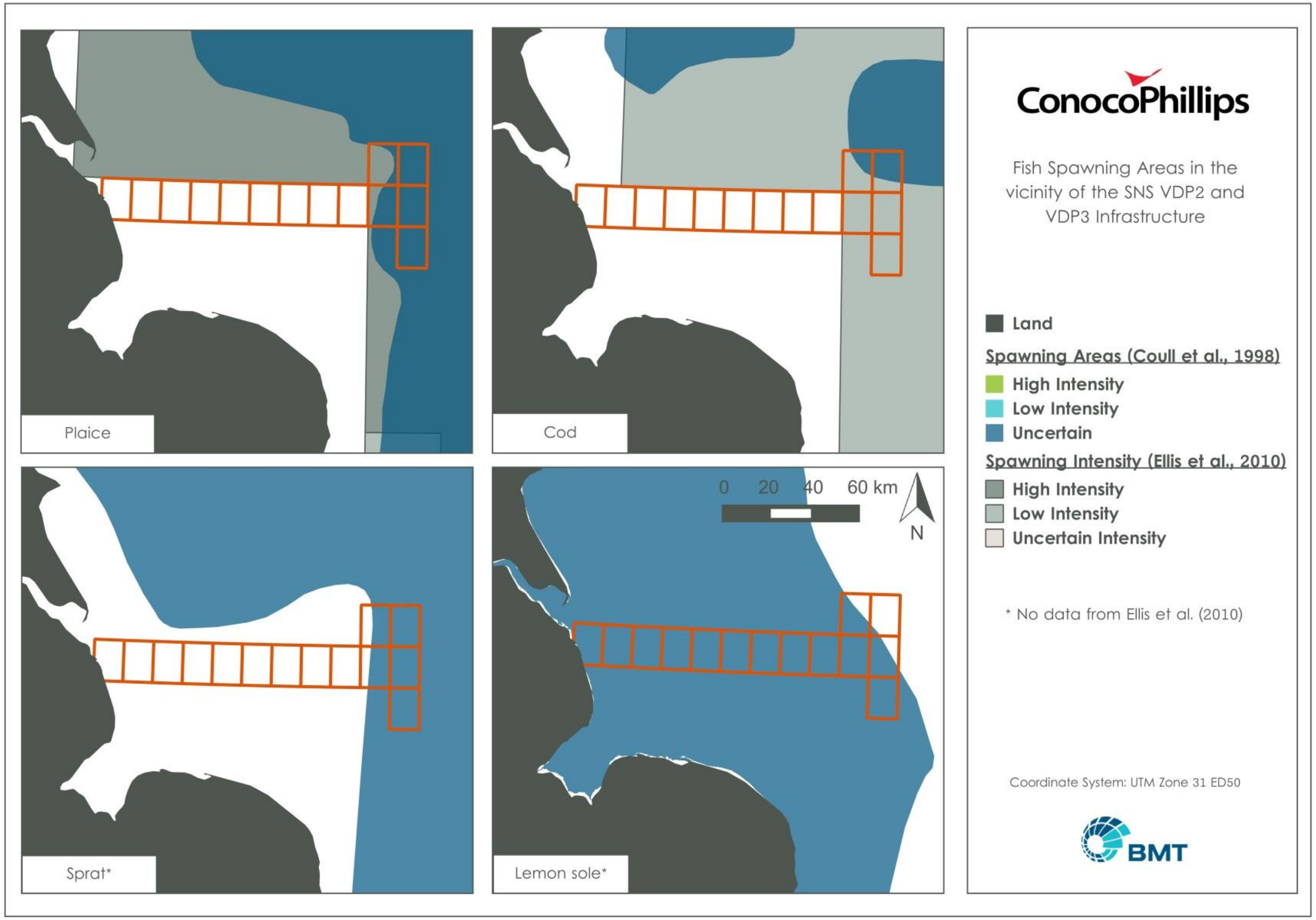
The infrastructure to be decommissioned under VDP2 and VDP3 are located within International Council for the Exploration of the Sea (ICES) Rectangles 35F0, 35F1, 35F2 and 36F2. These ICES rectangles coincide with spawning grounds for mackerel (*Scomber scombrus*; May to August), cod (*Gadus morhua*; January to April), plaice (*Pleuronectes platessa*; January to March), lemon sole (*Microstomus kitt*; April to September), sole (*Solea solea*; March to May), sandeel (*Ammodytidae* sp.; November to February), sprat (*Sprattus sprattus*; May to August), herring (*Clupea harengus*;

November to January) and *Nephrops* (*Nephrops norvegicus*; throughout the year). The area is considered to be a part of an important spawning area for plaice and sandeel, with a relative high intensity spawning recorded from the ICES fish survey data (Ellis *et al*., 2010; Coull, *et al*., 1998) (Figures 4.5 and 4.6). Figures 4.5 and 4.6 present both the Coull *et al*. (1998) and the Ellis *et al*. (2010) indicative areas of spawning grounds. Where areas of presence from all data sets overlap there is a greater probability that the area is a spawning ground. The Ellis *et al*. (2010) data provide an insight into the intensity of the spawning areas based on the data gathered from research surveys conducted within ICES rectangles in the area.

The VDP2 and VDP3 infrastructure also lie within the nursery grounds for anglerfish (*Lophius piscatorius*), spurdog (*Squalus acanthias*), thornback ray (*Raja clavata*), mackerel, herring, cod, haddock (*Melanogrammus aeglefinus*), whiting (*Merlangius merlangus*), plaice, lemon sole, sandeel, *Nephrops*, tope shark (*Galeorhinus galeus*), Norway pout (*Trisopterus esmarkii*), sprat, sole and horse mackerel (*Trachurus trachurus*) (Aires *et al*, 2014; Ellis *et al*., 2010; Coull, *et al*., 1998) (Figures 4.7 to 4.9). These species are present throughout the year.

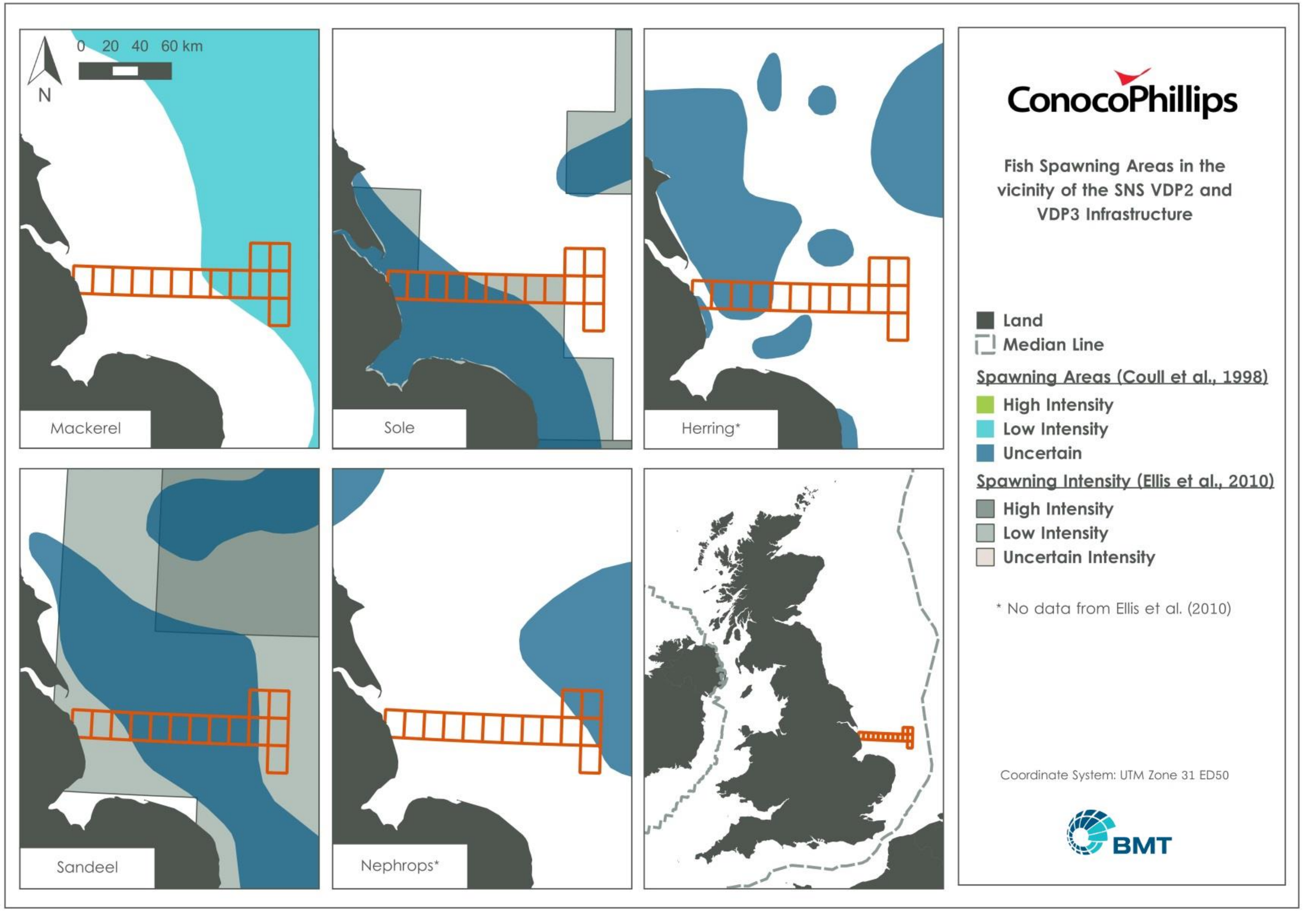
In the vicinity of VDP2 and VDP3 recent data indicates the probable presence of Age 0 group fish (Aires *et al*., 2014). Age 0 group fish are defined as fish in the first year of their lives or those that can be classified as juveniles. The predictive model for this group uses previously identified nursery grounds data from Coull *et al*. (1998), combined with environmental habitat variables. The results provide the probability of the presence of Age 0 group fish within areas that have defined and predictable environmental habitat specifications for the development of juveniles.

The likelihood of Age 0 group fish species in the vicinity of VDP2 and VDP3 infrastructure are shown within Figures 4.7 to 4.9 alongside data from Coull *et al*. (1998) and Ellis *et al*. (2010), which show indicative nursery grounds. Where areas of presence from all data sets overlap there is a greater probability that the area is a nursery ground. The Ellis *et al*. (2010) data provide an insight into the intensity of the nursery areas based on the data gathered from research surveys conducted within ICES rectangles in the area.



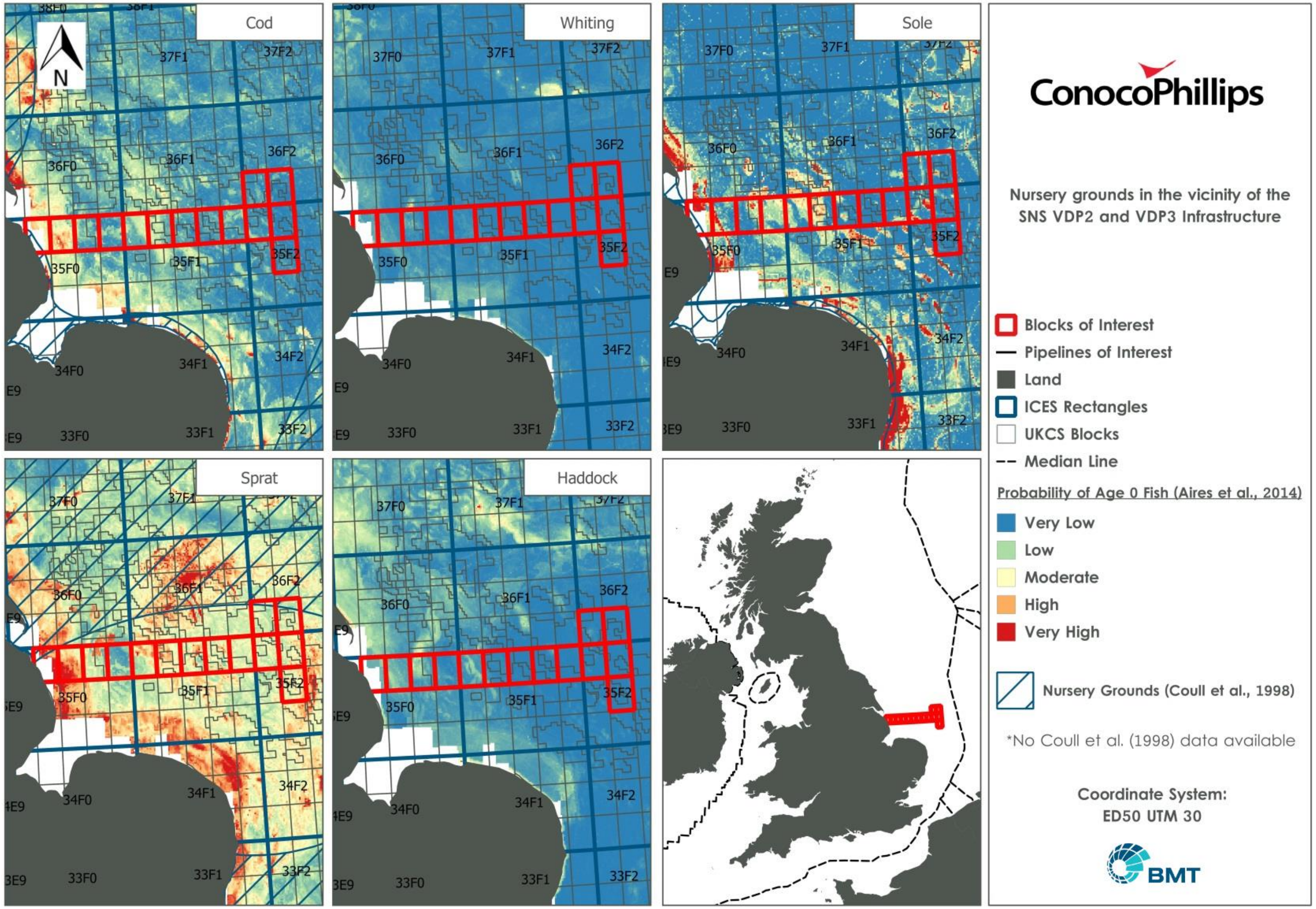
Sources: OGA, 2017; UK oil and gas data, 2017; Coull *et al*., 1998; Ellis *et al*., 2010

Figure 4.5: Spawning grounds for plaice, cod, sprat and lemon sole in the vicinity of VDP2 and VDP3



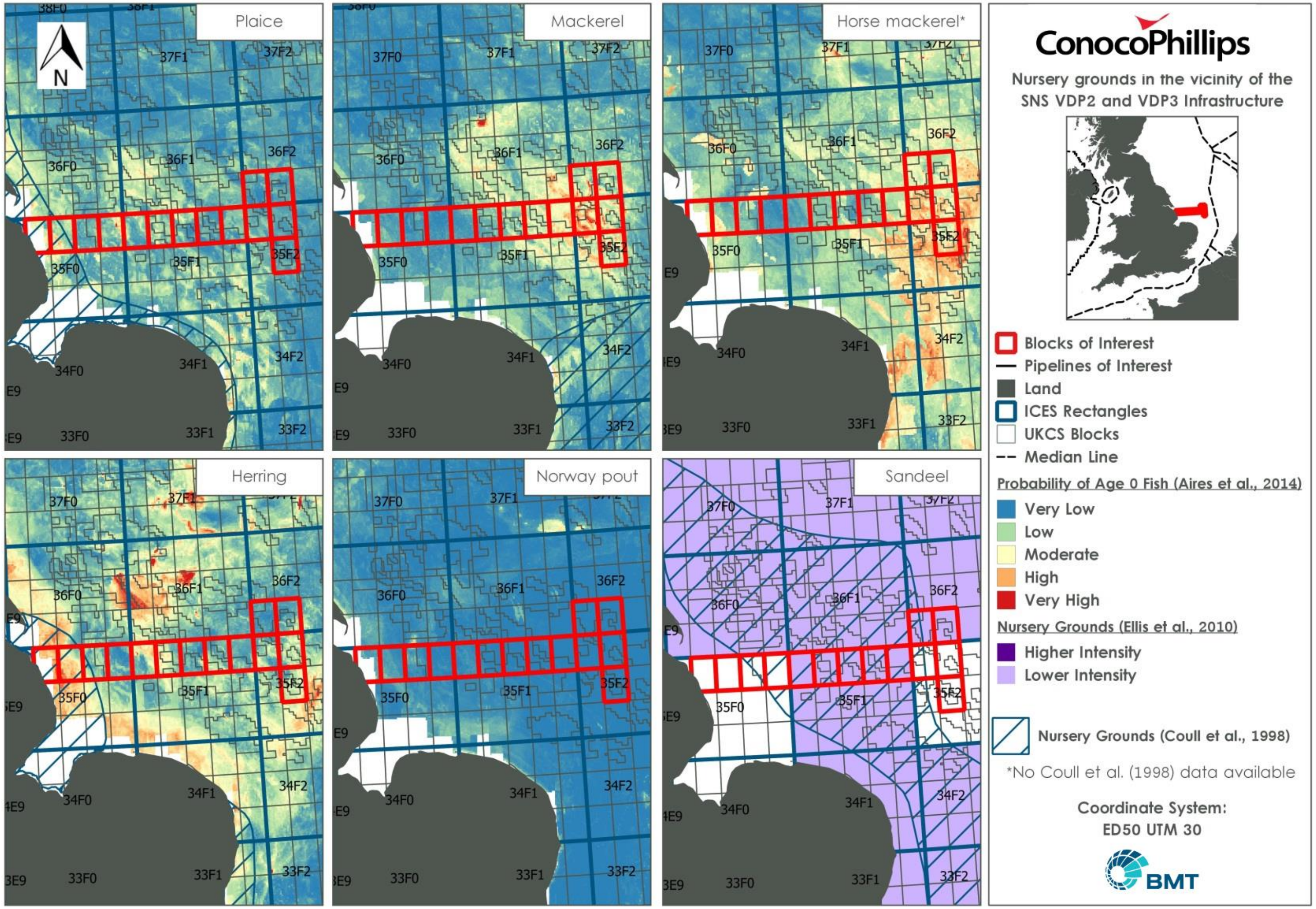
Sources: OGA, 2017; UK oil and gas data, 2017; Coull *et al*., 1998; Ellis *et al*., 2010

Figure 4.6: Spawning grounds for mackerel, sole, herring, sandeel and *Nephrops* in the vicinity of VDP2 and VDP3



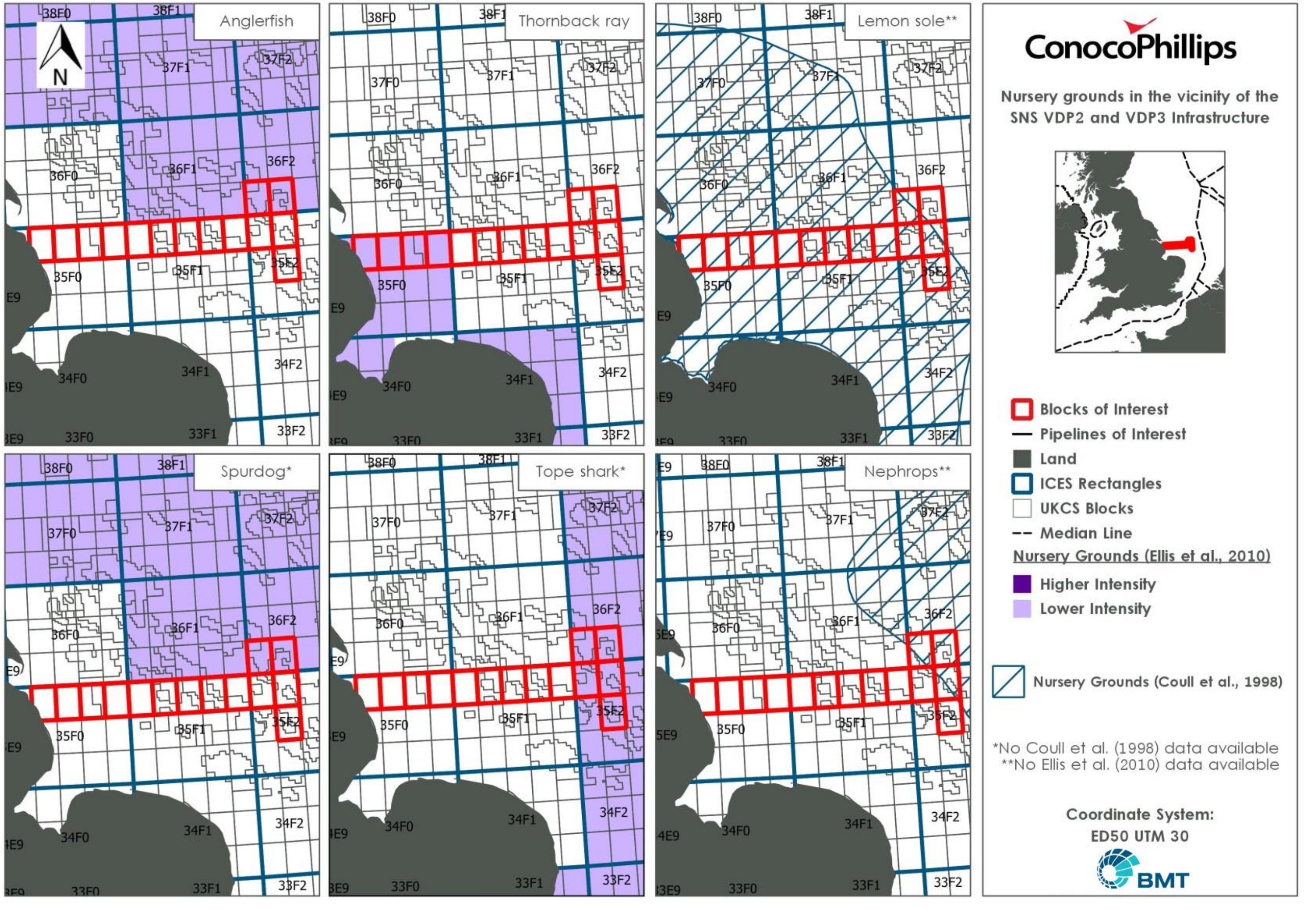
Sources: OGA, 2017; UK oil and gas data, 2017; Coull *et al*., 1998; Aires *et al*., 2014

Figure 4.7: Nursery grounds and probability of Age 0 fish for cod, whiting, sole, sprat and haddock in the vicinity of VDP2 and VDP3



Sources: OGA, 2017; UK oil and gas data, 2017; Coull *et al*., 1998; Ellis *et al*., 2010; Aires *et al*., 2014

Figure 4.8: Nursery grounds and probability of Age 0 fish for plaice, mackerel, horse mackerel, herring, Norway pout and sandeel in the vicinity of VDP2 and VDP3



Sources: OGA, 2017; UK oil and gas data, 2017; Coull *et al*., 1998; Ellis *et al*., 2010

Figure 4.9: Nursery grounds for anglerfish, thornback ray, lemon sole, spurdog, tope shark and *Nephrops* in the vicinity of VDP2 and VDP3

4.2.3 Seabirds

Seabirds found in offshore North Sea waters include Fulmars (*Fulmarus glacialis*), gannets (*Morus bassanus*), auks, gulls, and terns (DTI, 2001), while coastal regions accommodate their breading colonies (DTI, 2002). The Norfolk coast accommodates one of the most important breeding areas for waders, featuring estuarine shingle structures and beaches, sand dunes and salt marshes (DTI, 2002). In general, offshore areas of the North Sea contain peak numbers of seabirds following the breeding season and through winter, with birds tending to forage closer to coastal breeding colonies in spring and early summer (DTI, 2001).

The East Inshore and East Offshore Marine Plans (MMO, 2017a) indicate a clear seasonality in seabird density within the decommissioning area. Summer density is typically less than 5 seabirds per km^2 offshore, increasing to 5 to 10 seabirds per km^2 towards the PL27/ PL161 pipeline landfalls. Winter density is typically less than 5 seabirds per km^2 offshore, increasing to 10 to 20 seabirds per km^2 towards the PL27/ PL161 pipeline landfalls. This estimate is based on information from the combined work of the MMO and JNCC looking at the Special Protected Areas (SPAs) in UK waters and the 25 species that breed regularly in UK waters (MMO, 2017a).

Oil and Gas UK commissioned HiDef, a consultancy specialising in a digital aerial video and image analysis, to produce the Seabirds Oil Sensitivity Index (SOSI), a tool designed to aid planning and emergency decision making with regards to oil pollution (Webb *et al.*, 2016; Table 4.5). SOSI identifies sea areas with highest likelihood of seabirds becoming sensitive to oil pollution. It is based on 1995 to 2015 seabird survey data, extending beyond UKCS. The offshore sensitivity index is based upon the following factors (Certain *et al*., 2015):

- habitat flexibility (an ability of species to relocate to alternative feeding ground);
- adult survival rate;
- potential annual productivity;
- proportion of the biogeographical population in the UK.

Seabird sensitivity to oil in and around the Blocks of interest is recorded in Table 2.5. In the Blocks of interest themselves, sensitivity ranges between low and extremely high for the months where data are available (Table 2.5). Data entered in red indicate where extrapolation of SOSI scores has been made in light of coverage gaps, following methodology recommended by JNCC (Webb *et al*., 2016). The periods of high to very high sensitivity can be attributed to moulting of some of the species and foraging or feeding behaviour (Webb *et al*., 2016).

According to the Marine Management Organisation's (MMO) East Inshore and Offshore Marine Plans (MMO, 2017a), there are estimated to be low occurrences of overlapping foraging ranges (between 2 and 7 foraging ranges) in the vicinity of the VDP2 and VDP3 decommissioning areas, with the highest overlap nearshore reducing to the lower end of the range further offshore.

Table 4.5: Seabird vulnerability within the VDP2 and VDP3 decommissioning area

Block	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
47/17	4	4	3	5	5	5	5	5	5	2	2	2
47/18	4	4	2	5	5	5	5	4	4	1	2	2
47/19	3	3	2	5	5	5	5	4	4	3	1	2
47/20	3	4	2	5	5	5	5	4	4	3	1	2
48/16	3	4	3	3	5	5	5	4	5	4	2	3
48/17	3	3	3	3	5	5	5	3	4	2	1	3
48/18	1	2	3	3	5	5	5	3	3	1	1	1
48/19	1	1	3	3	3	5	5	3	3	1	1	1
48/20	1	1	1	ND	3	5	5	5	5	ND	1	1
49/11	1	1	1	ND	ND	1	1	5	5	ND	ND	1
49/12	ND	1	ND	ND	5	5	1	5	5	5	ND	1
49/16	2	2	2	ND	ND	5	1	5	5	ND	2	1
49/17	ND	1	2	ND	ND	2	2	5	5	5	ND	1
49/22	1	3	3	3	ND	5	5	5	3	3	1	1

KEY		
	1	Extremely high seabird vulnerability
	2	Very High seabird vulnerability
	3	High seabird vulnerability
	4	Moderate seabird vulnerability
	5	Low seabird sensitivity
	ND	No data
	X	Interpolated data where "X" represents the interpolated value

Source: Webb *et al*., 2016

Kober *et al*. (2010) analysed European Seabirds at Sea (ESAS) density data for seabirds within the British Fishery Limit to identify 'hotspots,' with a view to assigning these areas marine Special Protected Area (SPA) status (Section 4.3.2 provides more detail on SPA designation). Several hotspots for seabirds have been identified around UK, however, none of these overlap with the VDP2 and VDP3 areas. Although not identified as a potential SPA at the time, in 2018, the Greater Wash offshore SPA, which overlaps the export pipeline route, was designated for the protection of Red-throated Diver (*Gavia stellata*), Common Scoter (*Melanitta nigra*) and Little Gull (*Hydrocoloeus minutus*) during non-breading season and breeding Sandwich Tern (*Sterna sandvicensis*), Common Tern (*Sterna hirundo*) and Little Tern (*Sternula albifrons*) (JNCC, 2018a).

4.2.4 Marine mammals

Marine mammals include whales, dolphins and porpoises (cetaceans) and seals (pinnipeds). Marine mammals may be vulnerable to the effects of oil and gas activities and can be impacted by noise, contaminants, oil spills and any effects on prey availability (SMRU, 2001). The abundance and availability of prey, including plankton and fish, can be of prime importance in determining the numbers and distribution of marine mammals and can also influence their reproductive success or failure. Changes in the availability of principal prey species may result in population level changes of marine mammals but it is currently not possible to predict the extent of any such changes (SMRU, 2001).

Cetaceans

The main cetacean species occurring in the VDP2 and VDP3 decommissioning area (Quadrants 47, 48 and 49) are white-beaked dolphin (*Lagenorhynchus albirostris*) and harbour porpoise (*Phocoena phocoena*), with sightings occurring throughout the year. Further species observed in the surrounding areas include white-sided dolphin (*Lagenorhynchus acutus*), minke whale (*Balaenoptera acutorostrata*), long-finned pilot whale (*Globicephala melas*), bottlenose dolphin (*Tursiops truncatus*) and common dolphin (*Delphinus delphis*) (Reid *et al*., 2003; UKDMAP, 1998) (Table 4.6).

Table 4.6: Cetacean densities in Quadrants 47, 48 and 49

Species	J	F	M	A	M	J	J	A	S	O	N	D
Harbour porpoise		M	H	L	H	H	H	VH	H	L	M	L
White-beaked dolphin	M		VH	VH	L	H	L	L	M	M	H	L
Minke whale						L	L	L	L	L		
Long-finned pilot whale								L				
Bottlenose dolphin								L			L	
White-sided dolphin								L	L			
Common dolphin		L							M			

KEY				
		No sightings / no data	(green)	Sightings within Quadrants 47, 48 and 49
	L	Low densities	(blue)	Sightings in surrounding Quadrants
	M	Moderate densities		
	H	High densities		
	VH	Very high densities		

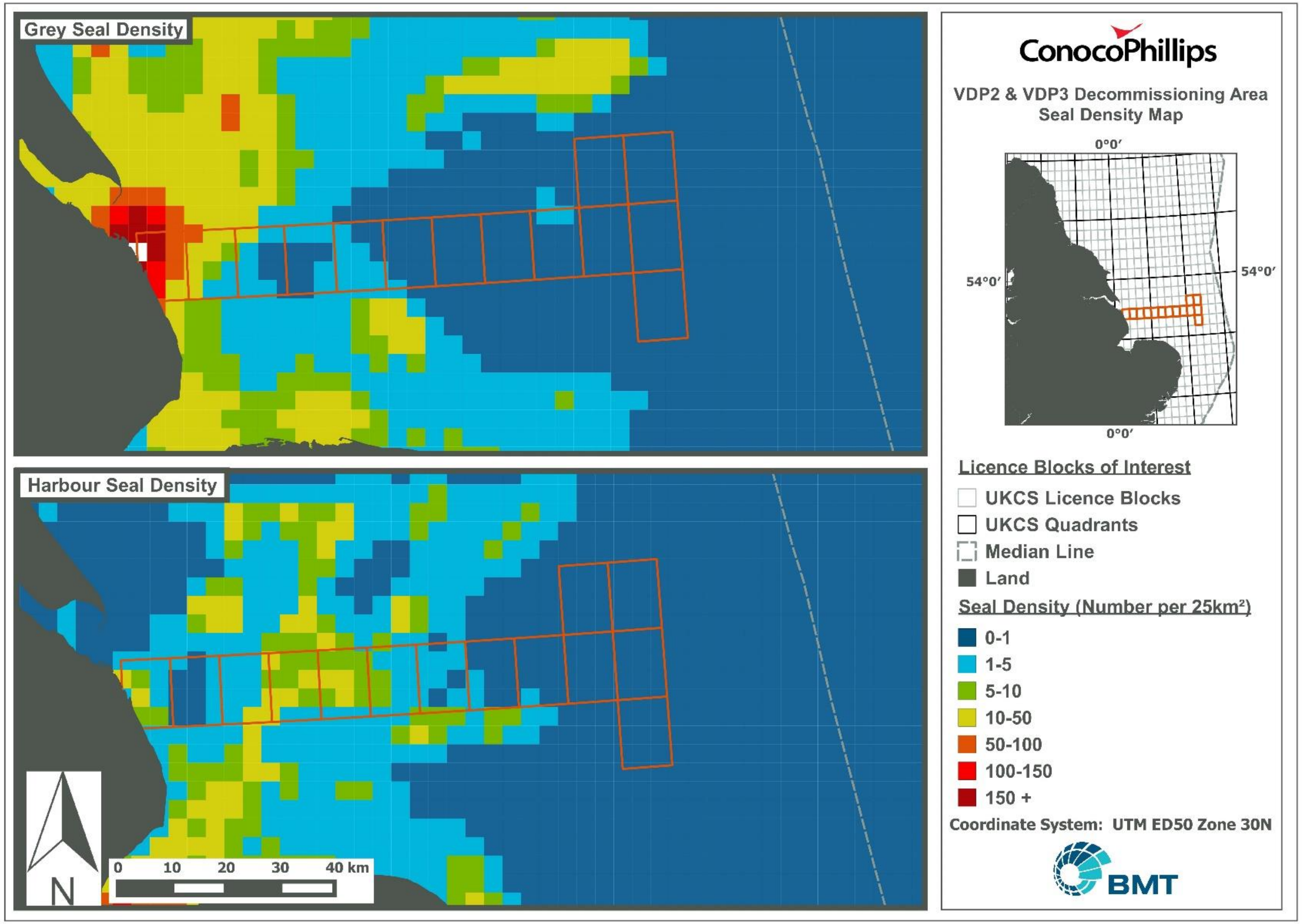
Source: Reid *et al*., 2003; UKDMAP, 1998

Pinnipeds

The grey seal and the harbour seal are both resident in UK waters and occur regularly over large parts of the North Sea (SCOS, 2009). Density mapping by NMPi, (2018) indicates a high grey seal usage around the mouth of the Humber River and close to the Donna Nook National Nature Reserve (Natural England, 2014a). Figure 4.10 illustrates that seals may travel past the VDP2 and VDP3 decommissioning area into the offshore foraging grounds.

Grey seal density around the VDP2 and VDP3 decommissioning area decreases with distance offshore. In the offshore regions of Quadrant 47 between 0 and 50 grey seals per 25 km^2 could be present at any one point in time, while and in Quadrants 48 and 49 between 0 and 100 grey seals per 25 km^2 could be present at any one point in time (NMPi, 2018; Figure 4.10).

Harbour seals have been observed in high concentrations in The Wash National Nature Reserve which supports one of the largest harbour seal population in England (Natural England, 2014b) and are also more likely to be found further offshore in the area to be decommissioned. It is likely that they are travelling to this area from haul-out sites in The Wash to forage for food. In Quadrants 47 and 48 between 10 and 150 harbour seals per 25 km^2 could be present at any one point in time, while in Quadrant 49 between 0 and 100 harbour seals per 25 km^2 could be present at any one point in time (NMPi, 2018) (Figure 4.10).



Sources: MMO, 2017a; OGA, 2017; UK oil and gas data, 2017; NMPi, 2018

Figure 4.10: Pinniped density in the VDP2 and VDP3 decommissioning area

4.3 Conservation Areas

Designated conservation sites are widespread and abundant around the UK coastline and in the marine environment. Numerous levels of designation exist from statutory international to local voluntary schemes. These afford differing levels of protection for habitats, species, as well as geological, cultural and landscape features. More widespread designations include the European-level Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) and the national-level Sites/ Areas of Special Scientific Interest (SSSIs/ ASSIs) (DECC, 2011b).

The Government is in the process of identifying and designating potential marine conservation sites (Marine SACs), as well as the identification of new marine SPAs, the boundaries of some coastal and marine sites are being extended. In addition, the Marine and Coastal Access Act 2009 has introduced measures for the designation of marine protected areas, known as Marine Conservation Zones (MCZs) in England (DECC, 2011b).

4.3.1 Special Areas of Conservation (SAC), Sites of Community Interest (SCI) and Candidate SACs (cSACs)

There are currently 105 SACs with marine components that cover 14% of the UK's marine area. Eighty SACs are found in inshore waters (<12 nautical miles from the coast), 18 are located in offshore waters (beyond 12 nautical miles) and there are nine sites within both inshore and offshore waters. SACs are sites that have been adopted by the European Commission (EC) and formally designated by the government of each country in whose territory the site lies and SCIs are sites that have been adopted by the EC but not yet formally designated by the government of each country. Candidate SACs (cSACs) are sites which have been submitted to the EC, but not yet formally adopted.

The VDP2 and VDP3 decommissioning areas are located within the following SACs and cSAC:

- The North Norfolk Sandbanks and Saturn Reef SAC (Figure 4.11) (JNCC, 2018b), designated for the Annex I sandbanks that are slightly covered by water all the time and *S. spinulosa* biogenic reef habitats (Table 4.7). Annex I habitats sandbanks occurring within this SAC radiate northeast parallel to the Norfolk coast. The sandbanks typically have fields of sand waves associated with them, the amplitude of which decreases with distance from the shore.
- Inner Dowsing, Race Bank and North Ridge SAC (Figure 4.11) (JNCC, 2018c), designated for the Annex I sandbanks which are slightly covered by seawater all the time and *S. spinulosa* reef habitats (Table 4.7).
- Southern North Sea cSAC (Figure 4.11) identified as an area of importance for harbour porpoise (*Phocoena phocena*) populations (JNCC, 2018d) (Table 4.7).

Table 4.7 lists Annex I habitats and Annex II species of the European Union Habitats Directive (92/43/EEC) that have been considered for the identification of marine SACs relevant to this decommissioning project.

Table 4.7: Annex I habitats and Annex II species which are qualifying features for marine SAC designations in the UK waters

Annex I habitats considered for marine SAC selection in UK waters	Annex II species considered for marine SAC selection in UK waters
• Sandbanks that are slightly covered by seawater all the time* • Biogenic reefs – formed by the polychaete worm *S. spinulosa** • Submarine structures made by leaking gases • Estuaries • Mudflats and sandflats not covered by seawater at low tide • Coastal lagoons • Large shallow inlets and bays • Submerged or partially submerged sea caves • Annual vegetation of drift lines • Salicornia and other annuals colonizing mud and sand • *Spartina* swards (*Spartinion maritimae*) • Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) • Meditierranean and thermos-Atlantic halophilious scrubs (*Sarcocornetea fruticosi*)	• Harbour porpoise (*Phocoena phocoena*) • Harbour seal (*Phoca vitulina*)* • Grey seal (*Halichoerus grypus*) • Bottlenose dolphin (*Tusiops truncatus*) • Sea lamphrey (*Petromyzon marinus*) • Allis shad (*Alosa alosa*) • Twaite shad (*Alosa fallax*) • Otter (*Lutra lutra*)

Note: * Primary reason for SAC designation.
Sources: JNCC, 2017a; JNCC, 2016 ; Johnston *et al*., 2002

Sediment sampling undertaken as part of a pre-decommissioning environmental baseline survey in 2013 (Fugro, 2014a, b, c and d) identified the presence of Annex I habitats (sandbanks that are slightly covered by seawater all the time) at the Viking AR survey area. Given that the water depth at this survey area is >20 m, the presence of this habitat is only likely to be present at the edge of the Viking AR survey area.

In addition, analysis of the ROV pipeline inspection footage for the pipelines and mattress status report (BMT Cordah, 2015c) found evidence of large aggregations of *S. spinulosa* along the PL27/ PL161 pipelines, approximately, 18 km from Viking AR. However, early indications from the 2015 ROV pipeline survey along PL27 are that these have either been damaged/ removed or have been covered by sediment in some areas.

Annex II species sighted within the VDP2 and VDP3 decommissioning areas (UKCS Quadrants 47, 48 and 49) include the harbour porpoise, which has been sighted in very high numbers in August, high numbers in March, May and September, moderate numbers in February and low numbers in April and December (Reid *et al.*, 2003; UKDMAP, 1998). Low numbers of bottlenose dolphins were only sighted in surrounding Quadrants in August and November. No bottlenose dolphins were observed in the decommissioning areas. (Reid *et al.*, 2003; UKDMAP, 1998). Harbour and grey seals have been observed throughout Quadrants 47, 48 and 49, with densities varying throughout the decommissioning area (NMPi, 2018; Section 4.2.4.)

Five cSACs (Bristol Channel Approaches, North Anglesey Marine, North Channel, Southern North Sea and West Wales Marine) have been submitted for the management of harbour porpoise populations in UK offshore waters (JNCC, 2018d). These cSAC sites have been identified within the North, Irish and Celtic Seas, encompassing areas that represent the physical and biological factors essential to harbour porpoise. The VDP2 and VDP3 subsea infrastructure is located within the boundary of the Southern North Sea cSAC, selected for the protection of harbour porpoise (Figure 4.11; Table 4.8).

The harbour porpoise is highly mobile and well distributed throughout the North Sea and adjacent waters (including Quadrants 47,48 and 49), Irish Sea and around the Scottish coast (Hammond *et al*., 2017) with the exception of the English Channel and south-east of England (Reid *et al*., 2003). Numbers of harbour porpoise in the southern North Sea declined during the twentieth century, but there is evidence of recent return to the area, for example Camphuysen (2004) and Thomsen *et al*., (2006).

The harbour porpoise abundance estimate for the entire North Sea from the SCANS III surveys (July 2016) was 345,000. During the surveys, harbour porpoise density was highest in the south central North Sea and coastal waters of northeast Denmark (~1.1 animals/ km^2). Elsewhere there was variation in porpoise density from 0.2 to 0.9 animals/ km^2 (Hammond *et al*., 2017).

During the SCANS III surveys, bottlenose dolphins were also encountered around the coasts of Britain, Ireland, France, Spain and Portugal. They were also sighted in outer shelf waters off Scotland and Ireland and in the Celtic Sea. The total abundance of bottlenose dolphins for the entire SCANS III survey area (i.e. the North Sea and beyond) was estimated to be 27,697 (Hammond *et al*., 2017).

Three SACs have been designated for bottlenose dolphin within UK territorial waters; Cardigan Bay, Moray Firth and Lleyn Peninsula and the Sarnau. According to the existing analysis of bottlenose dolphin data, it is not currently possible to identify suitable SACs in the UK offshore waters (JNCC, 2017a).

In the North Sea, bottlenose dolphins are most frequently sighted within 10 km of land and are rarely sighted outside coastal waters. It is possible, however, that some inshore dolphins move offshore during the winter months. According to UKDMAP, low numbers of bottlenose dolphins were sighted in the Quadrants surrounding VDP2 and VDP3 infrastructure in August and November (Table 4.6; UKDMAP, 1998).

In addition, there are two inshore SACs with marine components and one inshore SAC designated for qualifying marine habitats or species in the vicinity of TGT. These SACs are:

- Saltfleetby – Theddlethorpe Dunes & Gibraltar Point inshore SAC (JNCC, 2018e), designated for:
    - Habitats (Shifting dunes along the shoreline with *Ammophilia arenaria* - white dunes; fixed coastal dunes with herbaceous vegetation – grey dunes; dunes with *Hippophae rhamnoides*; humid dune slacks; embryonic shifting dunes (not primary designation)).
- Humber Estuary inshore SAC with marine components (JNCC, 2018f), designated for:
    - Habitats (Atlantic salt meadow; coastal lagoons; dunes; estuary; mudflats and sandflats not covered by seawater at low tide; sandbanks slightly covered by sea water at all times; annuals colonising mud and sand); and
    - Species (Grey seals, river and sea lamprey).
- The Wash and North Norfolk Coast inshore SAC with marine components (JNCC, 2018g), designated for:

- Habitats (Atlantic salt meadow; coastal lagoons; large shallow inlets and bays; scrubs; estuary; mudflats and sandflats not covered by seawater at low tide; reefs; sandbanks slightly covered by sea water at all times; annuals colonising mud and sand); and
- Species (Harbour seal and otter).

4.3.2 Special Protection Areas

SPAs are protected areas which have been classified in accordance with Article 4 of the EC Birds Directive. They are classified based on the location of rare and vulnerable birds and also for frequently occurring migratory species which are listed on Annex I of the Directive.

The VDP2 and VDP3 export pipeline crosses the Greater Wash marine SPA, newly designated in the offshore UK waters classified for breeding and non-breeding Annex I bird populations and the Humber Estuary coastal SPA, classified for breeding and over-wintering Annex I bird populations, on the shore approach (JNCC, 2017b; JNCC, 2018a).

There are three further SPAs in the vicinity (within 50 km) of TGT (Table 4.8). These are:

- Gibraltar Point, classified for breeding and non-breeding Annex I bird populations;
- The Wash, classified for breeding and over-wintering Annex I bird populations;
- North Norfolk Coast, classified for breeding and non-breeding Annex I bird populations.

4.3.3 Marine Conservation Zones

There are no designated, proposed or recommended MCZs located within the VDP2 and VDP3 decommissioning area (Defra, 2018; Figure 4.11). The nearest MCZs along with the qualifying features for designation are listed in Table 4.8.

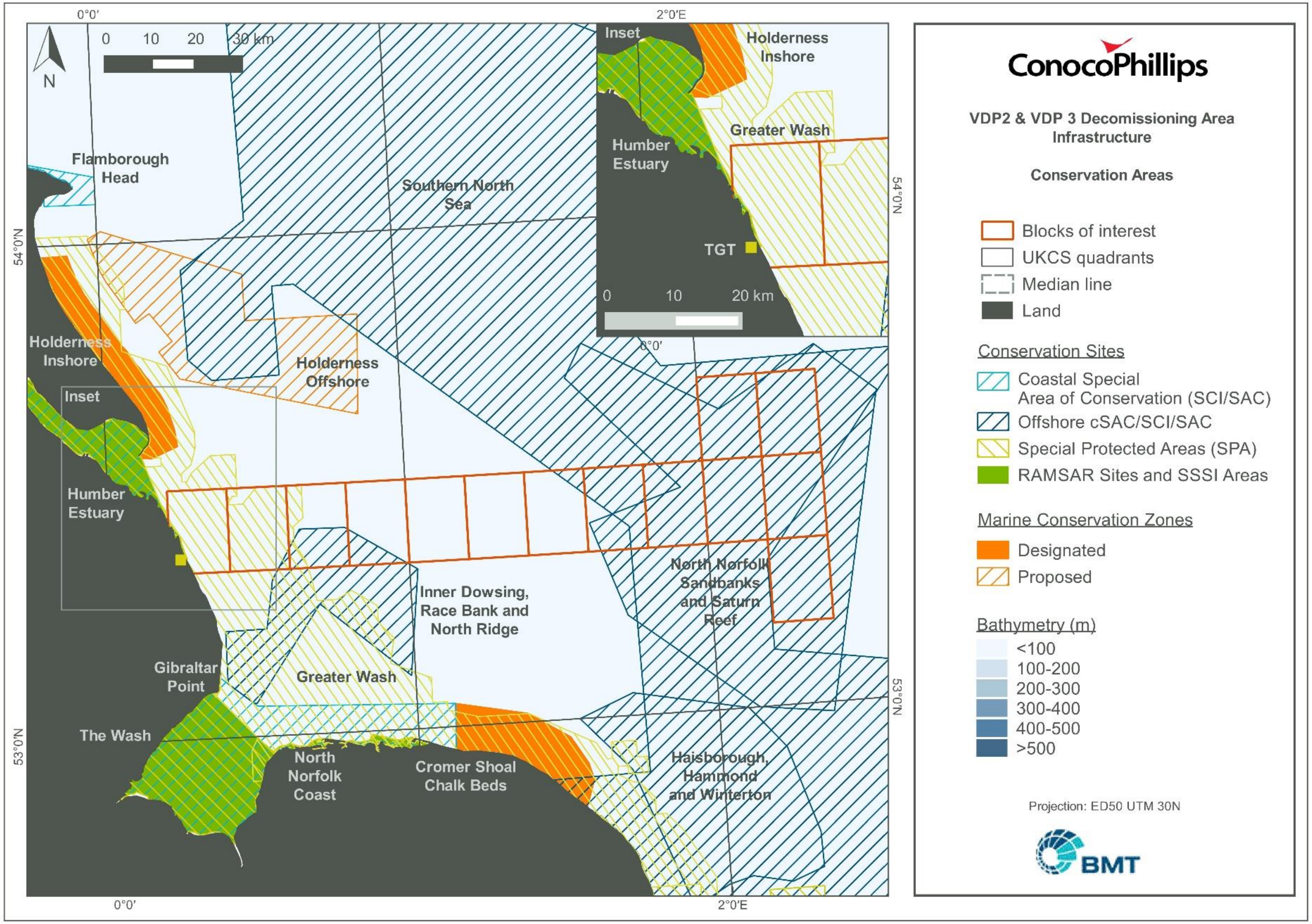
Table 4.8: Conservation sites

Name	Distance from VDP2/VDP3 or pipeline route (km)	Area (km^2)	Qualifying Features
Marine Conservation Zone (MCZ)/ recommended MCZ (rMCZ)			
Holderness Inshore MCZ	22	309	Broad Scale Habitats: • Subtidal coarse sediment • Subtidal sand • Intertidal mixed sediment Habitat Features of Conservation Importance (FOCI): • Peat and clay exposures • Subtidal chalk • Subtidal sands and gravels • Ross worm (*S. Spinulosa*) reef Geological feature: • Spurn Head
Holderness Offshore rMCZ	30	1,176	Broad Scale Habitats: • High energy circalittoral rock • Moderate energy circalittoral rock • Subtidal sand • Subtidal mud

Name	Distance from VDP2/VDP3 or pipeline route (km)	Area (km^2)	Qualifying Features
			Habitat FOCI: • Subtidal sands and gravel • Ross worm (*S. Spinulosa*) reef Species FOCI: • Ocean quahog (*A. islandica*)
Cromer Shoal Chalk Beds MCZ	35	320	Broad Scale Habitats: • High energy infralittoral rock • Moderate energy infralittoral rock • Moderate energy circalittoral rock Habitat FOCI: • Subtidal chalk
Special Protected Area (SPA) with Marine Components			
Humber Estuary	0	376	Breeding and over-wintering Annex I bird populations
Greater Wash	0	3,536	Breeding and non-breeding Annex I bird populations
Gibraltar Point	28	4	Breeding and non-breeding Annex I bird populations
The Wash	31	622	Breeding and over-wintering Annex I bird populations
North Norfolk Coast	40	79	Breeding and non-breeding Annex I bird populations
Site of Special Scientific Interest (SSSI)			
Saltfleetby – Theddlethorpe Dunes	0	972	Tidal sand and mudflats, salt and freshwater marshes and sand dunes, mud and silt flats, sandy beach.
Humber Estuary	6	370	Estuarine habitats (intertidal mudflats, sandflats, coastal saltmarsh), saline lagoons, sand dunes, standing water. Geological interest (coastal). Breeding and over-wintering bird populations.
Sea Bank Clay Pits	8	0.2	Brackish habitats. Breeding, wintering and passage bird populations. Aquatic invertebrate fauna.
Chapel Point to Wolla Bank	13	0.4	Geological interest (inter-tidal sediments).
Gibraltar Point	28	4	Coastal habitats (sand dunes) and associated fauna. Coastal geomorphology. Breeding and passage bird populations.
The Wash	31	631	Estuarine habitats (intertidal mudflats, saltmarshes). Breeding, wintering and passage bird populations. Breeding grounds for harbour seals.
North Norfolk Coast	52	77	Coastal habitats (reed bed, salt marsh, dunes, shingle beaches). Breeding and passage bird populations.
National Nature Reserve			
Saltfleetby – Theddlethorpe Dunes	0	619	Saltmarsh, foreshore and embryonic dunes. Breeding and passage bird populations.
Donna Nook	8	340	Dunes, slacks and intertidal areas. Breeding and passage bird populations. Noted for its uncommon bird passage migrants and one of the largest breeding colonies of grey seals in the UK.

Name	Distance from VDP2/VDP3 or pipeline route (km)	Area (km²)	Qualifying Features
Holme Dunes	47	2	Intertidal sands and mud, sand and shingle bars, saltmarsh, sand dune, freshwater and salty pools and grazing marshes
Scolt Head Island	49	73	Offshore barrier island
The Wash	52	89	Saltmarsh and mudflats
Holkham	55	39	Creeks and marshes, unspoilt sand dunes
Blakeney	65	11	Subtidal sandbanks, saltmarsh, intertidal mudflats and sandbanks, shallow inlets and bays and seal colonies.
Special Areas of Conservation (SACs), SACs with Marine Components and Candidate SACs (cSACs)			
The North Norfolk Sandbanks and Saturn Reef SAC	0	3,603	Annex I sandbanks that are slightly covered by water all the time and *S. spinulosa* biogenic reef habitats
Inner Dowsing, Race Bank and North Ridge SAC	0	845	Annex I sandbanks that are slightly covered by water all the time and *S. spinulosa* biogenic reef habitats
Southern North Sea cSAC	0	36,951	Identified as an area of importance for harbour porpoise (*Phocoena phocoena*).
Saltfleetby – Theddlethorpe Dunes & Gibraltar Point SAC	0	967	Habitats (Shifting dunes along the shoreline with *Ammophilia arenaria* - white dunes; fixed coastal dunes with herbaceous vegetation – grey dunes; dunes with *Hippophae rhamnoides*; humid dune slacks; embryonic shifting dunes (not primary designation)).
Humber Estuary SAC	6	376	Habitats (Atlantic salt meadow; coastal lagoons; dunes; estuary; mudflats and sandflats not covered by seawater at low tide; sandbanks slightly covered by sea water at all times; annuals colonising mud and sand). Grey seals, river and sea lamprey.
The Wash and North Norfolk Coast SAC	31	1,077	Habitats (Atlantic salt meadow; coastal lagoons; large shallow inlets and bays; scrubs; estuary; mudflats and sandflats not covered by seawater at low tide; reefs; sandbanks slightly covered by sea water at all times; annuals colonising mud and sand). Harbour seal and otter.
Haisborough, Hammond and Winterton SAC	96	1,467	Sandbanks which are slightly covered by sea water all the time and Reefs, especially *Sabellaria spinulosa* reefs.

Source: Natural England, 2018; JNCC, 2016; JNCC, 2018h



Sources: MMO, 2017a; OGA, 2017; JNCC, 2016; UK oil and gas data, 2017; Natural England, 2018; JNCC, 2018h

Figure 4.11: Conservation areas associated with the VDP2 and VDP3 decommissioning areas

4.3.4 Summary of environmental characteristics and sensitivities

Table 4.9 summarises the environmental sensitivities in the area surrounding the VDP2 and VPD3 infrastructure.

Table 4.9: Summary of environmental characteristics and sensitivities

Aspect	Months of the Year											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Site overview												
The VDP2 and VDP3 infrastructure is located in the southern North Sea Quadrants 47, 48 and 49, within 14 Blocks (Blocks 47/17, 47/18, 47/19, 47/20, 48/16, 48/17, 48/18, 48/19, 48/20, 49/11, 49/12, 49/16, 49/17 and 49/22).												
Conservation interests												
Annex I habitats												
North Norfolk Sandbanks and Saturn Reef SAC	All of the infield infrastructure included in VDP2 and VDP3 are located within this SAC. Approximately 20 km of PL27 pipeline also crosses this SAC. The sandbanks typically have fields of sand waves associated with them. The Annex I biogenic reef habitats formed by the polychaete worm (*S. spinulosa*) are also present in the SAC (JNCC, 2018b).											
Inner Dowsing, Race Bank and North Ridge SAC	PL27 crosses the northern extent of this SAC. The SAC is designated for its sandbanks which are slightly covered by seawater all the time, and for its *S. spinulosa* reef habitats (JNCC, 2018c).											
Haisborough, Hammond and Winterton SAC	The SAC is located 41 km south of the VDP2 and VDP3 areas. The SAC is designated for sandbanks which are slightly covered by seawater all the time, and for *S. spinulosa* reef habitats (JNCC, 2018i).											
Southern North Sea cSAC	All of the infield infrastructure included in VDP2 and VDP3 are located within this candidate SAC (cSAC). Approximately 42 km of the VTS pipeline crosses this cSAC. The site is designated due to the populations of harbour porpoise, and Annex II species, in the area (JNCC, 2018d).											
Coastal conservation sites												
SACs	The closest SAC with marine components, Saltfleetby – Theddlethorpe Dunes & Gibraltar Point, overlaps with PL27 landfall (JNCC, 2018e).											
SPAs	The closest SPAs are the Humber Estuary SPA with marine components and the Greater Wash offshore SPA, which overlap with PL27 landfall (JNCC, 2017b; JNCC, 2018a).											
*Coastal and Offshore Annex II species**												
Harbour porpoise		M	H	L	H	H	H	VH	H	L	M	L
Bottlenose dolphins								L			L	
Grey seals	Grey seal density along the decommissioning area ranges from 0 to 150 seals per 25 km^2. Haul-out and breeding sites are located within the Humber Estuary SAC.											
Harbour seals	Harbour seal density along the decommissioning area ranges from 0 to 100 seals per 25 km^2. Haul-out and breeding sites are located within The Wash and North Norfolk Coast SAC. This site represents the largest colony of harbour seals in the UK, with approximately 7% of the total UK population.											
*Note: this represents the abundance of Annex II species both within and in surrounding quadrants												
Designated areas												
No designated MCZs coincide with the VDP2 and VDP3 facilities or PL 27 route.												
Plankton												
Plankton in the sea area surrounding the VDP2 and VDP3 is likely to be typical for the southern North Sea. The zooplankton community is dominated by copepods including *Calanus helgolandicus*, *C. finmarchicus*, *Paracalanus* and *Pseudocalanus* spp., *Acartia* spp., *Temora* spp. and cladocerans such as *Evadne* spp. (OESEA, 2016). However, there has been a marked decrease in copepod abundance in the SNS, which has been linked to changes in global weather phenomena (OESEA, 2016).												

Table 4.9 (continued): Summary of environmental characteristics and sensitivities

Aspect	Months of the Year											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Benthic environment												
Sediments in the decommissioning areas comprise 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%. Surficial seabed sediments at the TGT approaches of the PL27/ PL161 pipelines are comprised of gravelly Sand (gS) and sandy Gravel (sG), with the latter being located towards the 12 nm limit off TGT. No cuttings piles have been identified in the study area. Chemical analysis of sediment samples found metals and TPH to be within the range of reported background concentrations and below the effects range. Sediment chemistry in the vicinity of TGT is thought to be similar to background levels in the wider are. No known contamination associated with the TGT site or near shore area. The seabed habitat when classified using the EUNIS code is A5.2: “Sublittoral, clean medium to fine or non-cohesive slightly muddy sands on open coasts, offshore or in estuaries and marine inlets”. An additional five seabed habitats can be identified throughout the pipelines and infield areas												
Benthic fauna	Benthic fauna identified during seabed surveys are typical for this area of the southern North Sea. The shallow-water infaunal assemblage is typically characterised by taxa including polychaetes, bivalve molluscs and amphipods and crustaceans. *S. spinulosa* were identified in several historical survey reports within and adjacent to the areas containing VDP2 and VDP3 infrastructure. Also recent ROV pipeline inspection surveys observe sections of *S. spinulosa* along the PL27/ PL161 pipelines, within boundaries of North Norfolk Sandbanks and Saturn Reef SAC.											
***Fish* – spawning and nursery areas** for the ICES Rectangles 35F0, 35F1, 35F2 and 36F2												
Anglerfish	N	N	N	N	N	N	N	N	N	N	N	N
Mackerel	N	N	N	N	NS*	NS*	NS*	NS	N	N	N	N
Herring	NS	N	N	N	N	N	N	N	N	N	NS	NS
Cod	NS	NS*	NS*	NS	N	N	N	N	N	N	N	N
Haddock	N	N	N	N	N	N	N	N	N	N	N	N
Whiting	N	N	N	N	N	N	N	N	N	N	N	N
Norway pout	N	N	N	N	N	N	N	N	N	N	N	N
Plaice	NS*	NS*	NS	N	N	N	N	N	N	N	N	N
Lemon sole	N	N	N	NS	NS	NS	NS	NS	NS	N	N	N
Sole	N	N	NS	NS*	NS	N	N	N	N	N	N	N
Sandeel	NS	NS	N	N	N	N	N	N	N	N	NS	NS
Sprat	N	N	N	N	NS*	NS*	NS	NS	N	N	N	N
Nephrops	NS	NS	NS	NS*	NS*	NS*	NS	NS	NS	NS	NS	NS
Tope shark	N	N	N	N	N	N	N	N	N	N	N	N
Spurdog	N	N	N	N	N	N	N	N	N	N	N	N
Thornback ray	N	N	N	N	N	N	N	N	N	N	N	N
Horse mackerel	N	N	N	N	N	N	N	N	N	N	N	N
Key:												
Fish spawning/ nursery	S	spawning			S*	peak spawning			N	nursery		

Table 4.9 (continued): Summary of environmental characteristics and sensitivities

*Seabirds **(median score for blocks containing infrastructure)***

The most common species of seabird found in these areas of the SNS include: Fulmar, Gannet, Guillemot, Kittiwake, Razorbill, Puffin, Little Auk; as well as numerous species of gull, tern, and skua.

Seabird sensitivity to oil pollution within the Blocks of Interest (Webb *et al*., 2016)

Block	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
47/17	4	4	3	5	5	5	5	5	5	2	2	2
47/18	4	4	2	5	5	5	5	4	4	1	2	2
47/19	3	3	2	5	5	5	5	4	4	3	1	2
47/20	3	4	2	5	5	5	5	4	4	3	1	2
48/16	3	4	3	3	5	5	5	4	5	4	2	3
48/17	3	3	3	3	5	5	5	3	4	2	1	3
48/18	1	2	3	3	5	5	5	3	3	1	1	1
48/19	1	1	3	3	3	5	5	3	3	1	1	1
48/20	1	1	1	ND	3	5	5	5	5	ND	1	1
49/11	1	1	1	ND	ND	1	1	5	5	ND	ND	1
49/12	ND	1	ND	ND	5	5	1	5	5	5	ND	1
49/16	2	2	2	ND	ND	5	5	5	5	ND	2	1
49/17	ND	1	2	ND	ND	2	2	5	5	5	ND	1
49/22	1	3	3	3	ND	5	5	5	3	3	1	1

Aspect	Months of the Year											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Marine mammals *(generalised for Quadrants 47, 48 and 49)*												
Harbour porpoise		M	H	L	H	H	H	VH	H	L	M	L
White-beaked dolphin	M		VH	VH	L	H	L	L	M	M	H	L
Minke whale						L	L	L	L	L		
Long-finned pilot whale								L				
Bottlenose dolphin								L			L	
White-sided dolphin								L	L			
Common dolphin		L							M			

Key

Seabird sensitivity	
1	Extremely high
2	Very High
3	High
4	Medium
5	Low
ND	No data
x	Interpolated data (where “x” is the interpolated value)

Marine mammal sightings	
VH	Very high
H	High
M	Moderate
L	Low
	No data

5.0 SOCIOECONOMIC ENVIRONMENT

Following section provides the major socioeconomic characteristics of the area around VDP2 and VDP3 infrastructure to be decommissioned.

5.1 Commercial Fisheries

An assessment of fishing activity in the area has been derived from International Council for the Exploration of the Sea (ICES) fisheries statistics, information provided by the MMO and The Marine Analytical Unit at Marine Scotland, information gathered as part of the Fisheries Impact study commissioned by ConocoPhillips for VDP1 and LDP1and updated fishery effort maps for the SNS area (MMO 2017b, Scottish Government, 2016; Brown and May, 2014; Brown and May, 2015). Data have been obtained for ICES rectangles 35F0, 35F1, 35F2 and 36F2 (Figure 5.1) and reports on the last five years of fisheries statistics which coincides with the location of the various VDP2 and VDP3 infrastructure (Figures 5.2-5.6).

The platforms are located primarily in 35F2 and 36F2, while the export pipelines PL27/PL161 is located in all four rectangles (35F0, 35F1, 35F2 and 36F2).

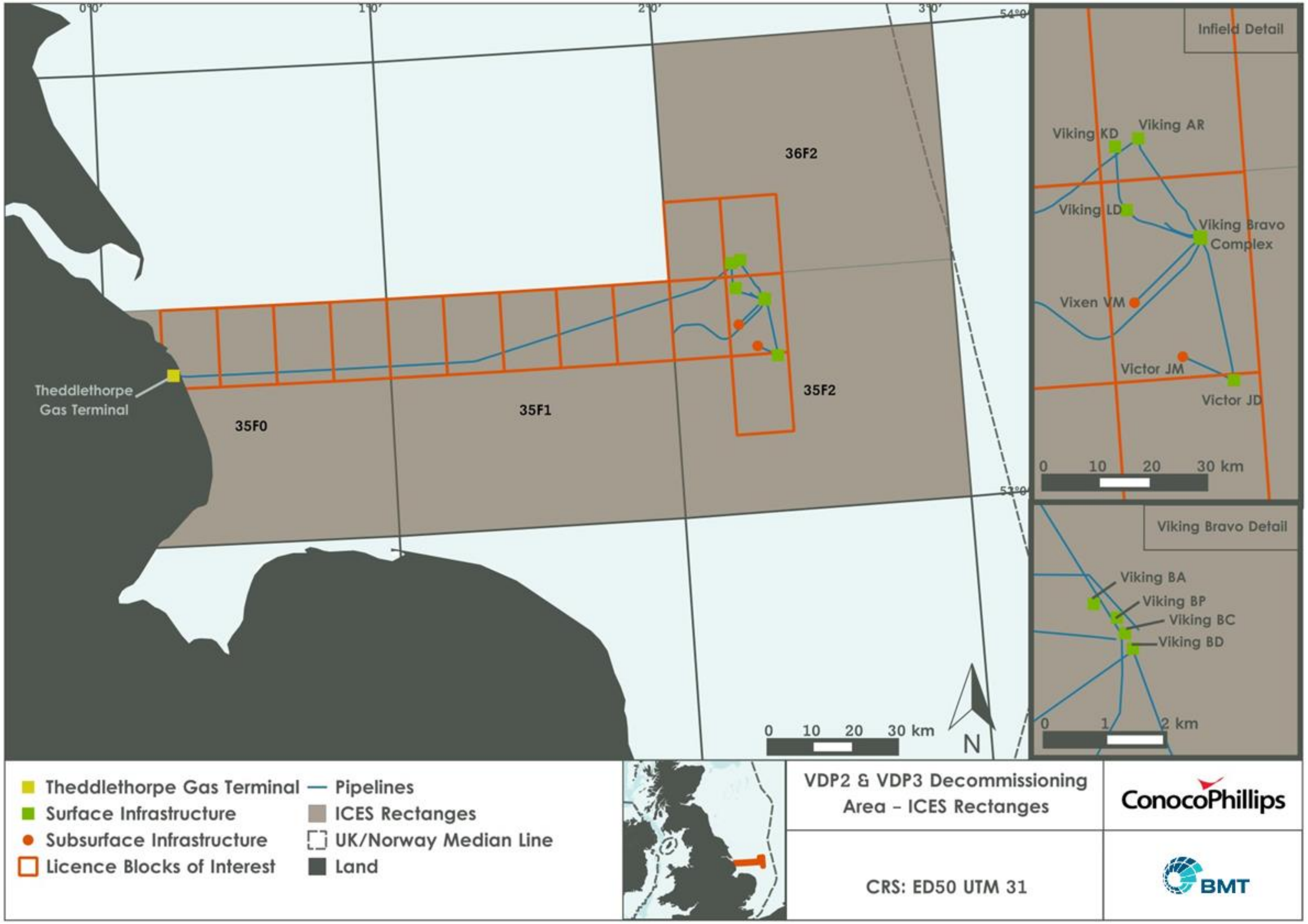
There are 11 different methods of commercial fishing recorded from these rectangles. At the VDP2 and VDP3 platform locations commercial fishing is mainly from demersal and beam trawlers. Based on satellite monitoring of fishing vessel activity, the export pipeline has a geographic split in the fishing grounds along the pipeline, with fishing grounds targeted by potters (creel vessels) from the shore to approximately 65 km and there after this shifts to primarily demersal and beam trawl fishery.

Vessel Monitoring Satellite (VMS) data indicate the majority of fishing effort is targeted out with the decommissioning area. These data are representative of vessels over 15 m in length, which is the majority of the vessels working in this offshore area.

Surveillance sightings data from the MMO between 2008 and 2012 (Brown and May, 2015), indicates a shift from a primarily UK registered fishing fleet (96% of vessels from UK) in ICES rectangle 35F0 to a primarily Dutch fleet in rectangle 36F2 (90% of vessels from Netherlands), ICES rectangle 35F1 is relatively equally split between the UK and Dutch (46% and 41%, respectively) with a small percentage of Belgium, France and Danish vessels (8%, 3% and 2%, respectively).

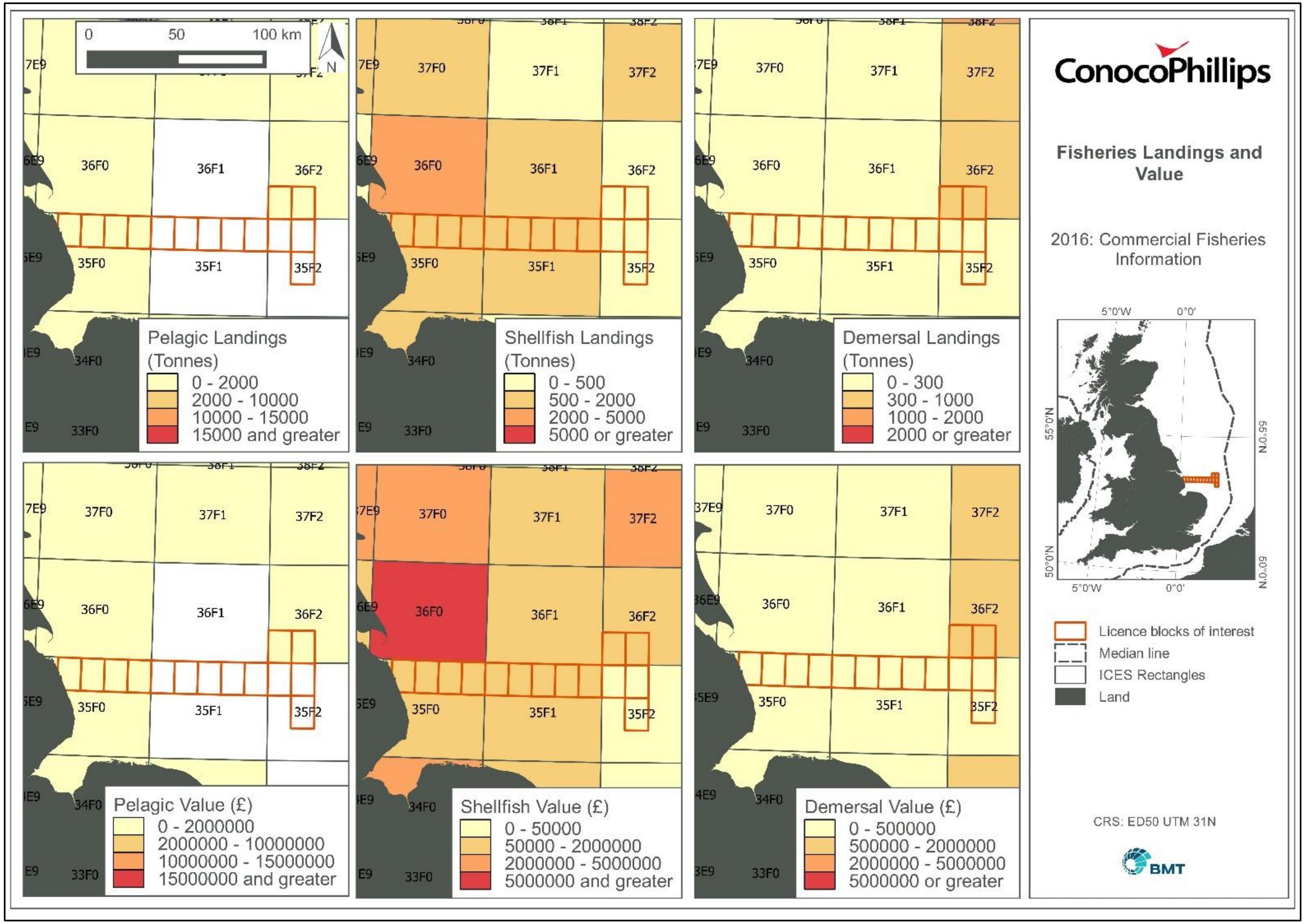
Within a 50 km radius of the VDP2 and VDP3 infield infrastructure, fishing vessels are mainly from the Netherlands. These vessels are primarily beam trawlers fishing for demersal species including plaice. However, these vessels are moving fishing practices to electric beam trawl gear which requires a clean seabed to operate, and as a result fewer vessels are actually fishing near the current infrastructure to minimise snagging risks to this expensive gear (Brown and May, 2014).

Figures 5.2 to 5.6 summarise the key fishing interests by nationality and gear type within the vicinity of the proposed decommissioning works. This information is based on VMS data supplied by the respective nationalities.



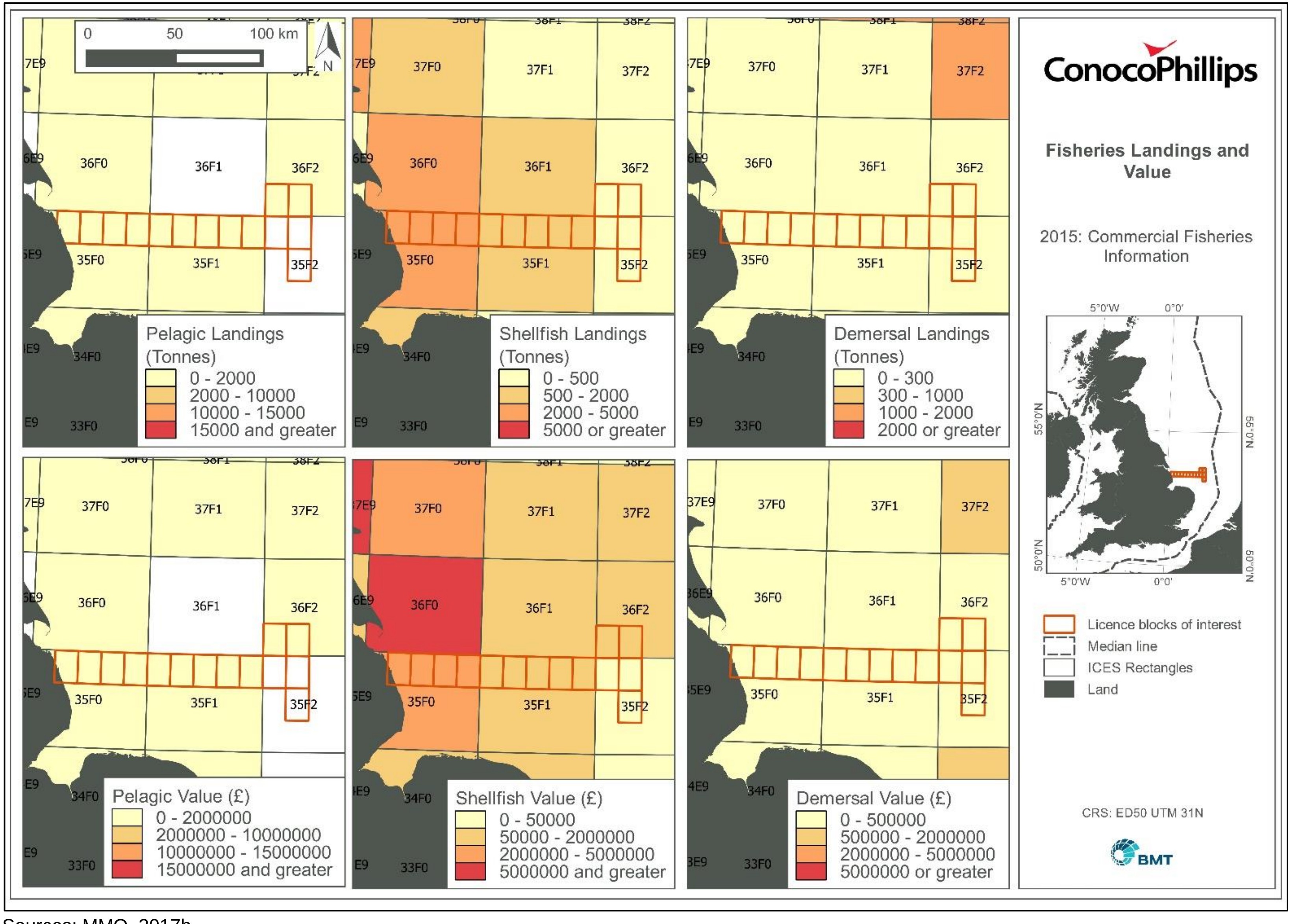
Sources: OGA, 2017; UK Oil and Gas Data, 2017

Figure 5.1: VDP2 and VDP3 decommissioning area in relation to ICES rectangles



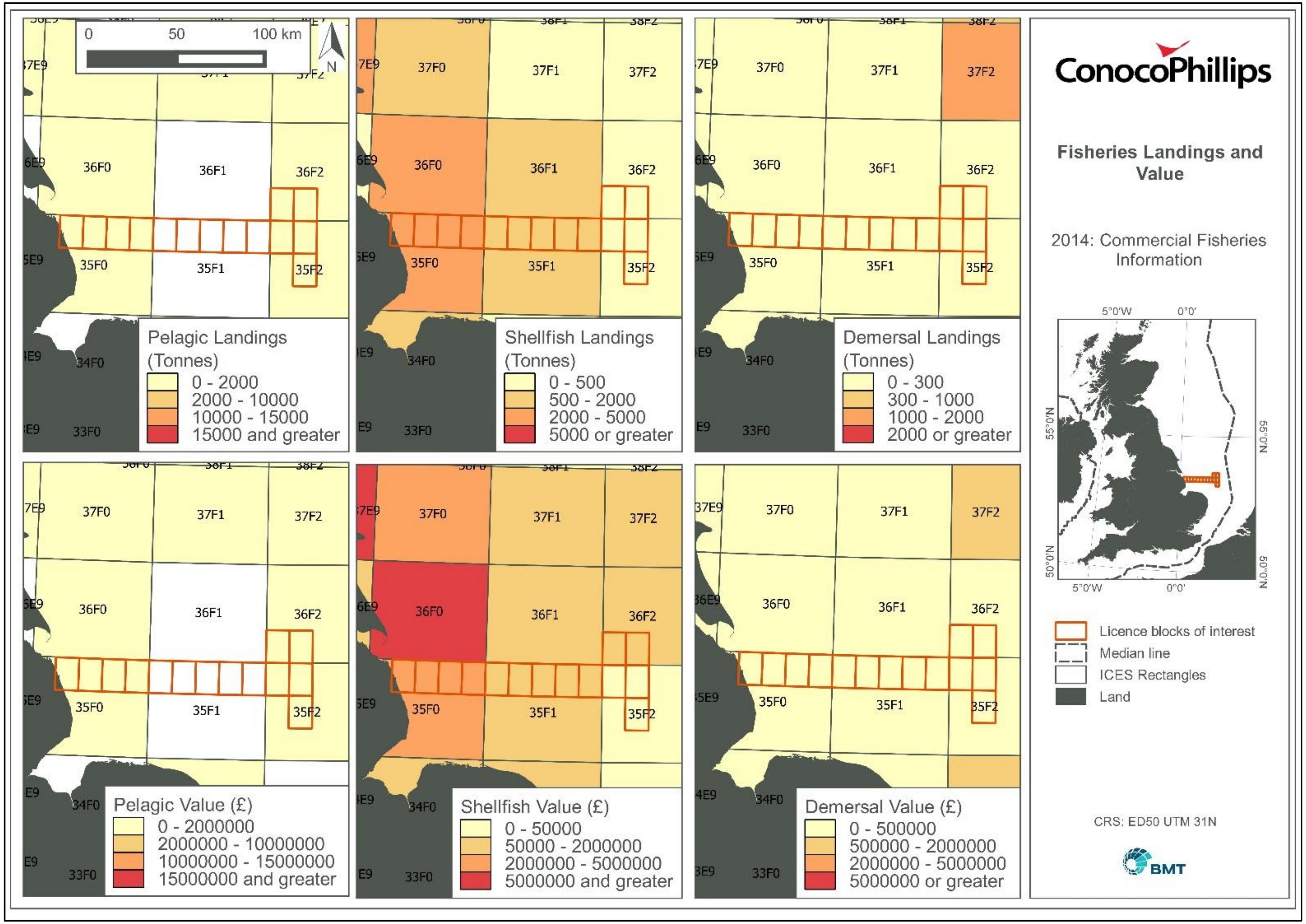
Sources: MMO, 2017b

Figure 5.2: Annual commercial fishing landings figures for 2016



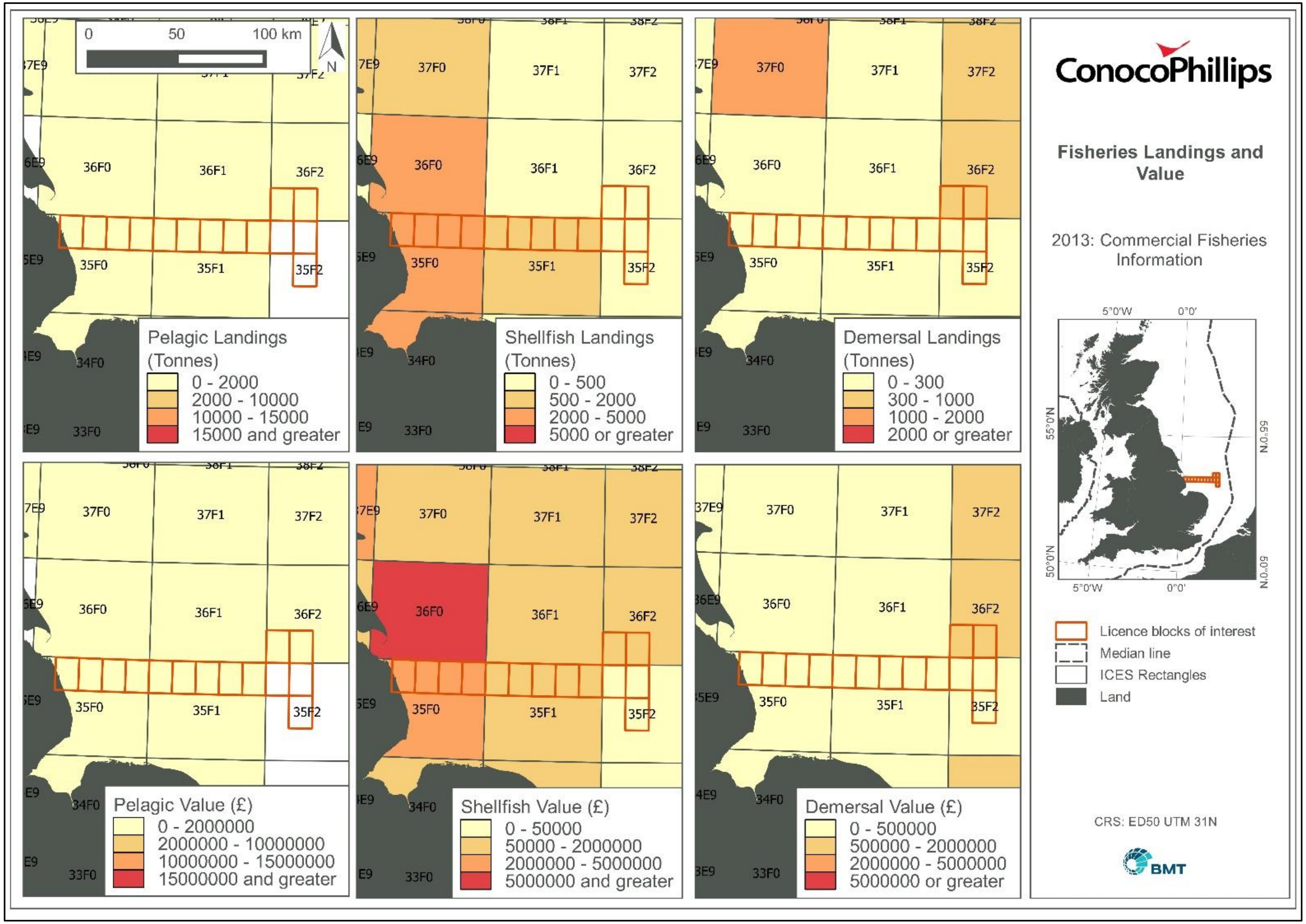
Sources: MMO, 2017b

Figure 5.3: Annual commercial fishing landings figures for 2015



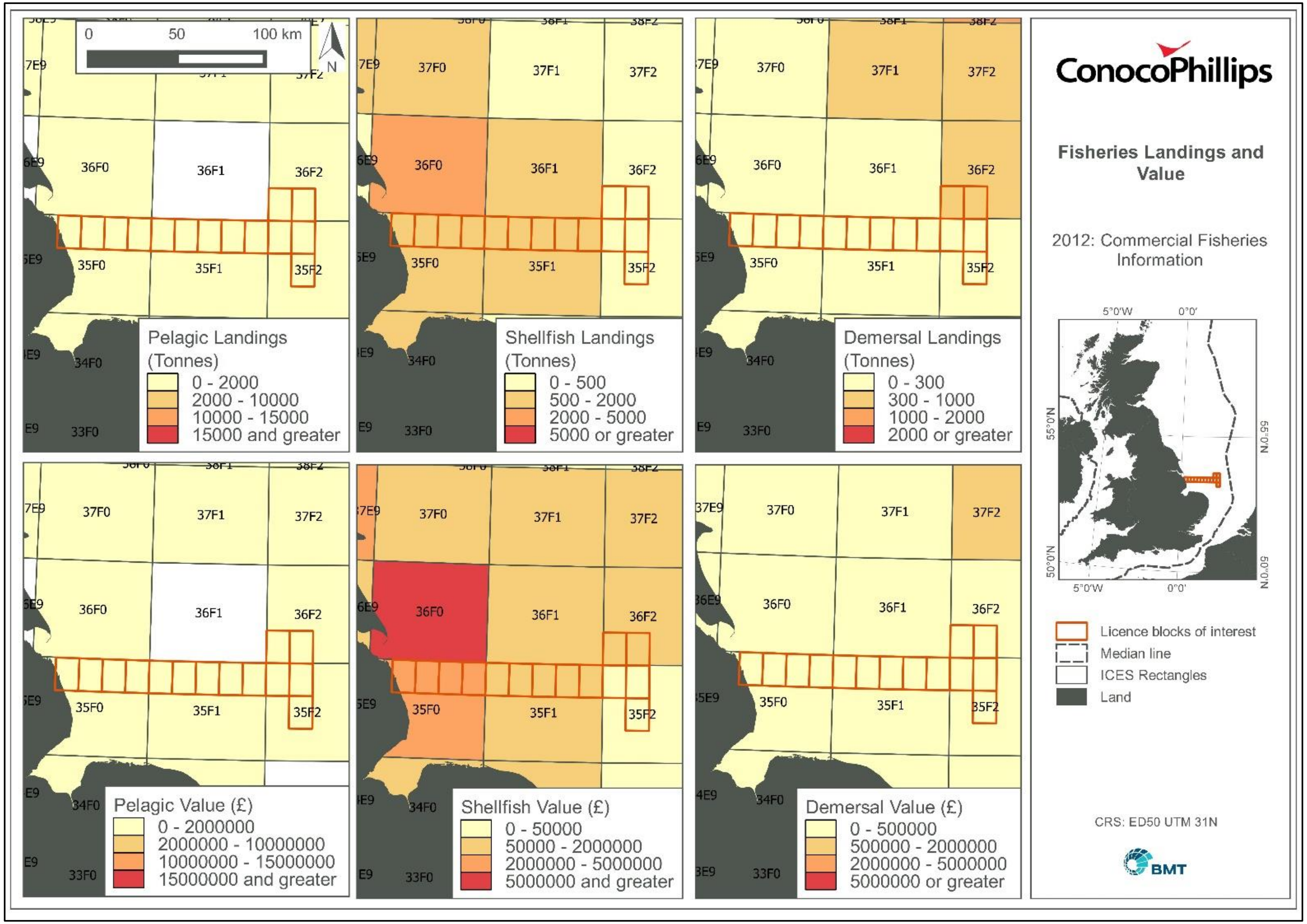
Sources: MMO, 2017b

Figure 5.4: Annual commercial fishing landings figures for 2014



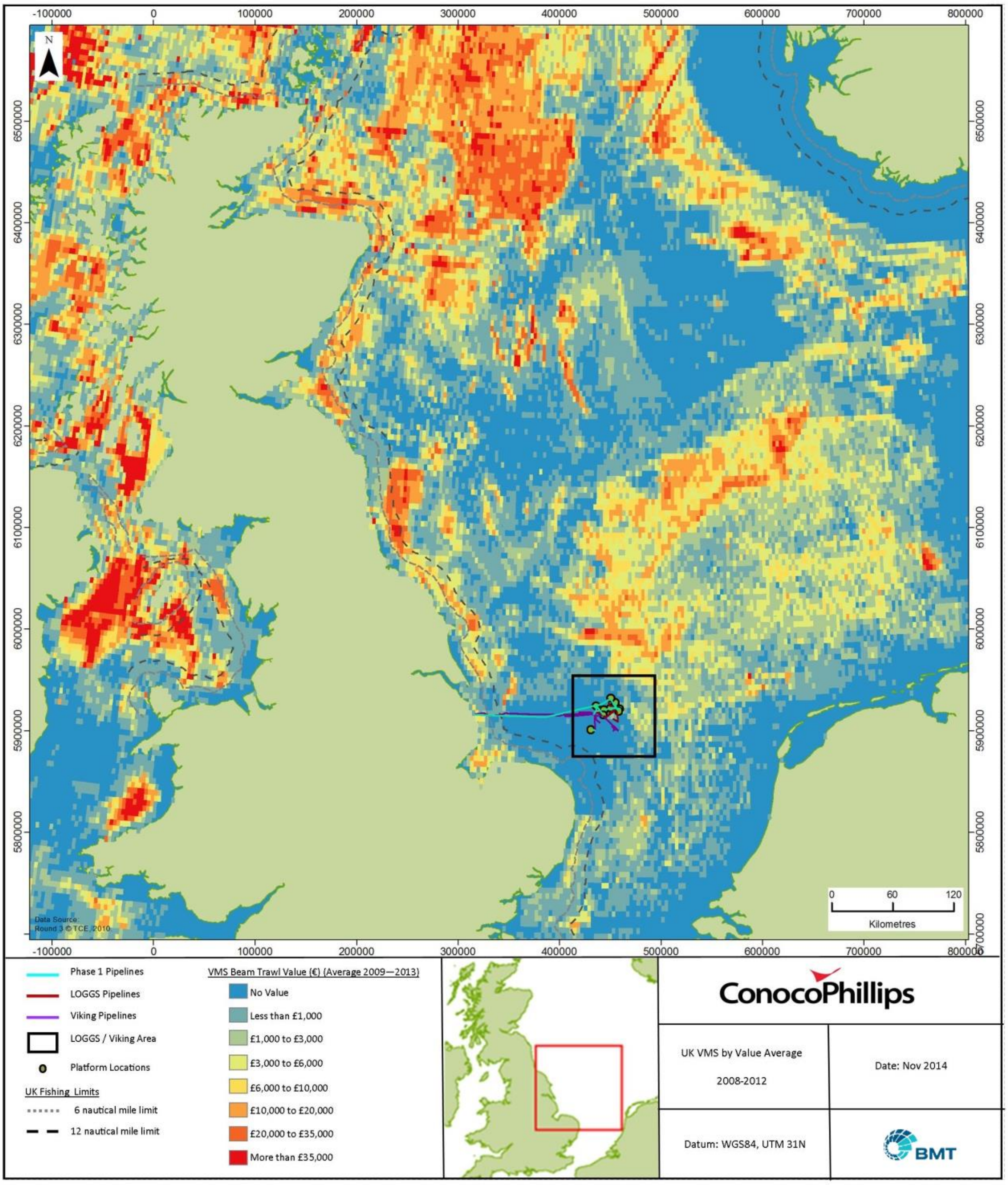
Sources: MMO, 2017b

Figure 5.5: Annual commercial fishing landings figures for 2013



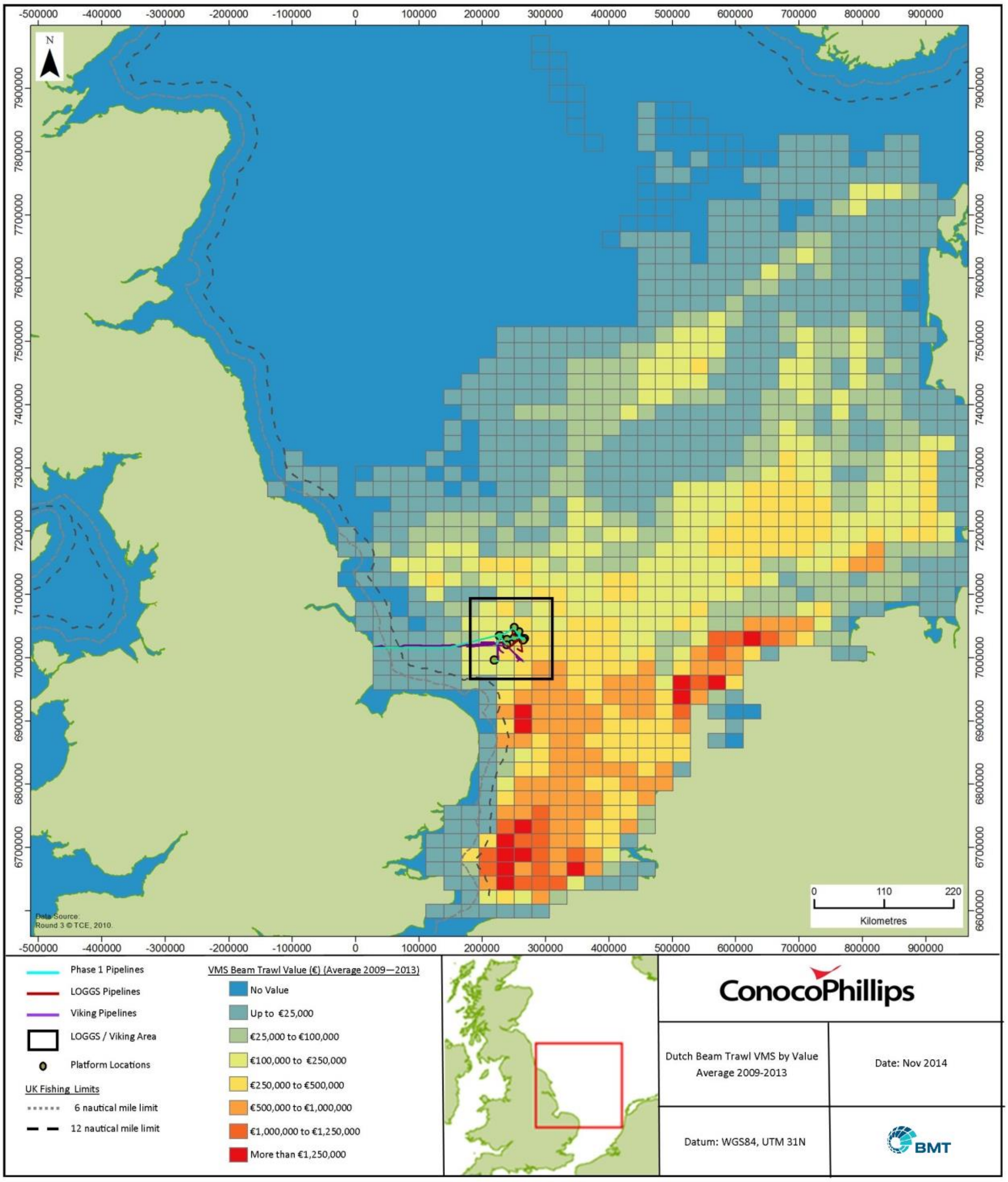
Sources: MMO, 2017b

Figure 5.6: Annual commercial fishing landings figures for 2012



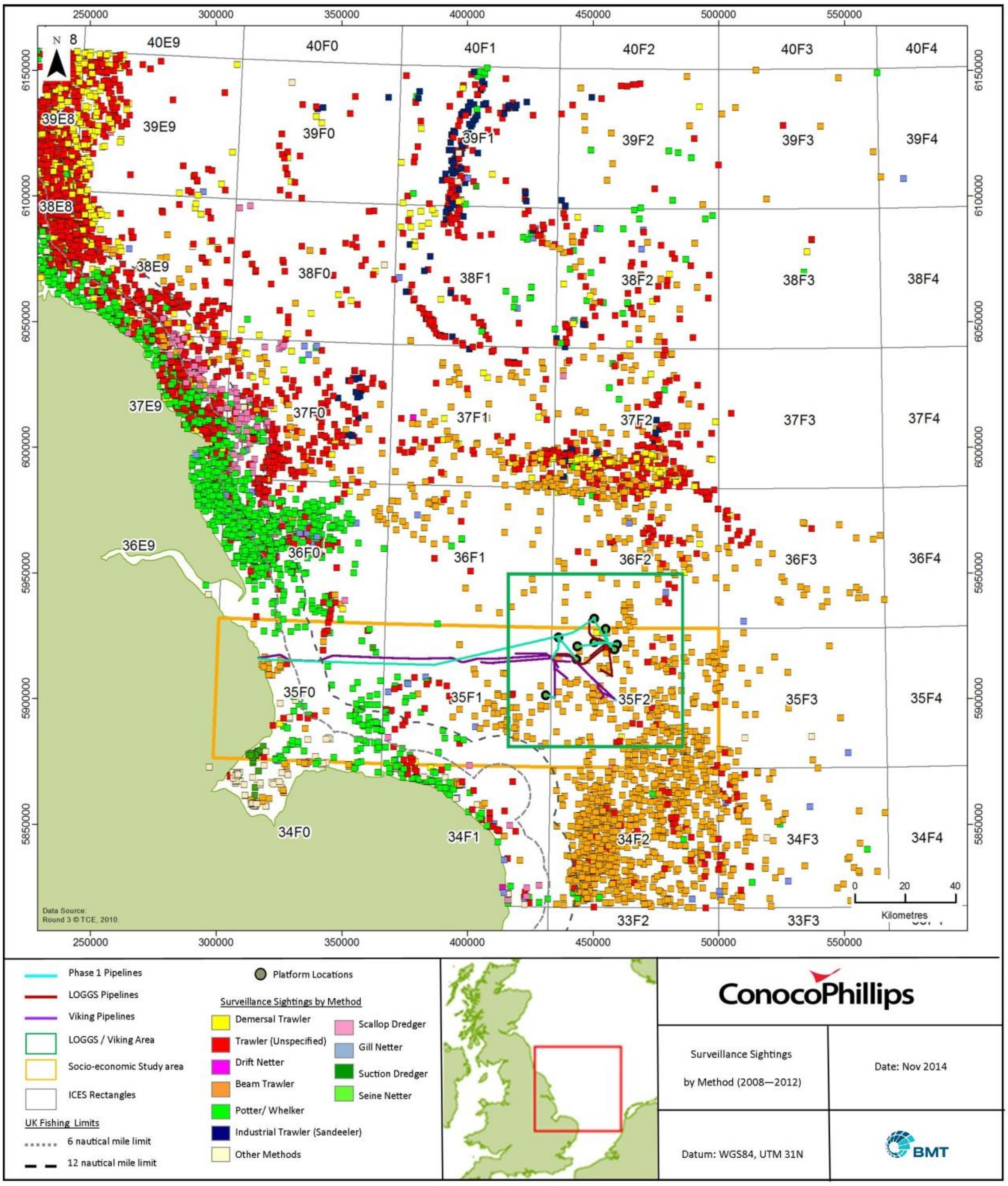
Sources: Brown and May, 2015; Crown Estate 2015.

Figure 5.7: Average fishing value based on UK VMS data



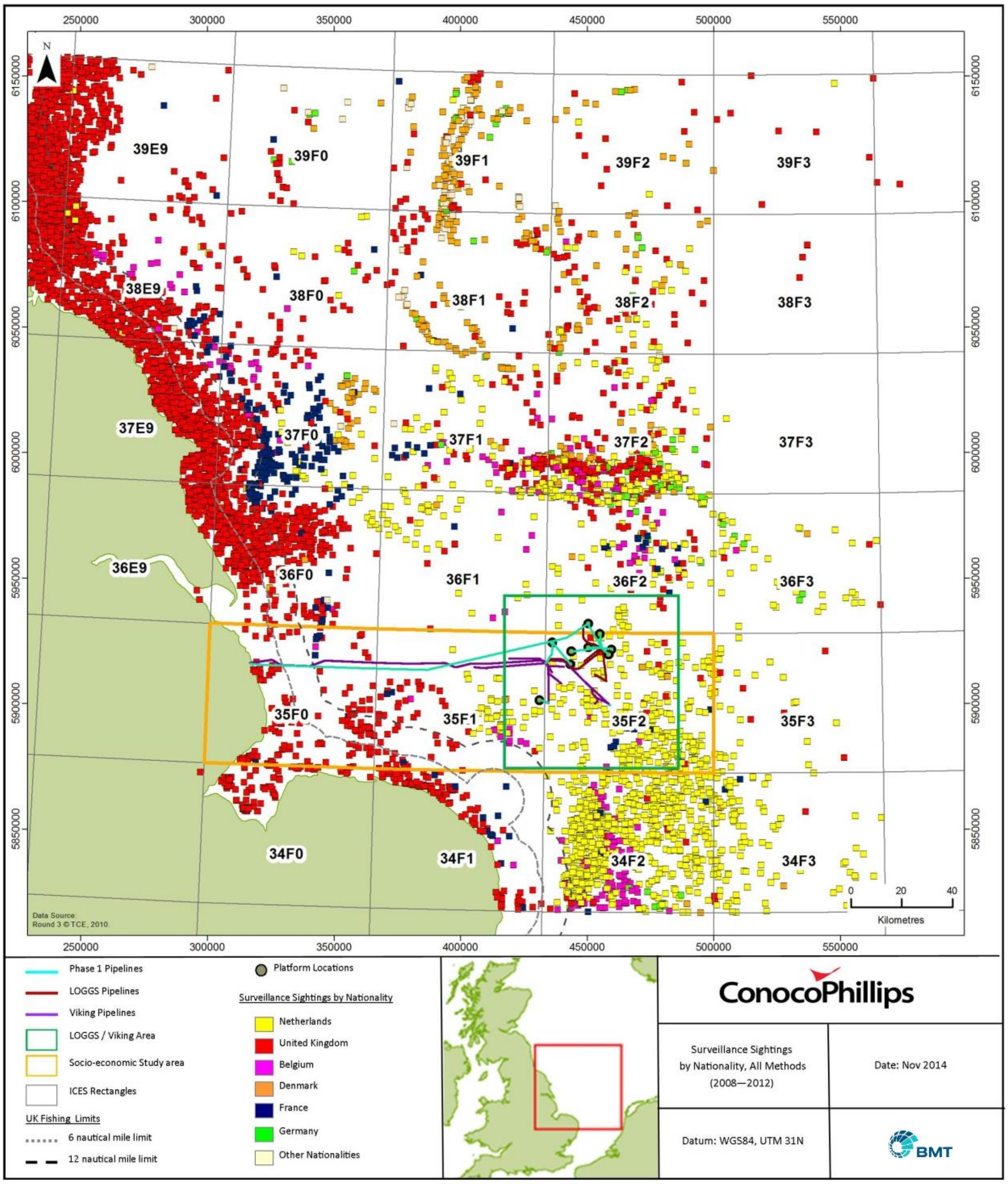
Sources: Brown and May, 2015; Crown Estate 2015.

Figure 5.8: Dutch beam trawl average fishing value



Sources: Brown and May, 2015; Crown Estate 2015.

Figure 5.9: Fishing effort by gear type



Sources: Brown and May, 2015; Crown Estate 2015

Figure 5.10: Fishing effort by nationality

Statistical data from ICES rectangles provides information on the UK fishing effort, provided by the Scottish Government (2017) and live weight of demersal, pelagic and shellfish caught by all UK vessels, provided by the MMO (2017b) is reported below. The overall value of the different species by area (financial yield per ICES rectangle) is an indication of the differential worth of areas and is used as a method of expressing commercial sensitivity (Coull *et al*., 1998). Tables 5.1 to 5.6 provide data on the economic value of fishing in this area based on UK catches and landings for 2016 (MMO, 2017). The UK landings in 2016 from four ICES rectangles (35F0, 35F1, 35F2 and 36F2) are relatively low, with the exception of the shellfish species in ICES 35F1 and demersal species in 36F2 (Figure 5.2-5.6 and Tables 5.3-5.6).

Table 5.1: Landings value by ICES rectangle for 2016 (MMO, 2017b)

ICES rectangle 35F0	
Species	**Value in GBP**
Brown Shrimps	426,927.24
Whelks	409,057.71
Lobsters	302,541.60
Crabs (Mixed Sexes)	135,902.15
Cockles	106,228.00
Sole	5,163.45
Cod	1,559.40
Bass	1,297.15
Smoothhound	415.00
Thornback Ray	274.20

ICES rectangle 35F1	
Species	**Value in GBP**
Whelks	876,555.21
Lobsters	361,694.35
Crabs (Mixed Sexes)	214,242.93
Sole	5,279.62
Plaice	2,028.55
Brown Shrimps	1,324.20
Scallops	471.60
Brill	393.60
Sea Trout	223.20
Tub Gurnards	131.29

ICES rectangle 35F2	
Species	**Value in GBP**
Sole	257,389.81
Plaice	56,292.48
Turbot	22,502.40
Brill	21,810.33
Tub Gurnards	3,276.34
Thornback Ray	1,968.10
Blonde Ray	1,206.22
Lemon Sole	879.33
Dabs	593.51
Red Mullet	192.58

ICES rectangle 36F2	
Species	**Value in GBP**
Plaice	393,749.46
Nephrops	265,389.33
Sole	166,161.14
Turbot	57,677.54
Brill	19,310.51
Tub Gurnards	5,578.98
Thornback Ray	4,019.73
Spotted Ray	3,473.58
Crabs (Mixed Sexes)	2,944.52
Lemon Sole	2,534.43

Table 5.2: Annual fishing effort in days for ICES rectangles containing VDP2 and VDP3 infrastructure (Scottish Government, 2017; MMO, 2017b)

ICES rectangle	35F0	35F1	35F2	36F2
Year	**Annual effort in days**			
2012	1077	686	18	76
2013	2276	767	86	147
2014	2081	572	59	108
2015	N/A	N/A	N/A	107
2016	N/A	N/A	N/A	171

Table 5.3: Annual landings in tonnes for ICES rectangles containing VDP2 and VDP3 infrastructure, ICES Rectangle 35F0

Year	Total value (£)	Species type	Value (£)	Total quantity (tonnes)	Species type	Quantity (tonnes)
2016	1,390,048	Demersal	9,312	932	Demersal	3.0
		Pelagic	22		Pelagic	0.0
		Shellfish	1,380,715		Shellfish	929.3
2015	2,527,577	Demersal	25,680	4,397	Demersal	10.87
		Pelagic	278		Pelagic	0.23
		Shellfish	2,501,619		Shellfish	4,386.04
2014	2,190,138	Demersal	28,418	3,565	Demersal	12.0
		Pelagic	161		Pelagic	0.1
		Shellfish	2,161,558		Shellfish	3,553.0
2013	3,051,195	Demersal	8,959	3,290	Demersal	2.2
		Pelagic	22,400		Pelagic	42.1
		Shellfish	3,019,836		Shellfish	3,245.8
2012	2,388,071	Demersal	6,220	1,847	Demersal	3
		Pelagic	262		Pelagic	0
		Shellfish	2,381,589		Shellfish	1,843

Table 5.4: Annual landings in tonnes for ICES rectangles containing VDP2 and VDP3 infrastructure, ICES Rectangle 35F1

Year	Total value (£)	Species type	Value (£)	Total quantity (tonnes)	Species type	Quantity (tonnes)
2016	1,462,374	Demersal	8,066	1,118	Demersal	2
		Pelagic	0		Pelagic	0
		Shellfish	1,454,308		Shellfish	1,117
2015	1,157,009	Demersal	27,014	936	Demersal	8
		Pelagic	20		Pelagic	0
		Shellfish	1,129,975		Shellfish	928
2014	1,286,988	Demersal	76,721	1,122	Demersal	22
		Pelagic	0		Pelagic	0
		Shellfish	1,210,267		Shellfish	1,100
2013	1,460,314	Demersal	115120.23	1,417	Demersal	25
		Pelagic	400		Pelagic	0
		Shellfish	1,344,793		Shellfish	1,392
2012	874,719	Demersal	23,047	887	Demersal	1
		Pelagic	2,436		Pelagic	0
		Shellfish	849,236		Shellfish	99

Table 5.5: Annual landings in tonnes for ICES rectangles containing VDP2 and VDP3 infrastructure, ICES Rectangle 35F2

Year	Total value (£)	Species type	Value (£)	Total quantity (tonnes)	Species type	Quantity (tonnes)
2016	366,345	Demersal	366,215	84	Demersal	84.1
		Pelagic	0		Pelagic	0
		Shellfish	130		Shellfish	0
2015	283,800	Demersal	283,654	82	Demersal	82.0
		Pelagic	0		Pelagic	0
		Shellfish	146		Shellfish	0.1
2014	379,667	Demersal	376,390	125	Demersal	121
		Pelagic	0		Pelagic	0
		Shellfish	3,277		Shellfish	4
2013	483,111	Demersal	477,082	151	Demersal	148.3
		Pelagic	0		Pelagic	0
		Shellfish	6,029		Shellfish	2.3
2012	89,727	Demersal	68,927	36	Demersal	29
		Pelagic	0		Pelagic	0
		Shellfish	20,800		Shellfish	8

Table 5.6: Annual landings in tonnes for ICES rectangles containing VDP2 and VDP3 infrastructure, ICES Rectangle 36F2

Year	Total value (£)	Species type	Value (£)	Total quantity (tonnes)	Species type	Quantity (tonnes)
2016	935,891	Demersal	663,863	431	Demersal	334.8
		Pelagic	124		Pelagic	0.1
		Shellfish	271,904		Shellfish	96.2
2015	562,101	Demersal	417,493	292	Demersal	229.9
		Pelagic	1		Pelagic	0.0
		Shellfish	144,607		Shellfish	61.6
2014	432,237	Demersal	324,436	235	Demersal	196.5
		Pelagic	24		Pelagic	0.0
		Shellfish	107,776		Shellfish	38.6
2013	863,461	Demersal	773,332	435	Demersal	396.2
		Pelagic	93		Pelagic	0.1
		Shellfish	90,036		Shellfish	38.8
2012	407,943	Demersal	299,215	957	Demersal	915.7
		Pelagic	1		Pelagic	0.0
		Shellfish	108,727		Shellfish	41.1

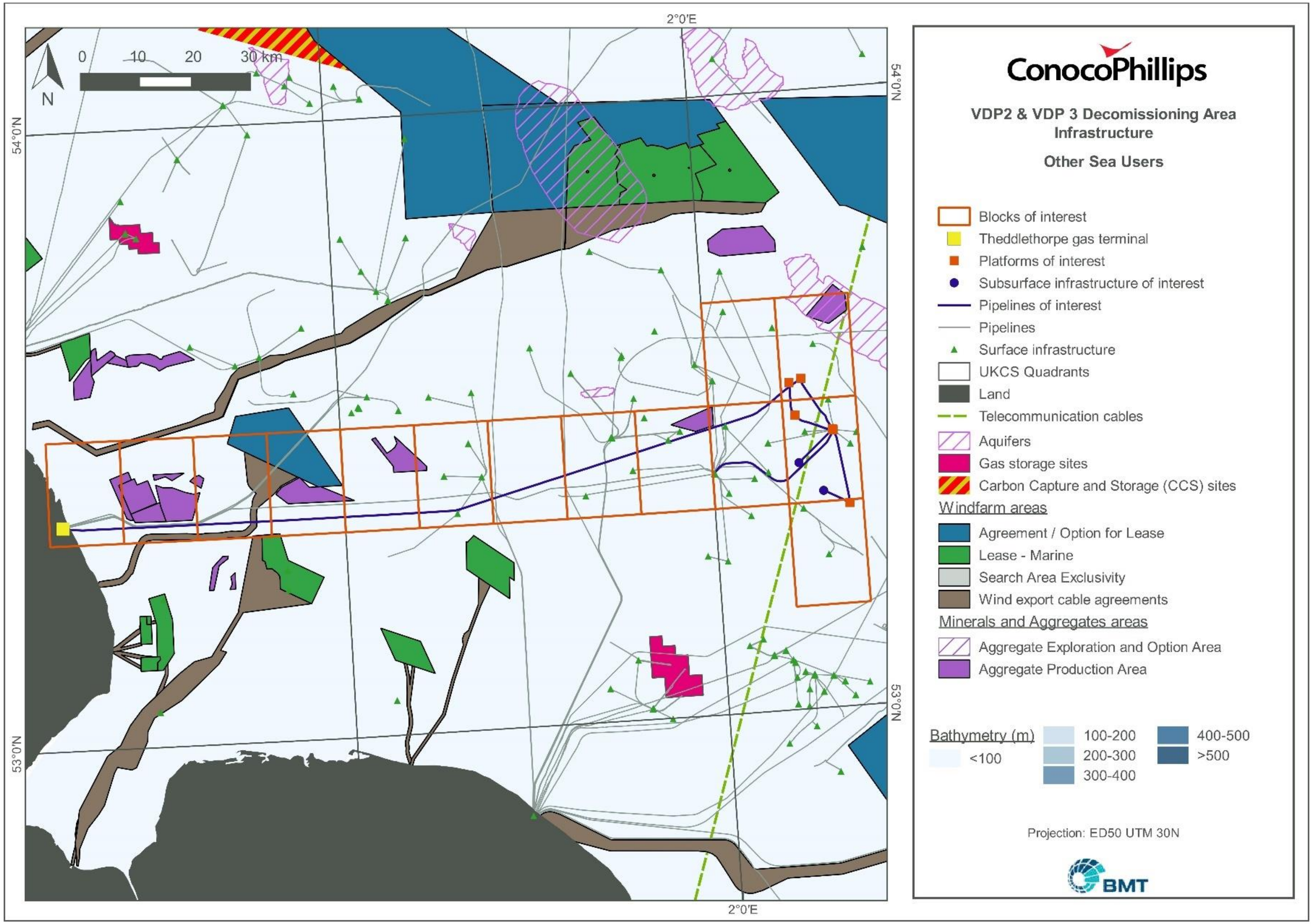
5.2 Nearby Oil and Gas Infrastructure

The VDP2 and VDP3 areas are located in the SNS gas basin which is densely populated by various installations (Figure 5.11) (OGA, 2017). The closest platforms, wellheads and tee-pieces, located within 5 km from VDP2 and VDP3 infrastructure, are listed in Table 5.7. The area is extensively developed, and therefore other installations and associated activities may present cumulative impacts onto the surrounding environment in conjunction with the VDP2 and VDP3 decommissioning activities, in particular the North Norfolk Sandbank and Saturn Reef SAC. Within the SAC, approximately 94% of the pipelines were trenched and buried, and therefore do not affect the seabed or related processes. An estimated 0.4 km^2 of seabed may be impacted by pipelines which remain on the surface, although the cyclical nature of the natural environment, and the movement of sand wave features in the area is recognised to present variability to this estimate (ConocoPhillips, 2014c). Within the next 10 years, ConocoPhillips intends to decommission further oil and gas installations in the area. ConocoPhillips has forecast potential activities to BEIS, and recognises future projects will be subject to the requirements of the Habitats Regulation once applications are made. The only other decommissioning operations under consideration in the area are the Centrica Ann and Alison fields (Centrica, 2017). Although the Ann field lies outwith the SAC and cSAC, the export pipelines cross both areas, and therefore a cumulative effect of decommissioning is considered likely. ConocoPhillips will plan to mitigate significant impact to the SAC and cSAC sites and other users of the sea with consideration of these potential cumulative impacts.

There are also 19 pipeline crossings located along export pipeline PL27. Details of all the crossings are given in Section 3.4.5 (Table 3.8).

Table 5.7: Platforms and subsea infrastructures located within 5 km from VDP2 and VDP3 export pipeline and infield infrastructure

Platform/ Subsea Structure	Block	Distance from VDP2 and VDP3 Pipeline/ Infrastructure (km)	From which infrastructure	Direction from Pipeline/ Infrastructure	Operator
Waveney platform	48/17	0.6	export pipeline	south	Perenco
Tee-piece on PL454	48/17	2.3	export pipeline	north	ConocoPhillips
Lancelot A platform	48/17	4.3	export pipeline	north	Perenco
Anglia West wellhead	48/18	3.0	export pipeline	south	Ithaca
Tee-piece on PL454	48/19	2.4	export pipeline	south	ConocoPhillips
Anglia A platform	48/19	4.6	export pipeline	south	Ithaca
Clipper South platform	48/19	2.8	export pipeline	south	Ineos
Clipper PR platform & Clipper North Field	48/19	3.9	export pipeline	north	Shell
Skiff platform	48/20	0.3	export pipeline	north	Shell
Galleon PN platform	48/20	1.2	export pipeline	north	Shell
Alison/ KX wellhead	49/11	0.9	export pipeline	north west	Spirit
Ganymede ZD platform	49/22	4.7	Victor JM	south west	ConocoPhillips



Sources: Crown Estate, 2017; OGA, 2017; UK Oil and Gas Data, 2017; MMO, 2017a

Figure 5.11: Other sea users in the vicinity of the VDP2 and VDP3 decommissioning area

5.3 Aggregate Extractions, Offshore Renewables and Carbon Capture Storage

The VDP2 and VDP3 infrastructure is located within areas of Crown Estate offshore activity for aggregates, windfarms and dredging (Figure 5.11).

Within the area of interest, there are a total of six active aggregate extraction sites and three application sites which all lie seaward of the 6 nm limit (Crown Estate, 2017; MMO, 2017a). None of these are considered to have a significant impact coinciding with activities associated with the decommissioning of the VDP2 or VDP3 infrastructure. Of note is that, for the most recently published statistics, of the 163 km^2 licensed for dredging within the Humber Region, only 18 km^2 was actually dredged (Crown Estate, 2017). Aggregate extraction sites 484 and 483 lie within the North Norfolk Sandbanks and Saturn Reef SAC. Site 484 has been given consent as of March 2015 (Crown Estate, 2017), and site 483 is awaiting a decision. Following an assessment undertaken by the applicants of both sites, it was concluded that dredging activities would not cause significant effect to the surrounding environment, and agreements made with the MMO and JNCC to avoid areas of *S. spinulosa* reefs (MMO, 2015). Further information is provided in Table 5.8.

Table 5.8 Schedule of marine aggregate and renewables activities of relevance to VDP2 and VDP3

Aggregate site incl. license number	Status of license	Block	Distance from VDP2/ VDP3 infrastructure (km)	From which infrastructure	Direction from infrastructure
Humber Overfalls (493)	Aggregate production area	47/17, 47/18	1.3	export pipeline	north
Off Saltfleet (197)	Aggregate production area	47/17, 47/18	2.5	export pipeline	north
Humber Estuary (106/1)	Aggregate production area	47/18	8.2	export pipeline	north
Humber Estuary (106/2)	Aggregate production area	47/18, 47/19	6.6	export pipeline	north
Humber Estuary (106/3)	active license	47/18, 47/19	0.9	export pipeline	north
Humber Estuary (400)	Aggregate production area	47/18	0.9	export pipeline	north
106 East (480)	Aggregate production area	47/18, 47/19	1.3	export pipeline	north
Outer Dowsing (515/1 & 515/2)	Aggregate production area	48/16, 48/17, 47/20	2.9	export pipeline	north
Inner Dowsing (481/1)	Aggregate production area	47/24	5.9	export pipeline	south

Inner Dowsing (481/2)	Aggregate production area	47/24	9.0	export pipeline	south
Humber 3 (484)	Aggregate production area	48/20, 49/11, 49/16	0	export pipeline	n/a
Humber 5 (483)	Application and extended option	49/11, 49/12	4.6	Viking AR	north east
Race Bank Wind Farm Limited	Under construction	47/19, 47/20, 47/24, 47/25	2.2	export pipeline	south
Dudgeon Offshore Wind Limited	In operation	48/22, 48/23	5.2	export pipeline	south
Triton Knoll Offshore Windfarm	Consented	47/14, 47/15, 47/19, 47/20	5.6	export pipeline	north
Lincs Wind Farm Limited	In operation	47/23, 47/28	12.2	export pipeline	south
Inner Dowsing Wind Farm Limited	In operation	47/23	15.8	export pipeline	south
SCIRA Offshore Energy Limited	In operation	48/21, 48/26, 48/27	20.3	export pipeline	south
Lynn Wind Farm Limited	In operation	47/28	23.2	export pipeline	south

Source: Crown Estate (2018)

Three wind farms are consented within 10 km of the VDP2 and VDP3 infrastructure (Figure 5.11). The Race Bank Wind Farm (Blocks 47/19, 47/20, 47/24 and 47/25) located 2.2 km south from the export pipeline, is currently under construction. The Dudgeon Offshore Wind Farm (Block 48/22 and 48/23) located 5.2 km south from the export pipeline, is in operation. The Triton Knoll Offshore Wind Farm (Blocks 47/14, 47/15, 47/19 and 47/20) is located 5.6 km north from the export pipeline. The electrical grid connection for this wind farm was granted consent in September 2016. Also, consented and live is the Triton Knoll export cable route, located in Blocks 47/19 and 47/20, which will cross the export pipeline (Crown Estate, 2018; MMO, 2017a). Furthermore, the Hornsea Project 1 Transmission Asset (OFTO) Wind Farm export cable, within Blocks 47/17 and 47/18 is currently under construction and is within the vicinity of the export pipeline. The Hornsea 3 Offshore Wind Farm, approximately 30 km from the area of interest, have recently published their Preliminary Environment Impact Report (Dong Energy, 2017). The proposed area of search for the Hornsea 3 Wind Farm export cable will cross the infield blocks, and therefore future construction works may be in place, this may include the use of rock placement to ensure the burial of the export cable, and therefore present a cumulative impact to the North Norfolk Sandbanks and Saturn Reef SAC. ConocoPhillips will ensure decommissioning operations pose a minimal risk to other users of the sea or is mitigated as necessary, and any remaining infrastructure is identified and communicated to reduce risk to other users of the sea and the surrounding environment, taking into consideration the possible cumulative activities associated with renewables activities.

All VDP2 and VDP3 blocks overlay the Bunter Sandstone Formation, which is thought to have the best aquifer storage potential for CO_2 amongst reservoir rocks of SNS. Suitable aquifers may be present in Blocks 48/19, 48/20, 49/11, 49/16 and 49/17 (Crown Estate, 2018; MMO, 2017a). The export pipeline crosses the aquifer located in Blocks 48/19 and 48/20. Most of infield pipelines, Viking LD and Viking Bravo Hub Complex are located over an aquifer that spreads over Blocks 49/11, 49/16 and 49/17 (Figure 5.11). These areas are highlighted in the MMO East inshore and offshore management plans as potential areas for future Carbon Capture Storage (CCS) opportunities.

5.4 Commercial Shipping

Shipping density in the area of the VDP2 and VDP3 infrastructure ranges from very low to very high (DECC, 2014a). The MMO has made vessel Automated Identification System (AIS) data available for 2011 and 2012. The combined AIS data images for 2011 and 2012 are presented in Figures 5.12 and 5.13. There is a degree of vessel activity in the vicinity of the platforms to be decommissioned; however, this is most likely attributed to vessels servicing the platforms. Figures 5.14a and 5.14b indicate the constituting vessel spread associated with the vessel activity presented in Figure 5.13 for 2012 AIS data.

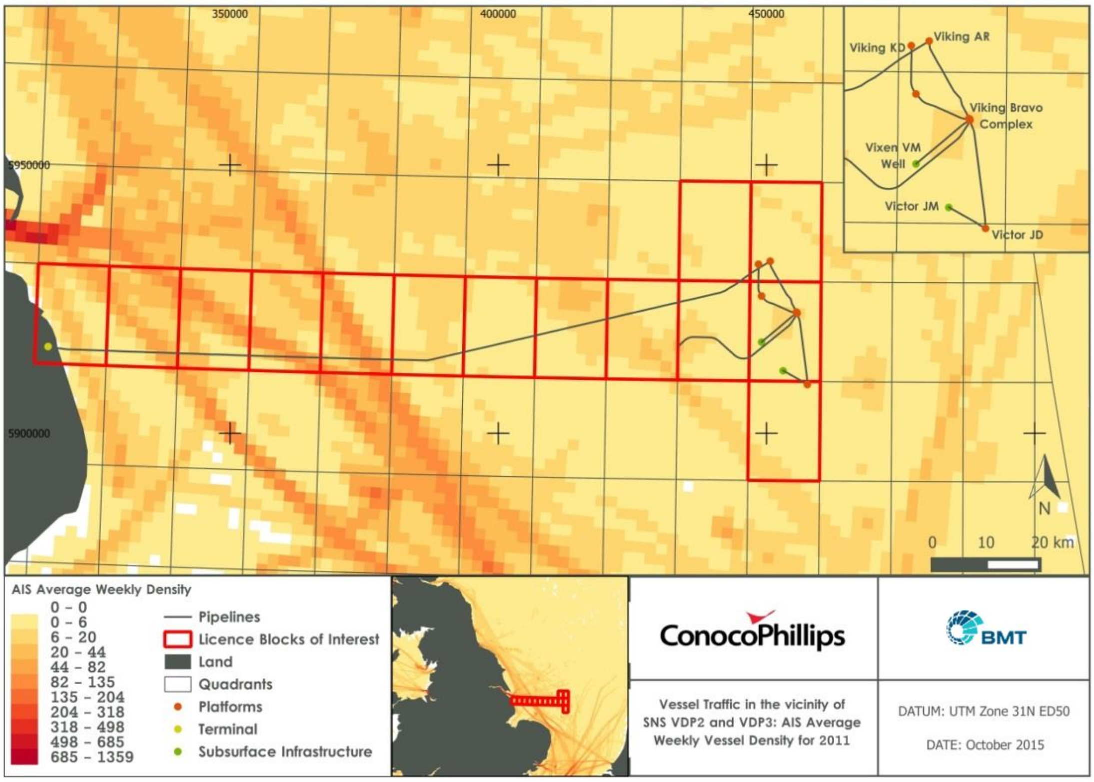
AIS data only provide information on the type of vessel and not what activity it is undertaking. This needs to be considered when looking at vessels such as fishing vessels (Figure 5.14b). This activity could represent transiting to/ from fishing grounds, guard vessel duties or fishing activities.

The main contributing factor of very high vessel density in the area closer to shore (Blocks 47/18, 47/19, 47/20 and 48/16) is the number of large international ports within the region, and includes the UK ports of:

- Hull (a commercial and passenger port, with ferry services to Zeebrugge and Rotterdam);
- Immingham (a commercial container port on the Humber);
- Grimsby (particularly important for commercial fishing landings); and
- Great Yarmouth (a supply/ fabrication base for the offshore oil and gas industry and a ro-ro ferry service to the Netherlands).

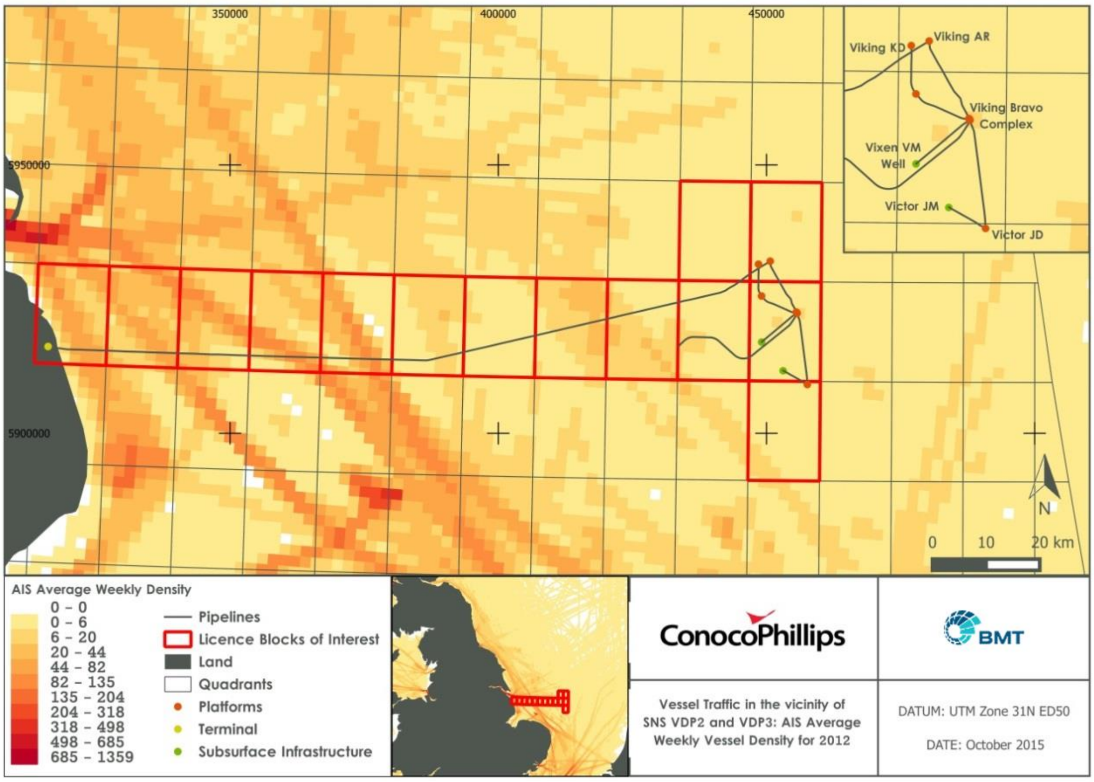
A number of shipping route surveys were undertaken in 2006 in support of the ES for the new Viking to LOGGS pipeline (ConocoPhillips, 2008). It was estimated that 1,549 vessels per year pass in the vicinity of the VDP2 and VDP3 areas. This equated to an average of four to five vessels per day. Although the area has a relatively high shipping density, this is not considered significant compared to other locations in the southern North Sea (ConocoPhillips, 2008).

Moderate vessel densities were observed in the ES for the Valkyrie well extension in 2003, which is located near the route of export pipeline. This assessment indicated several shipping lanes in the vicinity of Block 49/16, with approximately 1,000 vessels using these each year. Most of these vessels were large vessels over 40,000 tonnes. There were also about 1,500 supply vessels expected to use the area per year, these were primarily small vessels less than 1,000 tonnes (ConocoPhillips, 2003; MMO, 2014).



Sources: OGA, 2017; UK Oil and Gas Data, 2017; MMO, 2014

Figure 5.12: Summary of the AIS average weekly vessel density for 2011 within the blocks containing VDP2 and VDP3 infrastructure



Source: OGA, 2017; UK Oil and Gas Data, 2017; MMO, 2014

Figure 5.13: Summary of the AIS average weekly vessel density for 2012 within the blocks containing VDP3 and VDP3 infrastructure

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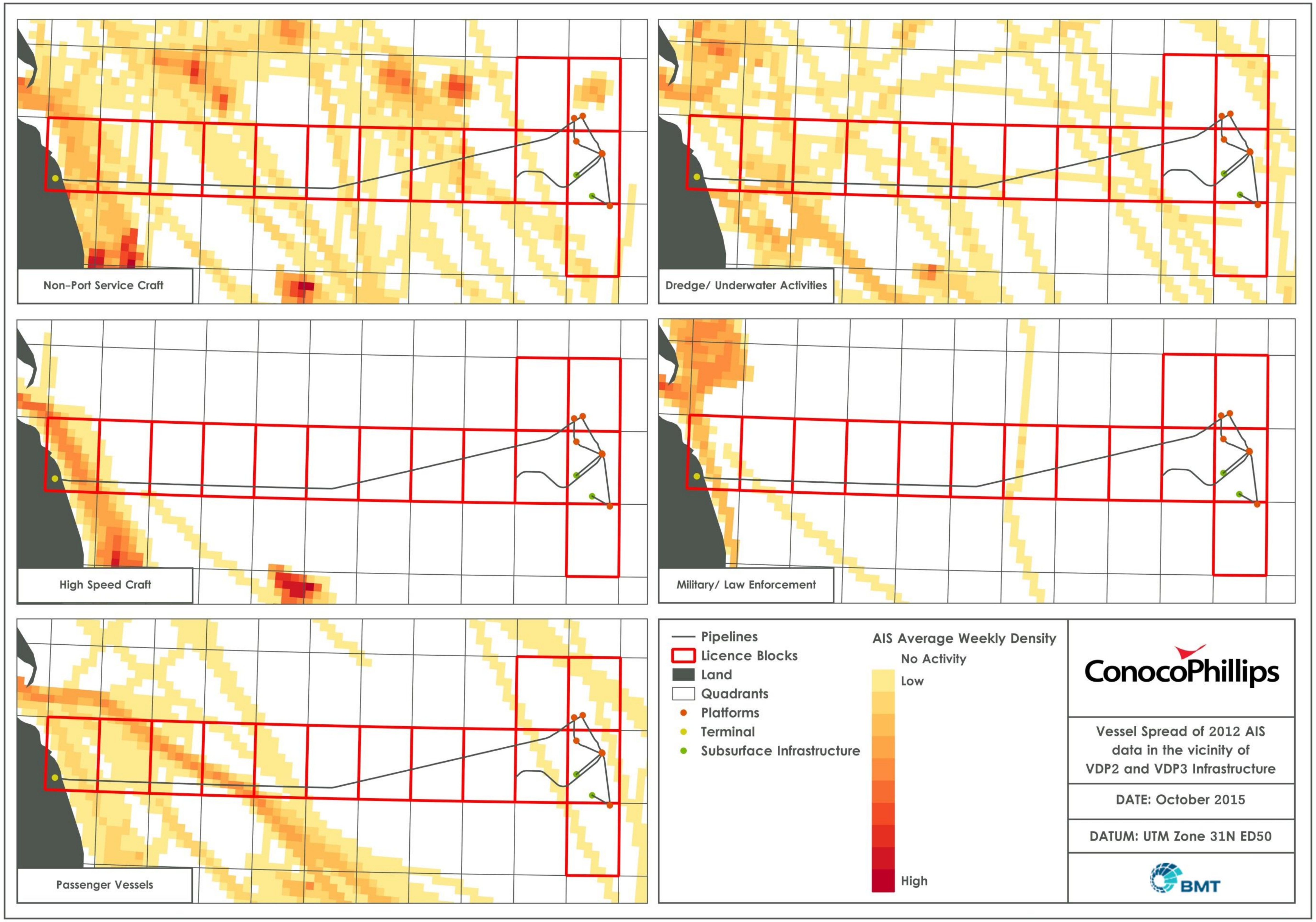
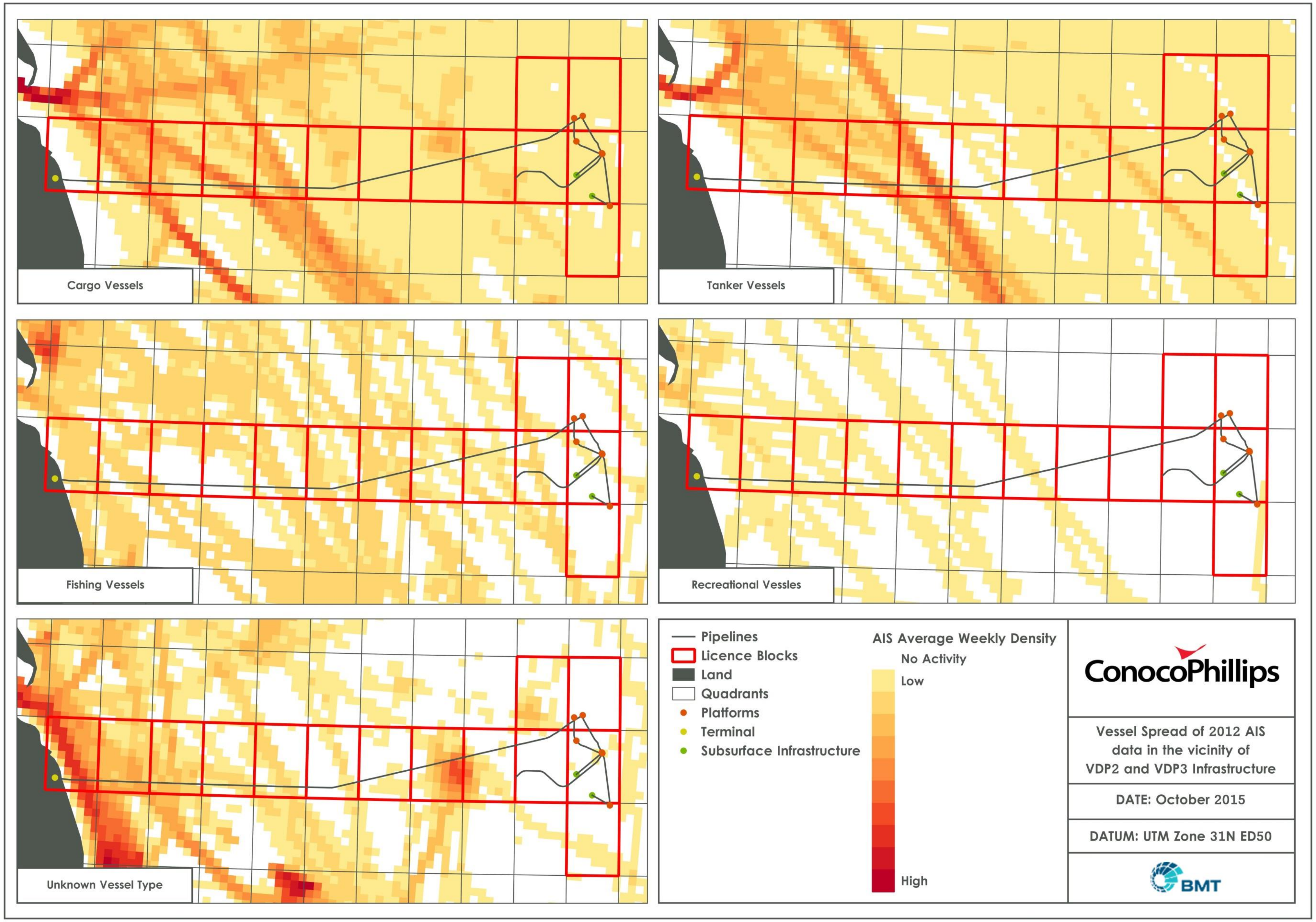


Source: OGA, 2017; UK Oil and Gas Data, 2017; MMO, 2014

Figure 5.14a: Vessel spread of the 2012 AIS data within the blocks containing VDP2 and VDP3 infrastructure



Source: OGA, 2017; UK Oil and Gas Data, 2017; MMO, 2014

Figure 5.14b: Vessel spread of the 2012 AIS data within the blocks containing VDP2 and VDP3 infrastructure

5.5 Telecommunication and Cabling

The Tampnet telecommunications cable links the UK and Norway and in addition connects five offshore platforms (Crown Estate, 2017). The landing points for the cable are Lowestoft in Suffolk in the UK and Kårstø, Rogaland in Norway. The five platforms that are connected to the network are Draupner platform, Ula oil field, Ekofisk, Valhall oil field and the Murdoch gas field. The cable system is currently owned by Tampnet AS.

The Tampnet cable crosses Blocks 49/12, 49/17 and 49/22 containing VDP2 and VDP3 infrastructure. The cable passes within 200 m of the Viking HD platform.

5.6 Military Activities

Block 47/17 containing final inshore section of the export pipeline lies within a military exercise area (MMO, 2017a). AIS data presented in Section 5.4, indicate that there is a regular shipping route used by military/ enforcement vessels which transects PL27. Timings of the proposed VDP2 and VDP3 operations would ensure that military activities remain unaffected.

5.7 Wrecks

There are 117 wrecks located within the 14 blocks containing VDP2 and VDP3 infrastructure (Wrecksite, 2015). None are classed as designated wrecks, however, among them there are 52 wrecks classed as dangerous, 41 located along the export pipeline route and 11 near infield infrastructure (Table 5.9). Only one of them, East Essex S Trawler, located in Block 49/16, 0.9 km south west from Viking Bravo Hub Complex (BA, BC, BP and BD platforms), could potentially interfere with planned decommissioning operations. Remaining wrecks are located more than 2 km away from infrastructure which will be removed during VDP2 and VDP3 decommissioning activities.

Table 5.9: Summary of the dangerous wrecks present in the vicinity of infrastructure proposed for decommissioning under VDP2 and VDP3

Wreck name	Type of wreck	Block
Pipeline		
Venture	M Fishing	47/17
Ravonia	SS	47/18
Unknown	Unknown	47/18
Unknown	Unknown	47/18
Amelie-Mathilde	M Trawler	47/18
Rivergate	MV	47/18
Unknown	Unknown	47/19
Petroswift	M Launch	47/19
Victoria	Unknown	47/19
Onesta	SS	47/19
Trignac	SS	47/19
Nimrod	SV (Smack)	47/19
Unknown	Unknown	47/19
Vernon	SS	47/19
Deodata	M Vegetable/Oil/Wine Tanker	47/19
Unknown	Unknown	47/19

Wreck name	Type of wreck	Block
Pipeline		
Unknown	Unknown	47/20
Unknown	Flare Stack	47/20
Fittonia	S Trawler	47/20
HMS Cape Spartel	S Trawler	47/20
Unknown	Unknown	47/20
Unknown	Unknown	47/20
Unknown	Unknown	47/20
Unknown	Unknown	47/20
Unknown	Unknown	47/20
Unknown	Unknown	47/20
Welsh Prince	SS	47/20
Ahamo	S Tanker	47/20
Unknown	SV	47/20
Carrier	SS	47/20
HMS St Donats	S Trawler	48/16
Harden	SS	48/16
Unknown	Aircraft	48/16
W F Vint	Ferry	48/16
Unknown	Unknown	48/16
Pacific	SS	48/16
Unknown	SS	48/16
Ogono	SS	48/16
Zor	SS	48/16
Unknown	SS	48/16
Unknown	Unknown	48/20
Infield		
Unknown	Unknown	49/11
Unknown	Unknown	49/12
Unknown	Unknown	49/12
Kidholm	M Fishing	49/12
Jork	M General Cargo	49/16
St Martin	M Standby Safety Vessel	49/16
Unknown	Unknown	49/16
Unknown	Unknown	49/17
East Essex	S Trawler	49/17
Unknown	Trawler	49/17
Tropic Shore	TM Oil Rig Supply Vessel	49/17

5.8 Summary of the Socioeconomic Characteristics and Sensitivities

Table 5.10 summarises the socioeconomic sensitivities in the area surrounding VDP2 and VDP3.

Table 5.10: Summary of the socioeconomic sensitivities in the decommissioning areas

Aspect	Characteristics
Commercial fishing	
Low to high fishing activity occurs within the vicinity of the VDP2 and VDP3 infrastructure. The UK vessel activity is targeted closer inshore and is primarily shellfish species fishery for crab and *Nephrops*. Dutch vessels primarily fish further offshore using trawlers fishing for demersal species, mainly plaice and sole. Based on VMS data there is little vessel activity in the immediate vicinity of the infield pipelines.	
Other users	
Shipping activity	Shipping activity in the area of the VDP2 and VDP3 infrastructure ranges from very low to very high.
Oil and gas	The nearest non-ConocoPhillips infrastructure to VDP2 and VDP3 is Skiff platform operated by Shell, located in Block 48/20, 0.3 km north from the export pipeline.
Telecommunications	The Tampnet Telecom cable passes 2.2 km from Viking BA platform and 2 km from the Vixen VM subsea manifold. This cable also transects pipelines, PL88/ PL134, PL1571/ PL1573, PL1767/ PL1768 and PL2643/ PL2644.
Military activities	Block 47/17 lies within a military exercise area.
Aggregate extractions	Aggregate application, option areas are located within the area of VDP2 and VDP3 infrastructure.
Windfarms	Three windfarm are located in the vicinity of VDP2 and VDP3 area.
Carbon capture storage (CCS)	Aquifers with the potential for CCS in the southern North Sea are located within Blocks 48/19, 48/20, 49/11, 49/16 and 49/17, containing VDP2 and VDP3 infield infrastructure.
Wrecks	No designated historical wrecks have been recorded in the area. There are 52 wrecks classed as dangerous wrecks by the United Kingdom Hydrographic Office in the vicinity of VDP2 and VDP3 infrastructure. East Essex S Trawler is located in Block 49/19, 0.9 km south west from Viking Bravo Complex.

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6.0 STAKEHOLDERS VIEWS

Consultation with stakeholders is an important part of the EIA process. It enables the issues and concerns of stakeholders to be recorded, addressed and communicated within the ES and, where applicable, acted upon during the planning stage.

6.1 Previous Consultation for VDP1 and LDP1

For VDP1 and LDP1, ConocoPhillips held initial meetings and/or dialogue with BEIS (formerly DECC), Environment Agency (EA), JNCC, Scottish Fishermen's Federation (SFF), Northern Irish Fish Producers' Organisation (NIFPO), Anglo North Irish Fish Producers Organisation (ANIFPO), National Federation of Fishermen's Organisations (NFFO) and VisNed (Association of Dutch Demersal Fishers) on the proposed decommissioning strategy.

Table 5.1 provides a summary of the key issues raised during the consultation process and ConocoPhillips responses to these issues for VDP1 and LDP1.

6.2 Initial Consultation for VDP2 and VDP3

Further meetings have been held regarding VDP2 and VDP3 with BEIS (formerly DECC) and JNCC on the proposed decommissioning strategy. Table 5.2 presents a summary of the issues raised during the consultation process for VDP2 and VDP3.

6.3 Future Consultation

The formal consultation process will begin with the submission of the consultation draft for the Decommissioning Programmes. The consultation process will include a public notice of the availability of the Decommissioning Programmes on the BEIS and ConocoPhillips websites and that a copy will be available at the ConocoPhillips Aberdeen office for inspection by members of the public. As well as making the programmes publicly available, copies will be sent to the following statutory consultees:

- SFF
- NFFO
- NIFPO
- ANIFPO
- Global Marine Systems Ltd (GMS)
- BEIS
- Any other stakeholder as directed by BEIS.

The public consultation period will last approximately 30 days, at the end of which ConocoPhillips will be notified of the nature of any objections to the proposals.

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Table 6.1: Summary of meetings and key issues raised with regulatory agencies and stakeholders for VDP1 and LDP1

Stakeholder	Meetings/ Focus	ConocoPhillips Related Activities and Responses
BEIS (General decommissioning activities for VDP1 and LDP1)	Between 8th December 2011 and the present day, numerous meetings have been held with BEIS to discuss the following: • Field performance and Cessation of Production dates • Well plug and abandonment campaign • Vessel scope and the placement of supportive rock berms at specific sites • Infrastructure overview • Decommissioning principles and strategic options • Overview of the scope of the SNS Decommissioning Programme and associated ongoing decommissioning activities • Pre-decommissioning baseline environmental surveys and results • Potential for a generic SNS environmental baseline approach • Decommissioning Programme structure, presentation and submission • Pipeline cleaning • Stakeholder engagement • Comparative Assessment progress • Decommissioning regulatory process and linkages with environmental permits, licences and consents.	• Scope of the pre-decommissioning baseline environmental survey for the VDP1 and LDP1 decommissioning activities finalised and commissioned. • Provided copies of the pre-decommissioning environmental baseline survey. • An additional meeting was scheduled with the BEIS (formerly DECC) Environmental Management Team 6th November 2014 to present the southern North Sea future outlook and the proposed scope of an additional SNS pre-decommissioning baseline environmental survey. • 20th November 2014 BEIS (formerly DECC) confirmed they have no objections to the proposed survey scope. ConocoPhillips commenced preparatory work to commission the survey. • BEIS confirmed that there were no objections to the scope of the proposed additional SNS pre-decommissioning baseline environmental survey. • BEIS requested one final review of the decommissioning programme VDP1 and agreed that following this review, should there be no further changes a date for statutory consultation would be agreed • 7th October 2015 statutory consultation of the decommissioning programme VDP1 commenced. • BEIS advised ConocoPhillips to submit a request for permission to execute decommissioning work prior to receipt of an approved decommissioning programme including riser cuts, topside infrastructure removal and subsea pipeline disconnects. • It was confirmed that the Oil & Gas PETS Portal system will allow for the application of derogation from the Consent to Locate Conditions should the use of the solar navigation aids not meet all current conditions.

Table 6.1 (continued): Summary of meetings and key issues raised with regulatory agencies and stakeholders for VDP1 and LDP1

Stakeholder	Meetings/ Focus	ConocoPhillips' Related Activities/ Responses
BEIS (HRA)	• Habitats Regulations Assessment (HRA) September 2017 • BEIS undertook a HRA in respect of the first Viking Decommissioning Programme (VDP1) prepared by ConocoPhillips. • The HRA outlines ConocoPhillips' planned activities in the decommissioning of the VDP1 and LOGGS infrastructure, and details the potential impacts and effects on designated sites, in-combination impacts, likely significant effects and an Appropriate Assessment (AA). • BEIS recognises the potential impacts on the North Norfolk Sandbanks and Saturn Reef SAC and Southern North Sea cSAC, in particular in the assessment. • The HRA and AA found, based on the predicted activities and potential effects, that no significant impact and no adverse effect on the integrity of any site. Furthermore, forecasted future activities, including further decommissioning activities by ConocoPhillips were found to also have no evidence of significant adverse effects on the SAC considered, although BEIS noted that due to lack of data, outwith the VDP1 and LDP1 planned decommissioning locations, lone or in-combination impacts on *Sabelleria* reef habitats could not be made.	• ConocoPhillips have utlised the information in the provided HRA to advise and aid the mitigation of impact for the present assessment of VDP2 and VDP3 activities. • In combination effects, where there is sufficient data, are considered in the present assessment. • ConocoPhillips recognise the presence of the North Norfolk Sandbanks and Saturn Reef SAC and Southern North Sea cSAC in this and future assessments, as well as other nearby designated areas in the aim to mitigate and manage potential impacts effectively.
JNCC	• Meeting 20th November 2014 • ConocoPhillips presented an overview of the scope of the VDP1 and LDP1 decommissioning activities and potential environmental impacts. • Meeting 5th August 2015 Second consultation meeting to provide an update on the status of the Viking decommissioning Programme VDP1. Key agenda items included: • Revised schedule for statutory consultation on VDP1; • Scope of the remaining SNS baseline habitat assessment and pre-decommissioning environmental survey undertaken in Q3 2015 to support all future SNS decommissioning programmes and associated environmental impact assessments.	• A detailed overview of the process undertaken to complete site specific assessments to identify geotechnical risks and associated rock dump requirements was provided. Discussion was held on selection criteria considered when contracting a jack-up work vessel including the costs, ability to complete scope of work, safety risk and environmental impacts and consideration of the conservation objectives of the North Norfolk Sandbanks and Saturn Reef protected marine habitat. • JNCC explained all the recommended Marine Conservation Zones sites which are relevant to ConocoPhillips are in tranche 3 for implementation. A decision will be made on Tranche 2 sites in 2016 and no timeline has been defined yet for tranche 3 implementation and designation.

Table 6.1 (continued): Summary of meetings and key issues raised with regulatory agencies and stakeholders for VDP1 and LDP1

Stakeholder	Meetings/ Focus	ConocoPhillips' Related Activities/ Responses
Fisheries Organisations	**Consultation letter 5th November 2014** Letter introducing the scope and schedule of VDP1 and LDP1 • Consultation meetings on the scope of VDP1 and LDP1 prior to statutory consultation scheduled W/C 26th January 2015. • VisNed; NFFO (UK); SFF (Scotland) ; NIFPO & ANIFPO **Meetings were held with the fisheries organisations relevant to the SNS decommissioning activities (NFFO, VisNed, ANIFPO and NIFPO) in January and February 2015** The aim of these meeting was to build upon the consultation letter previously issued and the primary focus was to: • Advise of ConocoPhillips' intentions and outline plan for managing marine activities; • Confirm ConocoPhillips understand fishing activity in the area and its importance; • Communicate current project schedules and establish communication channels ahead of commencement of statutory consultation. • Allow ConocoPhillips to better understand any concerns these organisations may have regards the proposed activities. **A meeting was also held with the SFF in June 2015 to communicate the following information** Initial consultation to present on the scope of the southern North Sea decommissioning activities and decommissioning programmes. Key agenda items included: • SNS Infrastructure located within the North Norfolk Sandbanks and Saturn Reef Special Area of Conservation (SAC); • Results of the VDP1 comparative assessment process and the intention to decommission mattresses in situ to protect the pipelines, reduce disturbance of the SCI and to minimise the introduction of further material to the marine environment and how this same strategy had been presented to the NFFO; • Future consultation plans.	• Following discussions, ConocoPhillips and the NFFO, NFFO have advised SFF that a meeting has occurred and on that basis a meeting with the SFF has not been scheduled. • NFFO requested that, as far as possible, it would be helpful to their membership if designated work areas could be used during decommissioning works, with designated transit routes to/from the work areas for contracted vessels. • NFFO did not raise any objections to the proposed decommissioning activities. • There was agreement on a bias against rock-placement, as this has the potential to create local effects resulting in increased scour and pipeline exposure, and also has implications for fishing gear. In cases where it is necessary for rock-placement, VisNed suggested that smaller-sized graded rock would be preferable. • VisNed suggested that the historic locations of the platforms be retained in electronic charts in some form, to cater for the possibility that seabed movements may uncover piles/conductors previously cut at 3m below the seabed. • VisNed did not raise any objections to the proposed decommissioning activities. • A general preference highlighted by VisNed for avoiding seabed disruption, though it was recognised that some disruption is inevitable near the platform locations, which ConocoPhillips is obliged to remove, with corresponding pipeline-cutting needs. • ANIFPO did not raise any objections to the proposed decommissioning activities. • NIFPO highlighted s general preference for avoiding seabed disruption, though it was recognised that some disruption is inevitable near the platform locations, which ConocoPhillips is obliged to remove, with corresponding pipeline-cutting needs. • NIFPO did not raise any objections to the proposed decommissioning activities. • It was noted that the NFFO had previously agreed that the rationale for the in situ decommissioning of mattresses within the SCI (now a designated SAC) was transparent and this was communicated to the SFF.

Table 6.1 (continued): Summary of meetings and key issues raised with regulatory agencies and stakeholders for VDP1 and LDP1

Stakeholder	Meetings/ Focus	ConocoPhillips' Related Activities/ Responses
Environment Agency	• Telephone Conversation 8th January 2015 ConocoPhillips commenced dialogue with the International Waste Shipments Team regarding the scope of VDP1 and LDP1 and the location of the disposal yards who have submitted commercial bids for the dismantlement and disposal of the infrastructure. • Shown decommissioning programme presentation 25th February 2015.	

Table 6.2: Summary of meetings and key issues raised with regulatory agencies and stakeholders for VDP2 and VDP3

Stakeholder	Meetings/ Focus	ConocoPhillips' Related Activities/ Responses
BEIS	Between 8th September 2015 and the present day, meetings have been held with BEIS to discuss the following: ConocoPhillips presented on the scope of the proposed VDP2 & VDP3 decommissioning programmes. This included: • Scope and status and current schedule of supporting environmental studies and the socioeconomic environmental impact assessment; • Results of the remaining SNS baseline habitat assessment and pre-decommissioning environmental survey undertaken in Q3 205 to support all future SNS decommissioning programmes and associated environmental impact assessments. • Future communications strategy and frequency of interface meetings throughout the development of the decommissioning programmes VDP2 and VDP3.	• There were no concerns raised regards the scope of the decommissioning programmes VDP2 and VDP3. • It was agreed that meetings every other monthly would be suitable.
JNCC	Consultation meeting in August, 2015, to introduce the scope of the Viking decommissioning programmes VDP2 and VDP3. Key agenda items included: • Scope of the remaining SNS baseline habitat assessment and pre-decommissioning environmental survey undertaken in Q3 2015 to support all future SNS decommissioning programmes and associated environmental impact assessments; • Scope of the decommissioning programmes Viking VDP2 & VDP3 programmes • Proximity of the VDP2 and VDP3 infrastructure to protected marine habitats and recommended Marine Conservation Zones and the implications to ConocoPhillips' decommissioning activities. • Status and current schedule of supporting environmental studies and the socioeconomic environmental impact assessment. Discussion was also held regarding the frequency of future meetings to ensure provision of sufficient information to support consultation of the various regulatory applications.	• A detailed overview of the process undertaken to complete site specific assessments to identify geotechnical risks and associated rock dump requirements was provided. • JNCC explained all the recommended Marine Conservation Zones sites which are relevant to ConocoPhillips are in tranche 3 for implementation. A decision will be made on Tranche 2 sites in 2016 and no timeline has been defined yet for tranche 3 implementation and designation.

7.0 EVALUATION OF POTENTIAL ENVIRONMENTAL IMPACTS

As required by the Petroleum Act, 1998 and OSPAR Decision 98/3, this section identifies and ranks the environmental and societal impacts and risks that could arise from planned operations or unplanned events associated with the VDP2 and VDP3 activities.

The decommissioning activities associated with VDP2 and VDP3 have the potential to cause environmental impact in several different ways, including physical disturbance of the seabed, emissions of gases to the atmosphere and the generation of wastes for disposal onshore. These effects could arise from, or be a consequence of the following decommissioning operations:

- Full removal of topsides and jackets;
- Decommissioning all pipelines in situ;
- Pipelines from VDP1 satellite platforms will be cut at Viking BD;
- Full removal of two manifolds, one pigging skid and two pipeline tie-in tee-pieces;
- Decommissioning associated mattresses/ grout bags:
    - Mattresses and grout bags moved to gain access to tee-pieces, pigging skid and manifolds will be fully removed where safe to do so; and
    - Mattresses needed for protection of the pipelines will be decommissioned in situ.

An assessment of the significance of risk to environmental and societal receptors as a result of the operations was undertaken. The assessment looked at both planned operations and unplanned/ accidental events. Both site specific and cumulative impacts were assessed and discussed where appropriate.

7.1 Risk Assessment Methodology

The purpose of the risk assessment is to:

- Identify potential impacts and risks that may be significant in terms of the threat they pose to particular receptors;
- The need for measures to manage the risk in line with industry best practice; and
- The requirement to address concerns or issues raised by stakeholders during the consultation process.

The scope of this risk assessment is limited to the selected VDP2 and VDP3 activities. Tables 7.6 to 7.10 present the outcome of this assessment; and Sections 8 to 13 provides a more detailed evaluation of those impacts and risks that were assessed as significant. Appendix C provides a justification for those operations assessed as low risk.

The selected VDP2 and VDP3 decommissioning activities were risk assessed against the environmental and societal resources/ concerns listed in Table 7.1.

Table 7.1: List of environmental and societal resources/ concerns

Physical and chemical	Biological	Societal
• Sediment structure • Seabed integrity/ physical change • Water quality • Land • Freshwater	• Sediment biology (benthos) • Water column (plankton) • Finfish and shellfish • Seabirds • Ecosystem integrity • Conservation sites • Terrestrial flora and fauna	• Commercial fishing • Shipping • Government or institutional users (e.g. Ministry of Defence (MoD)) • Other commercial users • Recreational users • Onshore communities (resources)

The risk assessments were undertaken using the following method:

1. Each decommissioning activity was broken down into its component operations and end points (e.g., rock-placement, cutting of pipeline sections, excavation of buried pipeline, and waste in landfill).
2. Receptors at risk (elements of society or the environment) were identified from the potential operational impacts and end-point impacts:
    - Environment (physical, chemical and biological):
        i. Marine environmental impacts/ risks, including operational and accidental/ unplanned impacts/ risks.
        ii. Onshore environmental impacts/ risks, including operational and accidental/ unplanned impacts/ risks.
    - Societal:
        i. Risk to other users of the sea (i.e., fisheries and non-project shipping, including end-point risks from the long-term presence of the pipeline, as appropriate).
        ii. Risk to those on land (i.e. onshore transport, quayside lifting operations, waste management, recycling and disposal).
3. The significance of potential environmental impacts and risks were assessed according to pre-defined criteria. These criteria recognise the likely effectiveness of planned mitigation measures to minimise or eliminate potential impacts/ risks.
4. Assessments were undertaken to determine what level of impacts/ risks the component activity/ operation could pose to the different groups of environmental or societal receptors. The following Scoring Criteria and Risk Matrix were applied to complete the worksheets:
    - ConocoPhillips Consequence Severity Description (Table 7.2), and
    - ConocoPhillips Likelihood Matrix (Table 7.3).

5 The overall risk for a particular activity was determined by the ConocoPhillips Risk Matrix and Risk Categories (Tables 7.4a and 7.4b).

Table 7.2: ConocoPhillips consequence/ severity descriptions

	Consequence – Severity Description (most severe down to least severe)			
Category	**Socio-Cultural Economic Impact**	**Biodiversity Impact**	**Environmental Impact (Remediation Costs)**	**Negative Public Image Exposure**
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; • 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	International Coverage
4	• Permanent partial restriction on access or use, or use, or total restriction >10 years in duration; • Temporary reduction in quality of life > 10 years duration; • Harm to cultural resources requiring major mitigation; • Scale typically regional to national level.	**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 processes and/or • Serious loss (>50%) of unique habitat or legally designated conservation site or intact ecosystems within area of study. • Mitigation only possible through prolonged and resource intensive effort (>50 years).	$1,000,000 to $10,000,000	National Coverage
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 • Temporary, but reversible loss (>25 to 50%) 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 $1,000,000	Regional Coverage
2	• Brief 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 • Brief, but reversible loss (>10 to 25%) of unique habitat or legally designated conservation site or intact ecosystems within area of study. • Minor mitigation efforts required (<1 year).	$10,000 to $ 100,000	Local Coverage
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 • Some minor loss (<10%) of unique habitat or legally designated conservation site or intact ecosystems within area of study. • Naturally and completely reversible.	$ 0 to $10,000	No Outside Coverage

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Table 7.3: ConocoPhillips likelihood matrix

Likelihood (most likely down to least likely)			
Category	**One word descriptor**	**Description**	**Quantitative range per year[1]**
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 improbable and unrealistic. • Very low likelihood or level of uncertainty.	$<10^{-6}$

Table 7.4a: ConocoPhillips 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 7.4b: ConocoPhillips risk categories

Score	Risk	Risk categories
IV: 17-25	**High**	**High Risk.** Manage risk utilising prevention and/ or mitigation **with highest priority**. Promote issue to appropriate management level with commensurate risk assessment detail.
III: 12-16	**Significant**	**Significant Risk.** Manage risk utilising prevention and/ or mitigation **with priority**. Promote issue to appropriate management level a with commensurate risk assessment detail.
II: 5-10	**Medium**	**Medium Risk** with controls verified. No mitigation required where controls can be verified as functional.
I: 1-4	**Low**	**Low Risk.** No mitigation required.

7.2 Risk Assessment Findings

The risk assessment summary is shown in Table 7.5, with detailed assessments presented in Tables 7.6 to 7.10. The left-hand column of the detailed tables identifies aspects of the VDP2 and VDP3 decommissioning activities that may cause, or have the potential to cause impacts to sensitive receptors. These environmental aspects (BSI, 2004) include routine, abnormal and emergency events during the lifetime of the decommissioning project. The remaining columns of the tables identify the potential physical, chemical, biological and societal receptors. The last two right-hand columns of the tables present the overall assessed risk category and the sections of the report that give a detailed justification of the assessment made.

Taking the effects of planned mitigation into account, there were no high environmental risks identified during the assessment. However, the risk assessment identified six activities associated with VDP2 and VDP3 as having the potential to be of significant risk and several activities to be of medium risk, which are assessed further in Sections 8 to 13:

- Energy and emissions (Section 8);
- Underwater noise (Section 9);
- Seabed impacts (Section 10);
- Discharges to sea (Section 11);
- Societal impacts (Section 12);
- Accidental events (Section 13).

For the impacts or risks that were considered to be low, Appendix C provides the justification for excluding these potential impacts and risks from further investigation in the EIA.

Table 7.5: Summary of the total number of risks for the VDP2 and VDP3 risk assessment

Decommissioning activities	Risk categories							
	I - Low		II - Medium		III - Significant		IV - High	
	Planned operations	Unplanned events	Planned operations	Unplanned events	Planned operations	Unplanned events	Planned operations	Unplanned events
General decommissioning activities	6	1	3	1	0	0	0	0
Full removal of topsides	6	2	2	0	1	0	0	0
Full removal of jackets	4	2	3	0	1	0	0	0
Full removal of tee-pieces, manifolds and pigging skid	4	1	0	0	0	0	0	0
Decommissioning of pipelines and mattresses in situ	3	0	3	0	2	0	0	0

Table 7.6: General decommissioning activities associated with VDP2 and VDP3

Key to Risk categories:

IV	High
III	Significant
II	Medium
I	Low

	Physical and chemical						Biological								Societal							
	Sediment structure/ chemistry	Seabed Integrity/ physical change	Water quality	Air quality (local)	Land	Fresh-water	Sediment biology (benthos)	Water column (plankton)	Finfish and shellfish	Sea mammals	Seabirds	Ecosystem integrity	Conservation sites	Terrestrial flora and fauna	Commercial fishing	Shipping	Government, institution users (e.g MOD)	Other commercial users	Recreation and amenity users	Onshore communities (resources)	Overall Risk Category	Justification Section Reference
Planned operations																						
Physical presence of vessels															✓	✓	✓	✓	✓	✓	I	Appendix C
Underwater noise from Dynamic Positioning (DP) vessels, engines and on-board equipment									✓	✓											II	Section 9
Operational discharges of treated oily bilge			✓					✓	✓	✓	✓										I	Appendix C
Waste produced from onsite vessels				✓										✓						✓	I	Appendix C
Sewage and grey water discharges			✓					✓	✓												I	Appendix C
Macerated food waste discharge			✓					✓	✓												I	Appendix C
Ballast water uptake and discharge from the vessels on site							✓	✓	✓												I	Appendix C
Atmospheric emissions from vessels				✓																	II	Section 8
Atmospheric emissions from helicopters				✓																	II	Section 8
Unplanned Events																						
Dropped objects	✓	✓													✓			✓			I	Appendix C
Vessel to vessel collision			✓		✓			✓	✓	✓	✓	✓	✓		✓	✓		✓	✓	✓	II	Section 13

Table 7.7: Full removal (single or multiple lifts) of topsides

Key to Risk categories:

IV	High
III	Significant
II	Medium
I	Low

	Physical and chemical						Biological								Societal							
	Sediment structure/ chemistry	Seabed Integrity/ physical change	Water quality	Air quality (local)	Land	Fresh-water	Sediment biology (benthos)	Water column (plankton)	Finfish and shellfish	Sea mammals	Seabirds	Ecosystem integrity	Conservation Sites	Terrestrial flora and fauna	Commercial fishing	Shipping	Government, institution users (e.g MOD)	Other commercial users	Recreation and amenity users	Onshore communities (resources)	Overall Risk Category	Justification Section Reference
Planned operation																						
Topside preparation for removal using hot cut, welding, etc.			✓	✓				✓	✓												I	Appendix C
Engineering down and cleaning			✓					✓	✓												I	Appendix C
Power generation for topside separation and cutting (plasma, flame or cold cutting)				✓																	I	Appendix C
Topside separation and cutting (plasma, flame or cold cutting)			✓	✓				✓	✓												I	Appendix C
Power generation for HLV onsite, during transportation to shore and transfer of modules to cargo barge				✓																	II	Section 8
Power generation for dismantling structures onshore				✓																	I	Appendix C
Dismantling structures/ recovery of materials onshore				✓	✓	✓														✓	I	Appendix C
Anchoring of the lifting vessel		✓					✓		✓			✓	✓								II	Section 10
Rock-placement of the AWV footing for removal of topsides		✓					✓		✓			✓	✓		✓						III	Section 10
Unplanned events																						
Topside loss during lifting and transportation	✓	✓	✓				✓		✓				✓			✓					I	Appendix C
Loss of minor/ small items e.g., scaffold within 500 m of the platform		✓						✓		✓			✓								I	Appendix C

Table 7.8: Full removal (single lift) of jackets

Key to Risk categories: IV High; III Significant; II Medium; I Low	Physical and chemical						Biological								Societal							
	Sediment structure/ chemistry	Seabed Integrity/ physical change	Water quality	Air quality (local)	Land	Fresh-water	Sediment biology (benthos)	Water column (plankton)	Finfish and shellfish	Sea mammals	Seabirds	Ecosystem integrity	Conservation Sites	Terrestrial flora and fauna	Commercial fishing	Shipping	Government, institution users (e.g MOD)	Other commercial users	Recreation and amenity users	Onshore communities (resources)	Overall Risk Category	Justification Section Reference
Planned operation																						
Power generation for underwater cutting of jackets legs				✓																	I	Appendix C
Underwater cutting of jacket piles 3.0 m below seabed	✓	✓	✓				✓	✓	✓	✓			✓								II	Section 10
Power generation for HLV onsite, during transportation to shore and transfer of modules to cargo barge				✓																	II	Section 8
Power generation for dismantling structures onshore				✓																	I	Appendix C
Dismantling structures/ recovery of materials onshore				✓	✓	✓														✓	I	Appendix C
Anchoring of the lifting vessel		✓					✓		✓			✓	✓								II	Section 10
Unplanned events																						
Jacket loss during lifting and transportation	✓	✓	✓				✓		✓				✓			✓					I	Appendix C
Loss of minor/ small items e.g., scaffold within 500 m of the platform		✓						✓		✓			✓								I	Appendix C

Table 7.9: Full removal of tee-pieces, manifolds and pigging skid

Key to Risk categories:

IV	High
III	Significant
II	Medium
I	Low

	Physical and chemical						Biological								Societal							
	Sediment structure/ chemistry	Seabed Integrity/ physical change	Water quality	Air quality (local)	Land	Fresh-water	Sediment biology (benthos)	Water column (plankton)	Finfish and shellfish	Sea mammals	Seabirds	Ecosystem integrity	Conservation Sites	Terrestrial flora and fauna	Commercial fishing	Shipping	Government, institution users (e.g MOD)	Other commercial users	Recreation and amenity users	Onshore communities (resources)	Overall Risk Category	Justification Section Reference
Planned operations																						
Removing grout bags	✓	✓					✓					✓	✓								I	Appendix C
Removing protective structure	✓	✓					✓					✓	✓								I	Appendix C
Seabed disturbance during full removal of mattresses to access tee-pieces, manifolds and pigging skid	✓	✓					✓	✓	✓			✓	✓								I	Appendix C
Lift the tee-piece/ manifold/ pigging skid using DSV	✓	✓	✓				✓	✓	✓			✓	✓								I	Appendix C
Unplanned events																						
Accidentally dropped sections of tee-piece/ manifold/ pigging skid during removal operations		✓					✓	✓	✓				✓								I	Appendix C

Table 7.10: Decommissioning pipelines and mattresses in situ

Key to Risk categories:

IV	High
III	Significant
II	Medium
I	Low

	Physical and Chemical						Biological								Societal							
	Sediment structure / chemistry	Seabed Integrity/ physical change	Water quality	Air quality (local)	Land	Fresh-water	Sediment biology (benthos)	Water column (plankton)	Finfish and shellfish	Sea mammals	Seabirds	Ecosystem integrity	Conservation sites	Terrestrial flora and fauna	Commercial fishing	Shipping	Government, institution users (e.g., MOD)	Other commercial users	Recreation and amenity users	Onshore communities (resources)	Overall Risk Category	Justification Section Reference
Planned operations																						
Cleaning and permitted discharge of pipeline contents to marine environment			✓			✓	✓	✓	✓	✓											II	Section 12
Physical presence of in situ pipelines	✓	✓	✓				✓	✓					✓		✓						II	Section 10
Physical presence of mattresses left in situ	✓	✓	✓				✓	✓					✓		✓						III	Section 10
Dredging operations to water jet out pipeline at each end (diver operated)	✓	✓	✓				✓	✓	✓			✓	✓								I	Appendix C
Cutting the pipelines with diamond wires	✓		✓					✓	✓			✓	✓								I	Appendix C
Seabed disturbance during full removal of mattresses to access pipeline ends	✓	✓	✓				✓	✓				✓	✓								I	Appendix C
Rock placed on the seabed to cover the pipeline ends (as above)	✓	✓					✓	✓	✓			✓	✓								III	Section 10
Residual contaminants released from degrading pipelines decommissioned in situ	✓		✓				✓	✓	✓												II	Section 10
Waste management (marine growth, NORM, landfill use)					✓	✓													✓	✓	II	Section 13

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8.0 ENERGY AND EMISSIONS

As discussed in Section 1, this ES covers two separate decommissioning programmes for the Viking area (VDP2 and VDP3). This section therefore provides separate quantitative estimates of the energy use and atmospheric emissions resulting from the proposed decommissioning operations for the VDP2 and VDP3 infrastructure. The potential for environmental impact and mitigation measures to minimise emissions and optimise energy use is also assessed.

8.1 Regulatory Context

Atmospheric emissions generated from the decommissioning of the VDP2 and VDP3 infrastructure will be managed in accordance with current legislation and standards as detailed within Appendix A.

8.2 Approach

This assessment is based on the Institute of Petroleum (IoP) Guidelines for the Calculation of Estimates of Energy Use and Gaseous Emissions in the Decommissioning of Offshore Structures (IoP, 2000). The assessment includes:

- Establishment of a materials inventory for each structure to be decommissioned;
- Identification of all operations associated with the selected decommissioning options;
- Identification of all end points associated with decommissioning each structure (end points are defined as the final states of the materials at the cessation of the decommissioning operations); and
- Selection of conversion factors and subsequent calculation of energy use and atmospheric emissions.

The calculations predominantly use the energy use and atmospheric emission factors provided within the IoP (2000) guidelines. In accordance with these guidelines, alternative factors may be used where specific equipment is considered to have a significantly different fuel use from that presented in the IoP database. The Energy and Emissions Technical Note is described in Appendix D and details the factors used for the energy and emissions calculations associated with the manufacture of new materials, recycling of materials, general fuel consumption and vessel fuel use.

8.3 Sources of Potential Impacts

This section reports the findings of the energy and emissions assessment which considered, where appropriate, the following sources:

- Vessels for transportation and offshore operations;
- Helicopters for transportation of personnel;
- Onshore dismantling and/ or processing of materials;
- Onshore transportation to processing, recycling and landfill sites;
- Manufacture or sourcing of new items (e.g., rock-placement and temporary steel work) required for decommissioning operations;
- Recycling; and
- New manufacture to replace recyclable materials decommissioned at sea or disposed of in landfill.

8.4 Assumptions

The following sub-sections outline the assumptions relevant to the VDP2 and VDP3 decommissioning activities as a whole and those assumptions specific to particular components of the infrastructure (e.g. topsides, jackets and pipelines). Insufficient information is presently available to be certain which landing and onshore processing locations will be selected because the waste contractor is not yet selected and so it is necessary to identify likely facilities and routes to account for onshore transportation within the energy and emissions budget.

Calculations were based on data supplied in 2015, however the decommissioning scope has not significantly changed since this initial assessment and any minor amendments to infrastructure weights are not perceived to significantly affect the overall impact of the project. Review carried out in 2018 indicated slightly reduced weights in comparison to the original assumptions, indicating appropriate conservative assessment was carried out.

8.4.1 General assumptions

For the calculation of the energy use and gaseous emissions, the following assumptions were made. These are applicable to all the components of the VDP2 and VDP3 decommissioning operations.

- The estimates of energy use and gaseous emissions will contain an inherent uncertainty. IoP (2000) reports a typical inherent uncertainty of approximately 30 to 40%. However, the primary function of the IoP approach is to compare decommissioning options rather than to obtain absolute estimates of energy use and gaseous emissions.
- A round trip by helicopter to the centre of the VDP2 and VDP3 area takes, approximately, one hour. The helicopter (Superpuma) uses approximately 0.467 tonnes of aviation fuel per hour (Airbus, 2014).
- Energy and emissions calculations for vessel use are based on a worst-case vessel type scenario for the operations (e.g., a Single-Lift Vessel (SLV) may be used as an alternative to a HLV where appropriate; Table 8.1). Therefore energy and gaseous emissions for vessel use may be an overestimation.
- Vessels associated with rock-placement for the stabilisation of the AWV have not been incorporated in this assessment. The exact quantity of rock required for stabilisation at the four satellite locations (Section 3.8) is currently under review. Therefore the number of vessels and duration of each rock-placement operation is unknown. As the placement of rock on the seabed is to provide stabilisation of the AWV at four of the platform locations, there will be an increase in energy use and gaseous emissions. A direction for deposits application will be submitted to the BEIS to seek approval for the commencement of the rock-placement operations. The volume of rock will be detailed within each application, based on the final SSA results (Section 3.8). The application will include detailed berm design drawings and identify, quantify and assess the risks associated with each rock placement operation. Seabed surveys are accounted for within both the Viking area.
- Recovered material is assumed to be landed at Hartlepool (Teesside Docks) and subsequently taken to landfill and/or recycling sites, approximately 1 km to the north of the landing site.
- Any component potentially containing NORM is assumed to have the NORM material removed and this material will be packaged and transported to the Kings Cliffe disposal facility in Northamptonshire, approximately 266 km to the south.

- Any waste requiring incineration is assumed to be sent to Ellesmere Port on Merseyside, approximately 150 km to the west of the landing site.
- Material is transported by lorries with a capacity of approximately 33 tonnes. Lorries are assumed to use approximately 0.46 litres of fuel per km (Defra & DECC, 2011) and are assumed to make a return trip from the landing site to the location of the disposal/ decontamination/ recycling facility.
- The energy use associated with the offshore and onshore deconstruction of materials is calculated according to the IoP factor for “overall dismantling” (IoP, 2000). This assumption has been made for two reasons. Firstly, there is inconsistency in the level of information provided by contractors on the fuel use of their deconstruction equipment. Secondly, there is an absence of published data on the deconstruction of different types of materials and components. Therefore, an overall value is used to allow a comparison between this and other studies.
- Conversion factors (IoP or otherwise) are not available for the emissions associated with overall dismantling. Therefore, atmospheric emissions values for dismantling are not included in the results for emissions associated with decommissioning of the various components.
- A theoretical replacement value is calculated for recyclable material decommissioned in situ or disposed of in a landfill site.
- The energy use and atmospheric emissions associated with recycling and the manufacture of new materials are calculated for all materials for which standard factors are available.

8.4.2 Topside assumptions

The following assumptions apply specifically to the decommissioning of the topsides:

- The VDP2 and VDP3 satellite platforms will be decommissioned using the Single Lift method.
- The decommissioning of the VDP2 hub topsides will be decommissioned using Reverse Installation.
- No material is decommissioned in situ.
- Some temporary steelwork is anticipated to be required to support the topsides during their removal. The quantity of steelwork required is currently unknown, but quantities have been based on previous decommissioning projects with comparable platforms in the North Sea.
- All recovered material that can be recycled will be where practical. Any remaining material will be sent to landfill.
- Where material is marked as miscellaneous, it is assumed that it will be sent to landfill. In reality, it may be possible to recycle or reuse some of this material. Therefore, the amount of material to be sent to landfill can be regarded as conservative. Material sent to landfill has been accounted for under “New manufacture to replace recyclable materials decommissioned in situ or taken to landfill”.
- Any steel pipework contaminated with NORM is assumed to have the NORM material removed at the receiving yard, with the subsequent transportation of the NORM material to the Kings Cliffe disposal facility in Northamptonshire, where the material will be disposed of to landfill. The pipework will remain at the receiving yard where it will be recycled. As it is currently unfeasible to estimate the quantity (and nature) of

NORM in topsides pipework, the quantity of NORM to be transported to Kings Cliffe has been omitted from this assessment.

- An estimate of 20% Wait on Weather (WOW) contingency is applied to all vessels involved with the topsides removal. This estimate is based on working days only.

8.4.3 Jacket assumptions

The following assumptions apply specifically to the decommissioning of the jackets:

- No material is decommissioned in situ above the seabed.
- Individual jacket components (e.g. risers) are indistinguishable from the total steel value.
- All recovered steel and anode material from the jacket is recycled.
- Some steel will remain in situ below the seabed. As the precise amount to be removed/ decommissioned in situ is governed by the location of the sub-seabed cut, it has been assumed that any steel below the seabed will be decommissioned in situ. This has not been accounted for in this assessment due to the unknown quantities of steel below the seabed. It has been assumed here that all jacket steel will be removed and recycled.
- As discussed previously, it is currently unfeasible to estimate the quantity (and nature) of NORM in pipework, the quantity of NORM to be transported to Kings Cliffe has been omitted from this assessment.
- An estimate of 20% WOW contingency has been applied to all vessels involved with topsides removal above sea level. For CSV activity that involves subsea activity, a 50% WOW contingency has been applied. These estimates are based on working days only.
- Post–decommissioning seabed surveys (including overtrawl and debris clearance surveys) for the seabed area surrounding the jacket location will be undertaken concurrently with the pipeline surveys. The vessel use for these surveys is therefore accounted for included in the pipeline decommissioning activities.
- The weight of marine growth on the jackets has not been included with the calculations as an estimate of the hard marine growth is difficult to derive until the jackets arrive onshore. In addition, due to the short distance from the landfall to the disposal site, the relatively small volume of material would have a negligible impact on the energy use and emissions calculations in comparison to other VDP2 and VDP3 activities.

8.4.4 Pipeline assumptions

The following assumptions were made that apply to the pipeline decommissioning:

- All the recovered steel and anode material is recycled; recovered concrete, plastic and coal tar coatings will be taken to landfill.
- Where energy and emissions values are available for a particular material, any items decommissioned in situ, lost to landfill or incinerated have been accounted for in the calculations for replacement. This assessment does not include the materials which do not have representative energy and emissions values for re-manufacture.
- Pipeline NORM values are based on Scotoil Service’s (2014) pipeline investigations. NORM contaminated scale quantities are may be up to an estimated 1.8 kg per metre of pipeline (based on known quantities of scale observed in the gas pipeline at the adjacent Viking GD platform).

- It is assumed that where NORM material cannot be separated from the pipeline materials, these materials will also be transported to the treatment facility at Kings Cliffe. Currently, only the quantity of NORM contaminated scale has been accounted for. This may therefore provide an underestimate of the quantity of material to be transported overland, and therefore an underestimate of the energy and emissions associated with this.
- Recovered concrete and plastic associated with the pipelines is assumed to be removed and taken directly to landfill in Hartlepool (2 km over-land return journey).
- In addition to the post-decommissioning survey, a pre-decommissioning survey has been included in the calculations in the event that additional site-specific data is required prior to the arrival of the work vessels.
- If pipelines and pipeline stabilisation features (mattresses and grout bags) are decommissioned in situ, further monitoring surveys are likely to be required. For the purpose of this assessment, it is assumed that three post-decommissioning surveys will be undertaken at intervals of two, five and ten years.
- For all vessels undertaking subsea operations involving diving operations, a WOW of 70% has been applied to account for safety constraints. For all CSV and rock-placement activities, a 50% WOW has been applied.
- No WOW value has been applied to pipeline cleaning activities as these will be undertaken from the adjacent topsides.
- Rock-placement and/ or trenching may be used as a burial method for the pipeline ends. Rock-placement has been accounted for in the “Manufacture of New Materials Required for Decommissioning” and in the “Vessels for Transportation and Offshore Operations.” Trenching activities (where applicable) have been accounted for in “Vessels for Transportation and Offshore Operations.”
- Vessels associated with rock-placement for the AWV stabilisation have not been incorporated in this assessment. This is due to uncertainties surrounding the quantity of rock required for stabilisation at the various platforms and therefore the number of vessels and duration of activity required to carry out the operations. If rock is required for AWV stabilisation at any of the locations, this will result in an increase in energy use and gaseous emissions.

8.4.5 Subsea structure assumptions

- No seabed structures will remain in situ
- It is assumed that any steel components will be transported from their location offshore to the Hartlepool dock. Any NORM material will be removed and transported to the Kings Cliffe disposal facility. The steel components would remain at Hartlepool where they would be recycled.
- As it is currently unfeasible to estimate the quantity (and nature) of NORM in topsides pipework, the quantity of NORM to be transported to Kings Cliffe has been omitted from this assessment.
- For DSV activity associated with subsea structure removal, a 70% WOW contingency has been applied. These estimates are based on working days only.
- Post–decommissioning seabed surveys (including overtrawl and debris clearance surveys) for the seabed area surrounding the subsea structure locations will be undertaken concurrently with the pipeline surveys. The vessel use for these surveys is therefore accounted for included in the pipeline decommissioning activities.
- Amendments to the estimated weight of the BD skid and JM wellhead, protection frame and pigging skid have been made in the materials inventory (Sections 3.4.6

and 3.5.2) however, as this was post 2015, these have not been included into the calculations of energy use and atmospheric emissions, as they are considered to have no significant effect on the outcomes or results.

8.5 Estimated Energy Use and Emissions

The estimated energy use (GJ) and atmospheric emissions (tonnes) for decommissioning of VDP2 and VDP3 are summarized in the sub-sections that follow. Calculations are based on the quantities and weights of materials taken from the D3 Consulting (2015) materials inventory (Section 3.6, Table 3.10). Table 8.1 summarises the vessels likely to be used during the decommissioning operations.

Table 8.1: Summary of vessel use during the decommissioning of the VDP2 and VDP3 infrastructure

Infrastructure	Recommended decommissioning option	Decommissioning method	Vessel use
Satellite topsides	Full removal	Single lift	• HLV • CSV.
Hub topsides	Full removal	Reverse Installation	• HLV • CSV,
Jackets	Full removal	Single lift	• HLV • tug • CSV • Survey vessel.
Pipelines	Decommission in situ, minimum intervention	Cut and lift pipeline ends and cover with rock/ trench in place. Decommission associated pipeline stabilisation features (mattresses and grout bags) in place.	• AWV • DSV • CSV • Survey vessel • Supply vessel • Rock dump vessel • Multi-support vessel (MSV)
Subsea structures	Full removal	Cut and lift	• DSV • Survey vessel

8.5.1 Satellite topsides

Estimated energy use and atmospheric emissions during full removal of the three satellite topsides for VDP2 and the one satellite topside for VDP3 are detailed within Tables 8.2 and 8.3, respectively. Energy use and emissions are expected to arise due to the manufacture of temporary steel for support, vessel and helicopter use, transportation of topsides components to decontamination, onshore deconstruction, recycling and the manufacture of otherwise recyclable materials lost to landfill.

The operations for the removal of the three VDP2 satellite topsides are predicted to use 57,835 GJ of energy and produce 4,652 tonnes of CO_2 emissions (Table 8.2). Approximately 60% of the energy use is attributed to vessel and helicopter use, with a further 34% attributed to recycling. Vessel and helicopter use account for 55% of CO_2 emissions, while recycling accounts for 44% of CO_2 emissions

Table 8.2: Energy use (GJ) and atmospheric emissions (tonnes) for the decommissioning the three VDP2 satellite topsides

Decommissioning aspect	Energy (GJ)	Emissions (tonnes)			
		CO_2	NOx	SO_2	CH_4
Manufacture of temporary steel for structural strengthening	425	32	<0.1	<0.1	No data
Vessel and helicopter use	34,588	2,568	47	3	0.2
Onshore transportation	11	0.8	<0.1	<0.1	No data
Onshore deconstruction	2,624	No data	No data	No data	No data
Recycling	19,613	2,034	3	10	No data
New manufacture to replace recyclable materials taken to landfill	574	17	No data	No data	No data
Total	**57,835**	**4,652**	**50**	**13**	**0.2**

Note: CO_2 = carbon dioxide; NOx = oxides of nitrogen; SO_2 = sulphur dioxide; CH_4 = methane
Values greater than 1 have been rounded to the nearest whole number

The operations for the removal of the VDP3 satellite topsides are predicted to use 18,997 GJ of energy and produce approximately 1,538 tonnes of CO_2 emissions (Table 8.3). Approximately 61% of the energy use is attributed to vessel and helicopter use, with a further 33% attributed to recycling. Vessel and helicopter use account for 56% of CO_2 emissions, while recycling accounts for 43% of CO_2 emissions.

Table 8.3: Energy use (GJ) and atmospheric emissions (tonnes) for the decommissioning the single VDP3 satellite topside

Decommissioning aspect	Energy (GJ)	Emissions (tonnes)			
		CO_2	NOx	SO_2	CH_4
Manufacture of temporary steel for structural strengthening	143	11	<0.1	<0.1	No data
Vessel and helicopter use	11,529	856	16	1	<0.1
Onshore transportation	9	0.7	<0.1	<0.1	No data
Onshore deconstruction	864	No data	No data	No data	No data
Recycling	6,323	666	1	3	No data
New manufacture to replace recyclable materials taken to landfill	129	4	No data	No data	No data
Total	**18,997**	**1,538**	**17**	**4**	**<0.1**

Note: CO_2 = carbon dioxide; NOx = oxides of nitrogen; SO_2 = sulphur dioxide; CH_4 = methane
Values greater than 1 have been rounded to the nearest whole number

8.5.2 Hub topsides

The estimated energy use and atmospheric emissions associated with the full removal of the four VDP2 hub topsides by Reverse Installation are detailed within Table 8.4.

Energy use and emissions are expected to arise due to the manufacture of temporary steel for support, vessel use, transportation of topsides components to decontamination, onshore deconstruction, recycling and the manufacture of otherwise recyclable materials lost to landfill.

The operations for the removal of the four VDP2 hub topsides are predicted to use 237,185 GJ of energy and produce approximately 19,234 tonnes of CO_2 emissions (Table 8.4). Approximately 55% of the energy use is attributed to vessel use, with a further 37% attributed to recycling. Vessel use accounts for 50% of CO_2 emissions, while recycling accounts for 48% of CO_2 emissions.

Table 8.4: Energy use (GJ) and atmospheric emissions (tonnes) for the decommissioning the four VDP2 hub topsides

Decommissioning aspect	Energy (GJ)	Emissions (tonnes)			
		CO_2	NOx	SO_2	CH_4
Manufacture of temporary steel for structural strengthening	3,000	227	0.4	0.7	No data
Vessel use	130,162	9,664	178	12	0.8
Onshore transportation	28	2	<0.1	<0.1	No data
Onshore deconstruction	11,489	No data	No data	No data	No data
Recycling	88,766	9,231	15	48	No data
New manufacture to replace recyclable materials taken to landfill	3,740	110	No data	No data	No data
Total	**237,185**	**19,234**	**195**	**61**	**0.8**

Note: CO_2 = carbon dioxide; NOx = oxides of nitrogen; SO_2 = sulphur dioxide; CH_4 = methane
Values greater than 1 have been rounded to the nearest whole number

8.5.3 Jackets

The estimated energy use and atmospheric emissions associated with the full removal of the seven VDP2 jackets and the single VDP3 jacket are detailed within Tables 8.5 and 8.6, respectively. The energy use and atmospheric emissions are expected to arise due to vessel and helicopter use for jacket removal operations, onshore transportation of NORM contaminated material to a disposal plant, onshore deconstruction, recycling and new manufacture to replace materials sent to landfill.

The operations for the removal of the seven VDP2 jackets are predicted to use 156,229 GJ of energy and produce approximately 12,568 tonnes of CO_2 emissions (Table 8.5). Approximately 70% of the energy use is attributed to vessel and helicopter use, with a further 27% attributed to recycling. Vessel and helicopter use account for 64% of CO_2 emissions, while recycling accounts for 35% of CO_2 emissions.

Table 8.5: Energy use (GJ) and atmospheric emissions (tonnes) for the decommissioning the seven VDP2 jackets

Decommissioning aspect	Energy (GJ)	Emissions (tonnes)			
		CO_2	NOx	SO_2	CH_4
Helicopter use	188	13	<0.1	<0.1	<0.1
Vessel use	108,433	8,051	148	10	0.7
Onshore transportation	4	0.3	<0.1	<0.1	No data
Onshore deconstruction	5,390	No data	No data	No data	No data
Recycling	42,174	4,468	<0.1	1	No data
New manufacture to replace recyclable materials taken to landfill	40	36	<0.1	<0.1	No data
Total	**156,229**	**12,568**	**148**	**11**	**0.7**

Note: CO_2 = carbon dioxide; NOx = oxides of nitrogen; SO_2 = sulphur dioxide; CH_4 = methane
Values greater than 1 have been rounded to the nearest whole number

The operations for the removal of the single VDP3 jacket are predicted to use 27,173 GJ of energy and produce approximately 2,354 tonnes of CO_2 emissions (Table 8.6). Approximately 59% of the energy use is attributed to vessel and helicopter use, with a further 36% attributed to recycling. Vessel and helicopter use account for 50% of CO_2 emissions, while recycling accounts for 44% of CO_2 emissions.

Table 8.6: Energy use (GJ) and atmospheric emissions (tonnes) for decommissioning the single VDP3 jacket

Decommissioning aspect	Energy (GJ)	Emissions (tonnes)			
		CO_2	NOx	SO_2	CH_4
Helicopter use	27	2	<0.1	<0.1	No data
Vessel use	15,878	1,179	22	1	<0.1
Onshore transportation	1	<0.1	<0.1	<0.1	No data
Onshore deconstruction	1,420	No data	No data	No data	No data
Recycling	9,681	1,027	<0.1	0.2	No data
New manufacture to replace recyclable materials taken to landfill	166	146	<0.1	<0.1	No data
Total	**27,173**	**2,354**	**22**	**1**	**0.1**

Note: CO_2 = carbon dioxide; NOx = oxides of nitrogen; SO_2 = sulphur dioxide; CH_4 = methane
Values greater than 1 have been rounded to the nearest whole number

8.5.4 Pipelines

The estimated energy use and atmospheric emissions for decommissioning the VDP2 and VDP3 pipelines are detailed within Tables 8.7 and 8.8, respectively. Energy use and atmospheric emissions are expected to arise mainly due to the excavation of rock to act as a stabilisation material, vessel and helicopter use, the onshore transportation of pipeline components for decontamination, recycling and new manufacture to replace recyclable materials decommissioned in situ or taken to landfill.

The operations for the decommissioning of the VDP2 pipelines are predicted to use 1,783,726 GJ of energy and produce approximately 221,003 tonnes of CO_2 emissions (Table 8.7). Approximately 85% of energy use is attributed to the manufacture of new material to replace recyclable materials decommissioned in situ or taken to landfill, with a further 16% attributed to vessel and helicopter use. Most of the material manufactured to replace recyclable materials will be decommissioned in situ. The manufacture of new material to replace recyclable materials accounts for 90% of CO_2 emissions, while vessel and helicopter use accounts for 9% of CO_2 emissions

Table 8.7: Energy use (GJ) and atmospheric emissions (tonnes) for the decommissioning the VDP2 pipelines

Decommissioning aspect	Energy (GJ)	Emissions (tonnes)			
		CO_2	NOx	SO_2	CH_4
Manufacturing of new components/ materials	35	2	No data	No data	No data
Helicopter use	3,044	211	0.8	0.3	<0.1
Vessel use	273,454	20,303	374	26	2
Onshore transportation	10	0.7	<0.1	<0.1	ND
Recycling	133	14	<0.1	<0.1	ND
New manufacture to replace recyclable materials decommissioned in situ or taken to landfill	1,507,050	200,472	781	314	<0.1
Total	**1,783,726**	**221,003**	**1,156**	**340**	**2**

Note: CO_2 = carbon dioxide; NOx = oxides of nitrogen; SO_2 = sulphur dioxide; CH_4 = methane
Values greater than 1 have been rounded to the nearest whole number

The operations for the removal of the VDP3 pipelines are predicted to use 174,514 GJ of energy and produce approximately 16,329 tonnes of CO_2 emissions (Table 8.8). Approximately 54% of the energy use is attributed to the manufacture of new material to replace recyclable materials decommissioned in situ/ to landfill, with a further 46% attributed to vessel and helicopter use. Most of the material manufactured to replace recyclable materials will be decommissioned in situ. The manufacture of new material to replace recyclable materials accounts for 63% of CO_2 emissions, while vessel and helicopter use accounts for 36% of CO_2 emissions.

Table 8.8: Energy use (GJ) and atmospheric emissions (tonnes) for the decommissioning the VDP3 pipelines

Decommissioning aspect	Energy (GJ)	Emissions (tonnes)			
		CO_2	NOx	SO_2	CH_4
Manufacturing of new components/ materials	8	0.4	No data	No data	No data
Helicopter use	1,046	73	0.3	<0.1	<0.1
Vessel use	78,923	5,860	108	7	0.4
Onshore transportation	10	0.7	<0.1	<0.1	No data
Recycling	29	3	<0.1	<0.1	No data
New manufacture to replace recyclable materials decommissioned in situ or taken to landfill	94,498	10,392	34	<0.1	<0.1
Total	**174,514**	**16,329**	**142**	**7**	**0.4**

Note: CO_2 = carbon dioxide; NOx = oxides of nitrogen; SO_2 = sulphur dioxide; CH_4 = methane
Values greater than 1 have been rounded to the nearest whole number

8.5.5 Subsea structures

Five subsea structures (two subsea manifolds, two pipeline tie-in tee-pieces; and one pigging skid) are to be decommissioned under VDP2 and VDP3 (Sections 3.4.4). Energy use and atmospheric emissions are expected to arise mainly due to vessel use, the onshore transportation of subsea components, onshore deconstruction and recycling of materials. Estimated energy use and atmospheric emissions for the removal of the three VDP2 subsea structures and the two VDP3 subsea structures are detailed in Tables 8.9 and 8.10, respectively.

The operations for the removal of the three VDP2 subsea structures are predicted to use 14,489 GJ of energy and produce approximately 1,092 tonnes of CO_2 emissions (Table 8.9). Approximately 95% of the energy use is attributed to vessel use, with vessel use accounting for 93% of CO_2 emissions.

Table 8.9: Energy use (GJ) and atmospheric emissions (tonnes) for the decommissioning the three VDP2 subsea structures

Decommissioning aspect	Energy (GJ)	Emissions (tonnes)			
		CO_2	NOx	SO_2	CH_4
Vessel use	13,706	1,018	19	1	<0.1
Onshore transportation	<0.1	<0.1	<0.1	<0.1	No data
Onshore deconstruction	89	No data	No data	No data	No data
Recycling	694	74	0.1	0.3	No data
Total	**14,489**	**1,092**	**19**	**1**	**<0.1**

Note: CO_2 = carbon dioxide; NOx = oxides of nitrogen; SO_2 = sulphur dioxide; CH_4 = methane
Values greater than 1 have been rounded to the nearest whole number

The operations for the removal of the two VDP2 subsea structures are predicted to use 10,004 GJ of energy and produce approximately 760 tonnes of CO_2 emissions (Table

8.10). Approximately 91% of the energy use and 89% of CO_2 emissions is attributed to vessel use.

Table 8.10: Energy use (GJ) and atmospheric emissions (tonnes) for the decommissioning the two VDP3 subsea structures

Decommissioning aspect	Energy (GJ)	Emissions (tonnes)			
		CO_2	NOx	SO_2	CH_4
Vessel use	9,137	678	13	0.9	0.1
Onshore transportation	0.1	<0.1	<0.1	<0.1	No data
Onshore deconstruction	98	No data	No data	No data	No data
Recycling	769	82	0.1	0.3	No data
Total	**10,004**	**760**	**13**	**1**	**0.1**

Note: CO_2 = carbon dioxide; NOx = oxides of nitrogen; SO_2 = sulphur dioxide; CH_4 = methane
Values greater than 1 have been rounded to the nearest whole number

8.5.6 Summary

Tables 8.11 and 8.12 summarise the total energy use for the VDP2 and VDP3 decommissioning operations, respectively.

The operations for the decommissioning of the VDP2 infrastructure are predicted to use a total of 2,249,464 GJ of energy and produce approximately 258,549 tonnes of CO_2 emissions (Table 8.11). Approximately 67% of the energy use is attributed to the manufacture of new materials to replace recyclable materials decommissioned in situ/ to landfill, with a further 25% attributed to vessel and helicopter use. The manufacture of new material to replace recyclable materials account for 78% of CO_2 emissions, while vessel and helicopter use accounts for 16% of CO_2 emissions.

Table 8.11: Total energy use (GJ) and atmospheric emissions (tonnes) for the VDP2 decommissioning activities

Decommissioning aspect	Energy (GJ)	Emissions (tonnes)			
		CO_2	NOx	SO_2	CH_4
Manufacturing of new materials	3,460	261	0.4	0.7	ND
Helicopter use	3,232	224	0.8	0.3	<0.1
Vessel use	560,343	41,604	766	52	4
Onshore transportation	53	4	<0.1	<0.1	ND
Onshore deconstruction	19,592	ND	ND	ND	ND
Recycling	151,380	15,821	18	59	ND
New manufacture to replace recyclable materials decommissioned in situ or taken to landfill	1,511,404	200,635	781	314	<0.1
Total	**2,249,464**	**258,549**	**1,566**	**426**	**4**

Note: CO_2 = carbon dioxide; NOx = oxides of nitrogen; SO_2 = sulphur dioxide; CH_4 = methane
Values greater than 1 have been rounded to the nearest whole number

The operations for the decommissioning of the VDP3 facilities are predicted to use a total of 230,688 GJ of energy and produce approximately 20,980 tonnes of CO_2 emissions (Table 8.12). Approximately 51% of the energy use is attributed to vessel and helicopter use, with a further 41% attributed to the manufacture of new materials to replace recyclable materials decommissioned in situ/ to landfill. Vessel and helicopter use account for 41% of CO_2 emissions, while the manufacture of new material to replace recyclable materials account for 50% of CO_2 emissions.

Table 8.12: Total energy use (GJ) and atmospheric emissions (tonnes) for the VDP3 decommissioning activities

Decommissioning aspect	Energy (GJ)	Emissions (tonnes)			
		CO_2	NOx	SO_2	CH_4
Manufacturing of new materials	151	11	<0.1	<0.1	No data
Helicopter use	1,073	75	0.3	<0.1	No data
Vessel use	115,467	8,573	159	10	0.4
Onshore transportation	20	1	<0.1	<0.1	No data
Onshore deconstruction	2,382	No data	No data	No data	No data
Recycling	16,802	1,778	1	4	No data
New manufacture to replace recyclable materials decommissioned in situ or taken to landfill	94,793	10,542	34	<0.1	<0.1
Total	**230,688**	**20,980**	**194**	**14**	**0.4**

Note: CO_2 = carbon dioxide; NOx = oxides of nitrogen; SO_2 = sulphur dioxide; CH_4 = methane
Values greater than 1 have been rounded to the nearest whole number

8.6 Impacts on Sensitive Receptors

Gaseous emissions from the proposed decommissioning activities include CO_2, CH_4, NOx, Oxides of Sulphur (SOx) and Volatile Organic Compounds (VOCs). These have the potential to impact sensitive receptors both onshore and offshore. The direct effect of the emission of CO_2, CH_4 and VOCs is the implication for climate change and the contribution to regional air quality deterioration through low-level ozone production (CH_4 has 21 times the global climate change potential of the main greenhouse gas CO_2 (IPCC, 2007)). The indirect effects of low level ozone include deleterious health effects, as well as damage to vegetation, crops and ecosystems.

The direct effect of NOx, SOx and VOC emissions is the formation of photochemical pollution in the presence of sunlight. Low level ozone is the main chemical pollutant formed, with by-products that include nitric and sulphuric acids and nitrate particulates. The effects of acid formation include contribution to acid rain formation and dry deposition of particulates.

The main environmental effect resulting from the emission of SO_2 is the potential to contribute to the occurrence of acid rain; however the fate of SO_2 is difficult to predict due to its dependence on weather.

The exposed offshore conditions, where the decommissioning activities will occur, will promote the rapid dispersion and dilution of these emissions. Outside the immediate vicinity of the decommissioning activities, all released gases would only be present in low concentrations. The VDP2 platforms are located approximately 85 km east of the nearest UK coastline and the VDP3 platform is located around 78 km east of the nearest UK coastline. No impact to designated coastal or onshore conservation sites from emissions originating offshore is expected.

Annex II species sighted within the VDP2 and VDP3 decommissioning areas include the harbour porpoise, which has been sighted in very high numbers in August, high numbers in March, May, June, July and September, and moderate numbers in February and November. For April, October and December numbers of harbour porpoise were recorded as low, with no sightings in January (Section 4). Low numbers of bottlenose dolphins were sighted in August and November January (Section 4). Harbour and grey seals have been observed throughout the decommissioning area (Section 4). In the open conditions that prevail offshore, the atmospheric emissions generated during the decommissioning activities would be quickly dispersed. The atmospheric emissions from the proposed activities are therefore considered unlikely to have any effect on the marine mammals.

Although the onshore transportation, deconstruction and recycling activities will contribute to the overall UK onshore emissions, the overall contribution to UK emissions will be small. The largest contributor is from the recycling of material taken to shore. The proposed decommissioning of the pipeline in situ with minimum intervention provides the lowest overall contribution to energy and emissions compared to other options considered in the CA (BMT Cordah, 2015d). Although Table 8.11 and 8.12 show a large proportion of VDP2 and VDP3 emissions would result from the remanufacture of material decommissioned in situ, this is a theoretical value based on the requirement to replace this material lost to the community rather than a direct effect of the decommissioning activities.

In summary, the atmospheric emissions from the VDP2 and VDP3 decommissioning activities are unlikely to have any significant effect on sensitive receptors.

8.7 Cumulative and Transboundary Impacts

The VDP2 and VDP3 infrastructure are located approximately 45 km west of the UK/ Netherlands median line. Gases released from the offshore decommissioning activities may therefore be present in very low concentrations across the UK/ Netherlands median line. However, under the exposed offshore conditions, the quantity of additional air emissions produced is unlikely to create any measurable transboundary impacts.

The potential cumulative effects associated with atmospheric emissions produced by the decommissioning activities includes contribution to climate change by emission of greenhouse gases, acidification (acid rain) and local air pollution. The total annual CO_2emissions from offshore oil and gas UKCS operations during 2013 was 14,310,000 tonnes.

The total CO_2 emissions from the VDP2 operations (258,549 tonnes CO_2) represent ~1.75% of the total annual UKCS CO_2 offshore emissions in 2015, while the total CO_2 emissions from VDP3 (20,980 tonnes CO_2) represent ~0.14% of the total annual UKCS CO_2 offshore emissions in 2015 (OGUK, 2016).

8.8 Mitigation Measures

Mitigation measures to minimise energy use and atmospheric emissions during the VDP2 and VDP3 decommissioning operations are detailed within Table 8.13.

Table 8.13: Planned mitigation measures

Potential source of impact	Planned mitigation measures
Vessels and helicopters for onshore and offshore transportation and operations Onshore and offshore operations	• Vessels will be audited as part of selection and pre-mobilisation. • All generators and engines will be maintained and operated to the manufacturers' standards to ensure maximum efficiency. • Vessels will use ultra-low sulphur fuel in line with MARPOL requirements. • Work programmes will be planned to optimise vessel time in the field. • Fuel consumption will be minimised by operational practices and power management systems for engines, generators and other combustion plant and maintenance systems.

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9.0 UNDERWATER NOISE

Sound is important to many marine organisms, with marine mammals, fish and certain species of invertebrates having a range of complex mechanisms for both the emission and detection of sound (Richardson *et al.,* 1995). Underwater noise may cause animals to avoid activities, potentially interrupting feeding, mating, socialising, resting and migration. Noise disturbance therefore may have consequential impacts upon the body condition and the reproductive success of individuals or populations (Southall et *al.,* 2007; Richardson et *al.,* 1995). Indirect impacts may also result should the noise disturb prey species, making feeding more difficult (Southall *et al.,* 2007; Richardson *et al.,* 1995).

During the proposed decommissioning of the VDP2 and VDP3 infrastructure, noise may be generated by a number of sources including:

- Accommodation Work Vessel (AWV);
- Dive Support Vessel (DSV);
- Survey vessel;
- Construction Support Vessel (CSV);
- Heavy Lift Vessel (HLV);
- Supply vessels;
- Helicopters and aircraft;
- Pipeline rock-placement vessel and operations;
- Pipeline and jacket cutting;
- Lifting and removing the platforms; and,
- Well plug and abandonment with a jack-up drilling rig.

These sources will emit low frequency noise both into the air and water column. The introduction of additional anthropogenic sounds into the environment has the potential to affect the behaviour of and, in extreme cases, even injure local wildlife.

This section will consider the noise and potential impact generated during the VDP2 and VDP3 decommissioning activities.

9.1 Regulatory Context

The control of underwater noise is driven by Regulations 41(1) (a) and (b) of the Conservation (Natural Habitats & c.) Regulations 1994 (as amended), and 39(1) (a) and (b) in the Offshore Marine Conservation (Natural Habitats & c.) Regulations 2007 (amended 2009 and 2010), which include a specific reference to the disturbance, injury or death of European Protected Species (EPS).

According to these regulations, it is an offence to:

- Deliberately capture, injure or kill any wild animal of an EPS; or
- Deliberately disturb wild animals of any such species.

Disturbance of animals is defined under the regulations and includes, in particular, any disturbance which is likely to impair their ability to:

- Survive, breed, rear or nurture their young;
- Hibernate or migrate (where applicable); or

- Significantly affect the local distribution or abundance of the species to which they belong.

In a marine setting, EPS include all species of cetaceans (whales, dolphins and porpoises) (JNCC, 2017c). As underwater noise has the potential to cause injury and disturbance to cetaceans, an assessment of underwater noise generated by the activities associated with a proposed development is required in line with guidance provided by the JNCC (2017c).

Further detail on the relevant regulations is provided in Appendix A.

9.2 Approach

The impact of underwater noise on any sensitive receptors is assessed here using a modelling approach, which includes the identification of potential noise sources, an evaluation of their levels and frequencies, an introduction to relevant underwater noise propagation pathways and the appropriate assessment model, followed by an impact assessment. The assessment results are then compared against relevant values from the literature, addressing both behavioural impacts to and injury of the target species. Any identified potential issues are then evaluated with respect to transboundary and cumulative impacts.

9.3 Sources of Potential Impacts

The quantification of noise impacts from the VDP2 and VDP3 decommissioning activities has been evaluated based on relevant scientific literature. In addition, potential noise impacts resulting from the associated vessels activities were further investigated using the Marsh-Schulkin propagation model (Schulkin and Mercer, 1985). The Marsh-Schulkin model applies to acoustic transmission in relatively shallow water (up to, approximately, 185 m) and represents sound propagation loss in terms of sea state, substrate type, water depth, frequency and the depth of the mixed layer. In order to model the worst-case scenario, it was assumed that all sources will operate at all times during each activity. In reality this is unlikely, and the received levels are expected to be lower than predicted within this assessment.

9.3.1 Assumptions

For all vessel operations, it was conservatively assumed that a maximum of eight vessels will be on site at any one time during VDP2 and VDP3 decommissioning operations. This corresponds to a worst-case scenario with multiple decommissioning activities occurring at various platforms, within either of the VDP2 or VDP3 decommissioning areas. The model considered the sound sources from the eight vessels at five locations:

- Viking KD and AR;
- Vixen VM;
- Viking LD;
- BA, BC, BP and BD; and
- Victor JD and JM.

The main environmental inputs parameters considered for the modelling are described in Table 9.1

Table 9.1: Main environmental inputs parameters used for the modelling

Parameter used for modelling	
Water depth (in m)	Viking KD and AR: 25 Vixen VM: 32.1 Viking LD: 20 BA, BC, BP, BD: 24 Victor JD and JM: 38 and 30.1 Average considered for the whole area: 30 m
Mixed layer depth in water column (*L* in m)	Approximately 10 m
Seabed substrate	Sand
Worst-case sea state	Calm

9.3.2 VDP2 and VPD3 decommissioning operations

All of the potential noise sources associated with VDP2 and VDP3 decommissioning operations are classed as continuous sounds and, as such, do not fall into the target Marine Safety Framework Directive (MSFD) descriptor for loud, low-frequency impulsive sounds. The vessel noise, dominant sound source, is classed as a non-pulse noise source.

Of note here is that the use of explosives is not currently anticipated by ConocoPhillips during the decommissioning activities of the VDP2 and VDP3 infrastructure.

Vessels

Broadband source levels for vessels rarely exceed 190 dB re 1 μPa m and are typically much lower (Hannay and MacGillivray, 2005; Genesis, 2011). The level and frequency of sound produced by vessels is related to vessel size and speed, with larger vessels typically producing lower frequency sounds (Richardson *et al.,* 1995). Noise levels depend on the vessel's operating status and can therefore vary considerably with time. In general, vessels produce noise over the range 100 Hz to 10 kHz, with strongest energy over the range 200 Hz to 2 kHz.

There are no industry-standard mitigation measures specifically designed to reduce the impact of vessel noise on fauna. However, standard operating procedures, such as maintenance schedules, will help to minimise the noise generated by propeller cavitation. For fixed pitch propellers, sound generated is relative to vessel speed, whereas for variable pitch propellers the relationship between vessel speed and propeller speed (and the inception of cavitation) is more complex.

Underwater noise modelling for the vessels noise associated with VDP2 and VDP3 decommissioning operations have been further assessed and modelled in this report.

Pipeline, jacket and other subsea structures cutting

The jacket members will be severed using internal cuts however as a worst case external cutting has been assumed, using a combination of diamond-wire cutting, abrasive water jetting and hydraulic shear. Pipelines would be exposed using jetting methods (where required) and would be removed by cutting with an underwater pipe cutter and lifting the cut pipeline sections onto a vessel for transportation to shore. Currently the preferred removal method for the tees involves cutting the tees from the attached pipelines with an underwater cutter. The pigging skid will be removed by cutting it from the attached pipelines with an underwater cutter (Section 3).

Underwater noise from pipeline, jacket and other subsea structures cutting is expected to be temporary and short-term. There are few studies currently available in the literature referring to noise assessments from either pipeline or jacket cutting, although one recent study suggests noise generation is low (Pangerc *et al.*, 2016). However, it may be expected that target species could be temporarily disturbed in the close vicinity.

Rock-placement

ConocoPhillips are undertaking SSAs for Viking KD, LD, AR and Victor JD to determine the requirement for the placement of rock on the seabed at the four possible AWV locations. Rock placement can be carried out by a fall pipe vessel or a side dumping vessel. Nedwell and Edwards (2004) measured the sound from a fall pipe vessel (Rollingstone) which has a specialised underwater chute that can accurately position rock on the seabed. This vessel used Dynamic Positioning (DP) and was powered by two main pitch propellers, two bow thrusters and two azimuth thrusters. The noise associated with vessel navigation, activities and transit has been compared, however, the noise associated with the rock-placement has not been compared; this is not thought to give a noticeable rise in noise over background levels. This is indicative of the fact that the sound levels were dominated by vessel noise and not the rock-placement activities (Nedwell and Edwards, 2004; Genesis, 2011).

Following conclusions presented in Nedwell and Edwards (2004), it is assumed that any rock-placement activities that may occur during the decommissioning of VDP2 and VDP3 infrastructure will be dominated by vessel noise.

Helicopters and aircraft

Helicopter activities related to the decommissioning of VDP2 and VDP3 infrastructure will occur throughout the year. ConocoPhillips plan to use helicopters for routine operations at a frequency of one helicopter per day during the cleaning activities.

Helicopter noise originates from both the sea surface disturbance by the downwash from the rotor blades and the transmission of engine and blade noise directly into the sea. The downwash noise is very similar to wind noise in its frequency characteristics and is greatest in the 2 to 20 kHz region. Additional strong tonals in the 10 to 100 kHz range are associated with rotors and turbine operation, respectively (Harland *et al.,* 2005).

When sound travels from air to water, the energy is largely reflected back from the water surface and only a small fraction of the sound produced by the helicopter is actually transmitted into the sea. Although helicopter sound is fairly broadband (0 to 20 kHz), the lower frequency sound, up to 200 Hz, is much more pronounced (Berrow *et al.,* 2002). The dominant tones in the noise spectra from helicopters are generally below 500 Hz (Richardson *et al.,* 1995). The angle at which sound from the aircraft intersects the water's surface is also important. At angles greater than 13° from the vertical, much of the incident sound is reflected and does not penetrate into the water (Richardson *et al.,* 1995).

Levels and durations of sounds received underwater from a passing aircraft depend on its altitude and aspect, receiver depth and water depth. In general, the peak received sound level in the water from the aircraft directly overhead decreases with increasing aircraft altitude (Richardson *et al.,* 1995).

9.4 Impacts on sensitive receptors

Underwater noise can affect the behaviour of or may cause injury to several different marine taxa, in particular fish and marine mammals such as pinnipeds and cetaceans.

9.4.1 Fish

Many fish species use sound for prey location, predator avoidance and for social interactions. The inner ear of fish, including elasmobranchs (sharks, skates and rays), is very similar to that of terrestrial vertebrates and hearing is understood to be present among virtually all fish (NRC, 2003). Relatively little is known about sound perception in fish, however, it is likely that particle motion and sound pressure in fish are equally important in the perception of sound. Fish are susceptible to injury due to particle motion and sound pressure ((Hawkins and Popper, 2017).

From the few studies of hearing capabilities in fishes that have been conducted, it is evident that there are potentially substantial differences in auditory capabilities from one fish species to an-other (Hawkins and Popper, 2017). Most of fish species detect sounds from below 50 Hz and within the range 500 to 1500 Hz. A small number of species can detect sounds to over 3 kHz, with very few species able to detect sounds over 100 kHz. Fish with the narrower bandwidth of hearing are often referred to as “hearing generalists” or hearing “non-specialists” whilst fish with the broader range are often called “hearing specialists”. The difference between hearing generalists and specialists is that the latter usually have specialised anatomical structures that enhance hearing sensitivity and bandwidth (Popper and Hastings, 2009).

Hearing generalists include salmonids, cichlids, tunas and numerous other species. Hearing specialists include all the Otophysi and Clupeiformes, and some representatives in a wide range of other fish groups including a few holocentrids and sciaenids. The fish known to have the widest hearing frequency bandwidth are limited to the members of the clupeiform genus *Alosa* (Popper and Hastings, 2009).

The fish species found in the locality of the VDP2 and VDP3 infrastructure are mainly “Hearing Generalists”, except for the European sprat and herring, which are considered as “Specialists”.

VDP2 and VDP3 offshore decommissioning areas (ICES Rectangles 35F0, 35F1, 35F2 and 36F2) are located within spawning grounds for mackerel, cod, plaice, lemon sole, sole, sandeel, sprat, herring and *Nephrops* (Section 4).

The VDP2 and VDP3 offshore decommissioning areas also lie within the nursery grounds throughout the year for anglerfish, spurdog, thornback ray, mackerel, herring, cod, haddock, whiting, plaice, lemon sole, sandeel, *Nephrops*, tope shark, Norway pout, sprat, sole and horse mackerel (Section 4).

Fish exhibit avoidance reactions to vessels and it is likely that radiated underwater noise is the cue. For example, noise from research vessels has the potential to bias fish abundance surveys by causing fish to move away (De Robertis and Handegard, 2013; Mitson and Knudsen, 2003). Reactions include diving, horizontal movement and changes in tilt angle (De Robertis and Handegard, 2013).

A comprehensive review by Popper and Hastings (2009) on the effects of anthropogenic sound on fish concluded that there are substantial gaps in the knowledge that need to be filled before meaningful noise exposure criteria can be developed. De Robertis and Handegard (2013) mentioned that further research is needed, to identify the stimuli fish perceive from approaching vessels and to what extent fish perceiving these stimuli will react, before further recommendations to reduce vessel-avoidance reactions can be made.

Concerning larval fish, the Bolle *et al.* (2016) study on delayed effects of larval exposure to pile-driving sound in European sea bass reveals that early-life exposure to high-intensity sound may affect behavioural responses later in life. It seems that behavioural responses are dependent on group size in the case of social fish such as juvenile sea bass. No studies have been undertaken to investigate delayed effect of larval exposure to continuous noise such as vessel. As the noise sources from the decommissioning of VDP2 and VDP 3 are only continuous, it is anticipated that delayed effects of vessel noise on fish larval would be negligible in comparison to the Bolle *et al.* (2016) study.

9.4.2 Pinnipeds

Pinnipeds (seals) produce a diversity of sounds within a bandwidth from 100 Hz to several tens of kHz. Their sounds are used primarily in critical social and reproductive interactions (Southall *et al.,* 2007). Available data suggest that most pinniped species have peak sensitivities between 1 and 20 kHz (NRC, 2003). Götz and Janik (2010) observed that well-marked individuals surfacing at greater distances than before when sound was playing. It is anticipated that the avoidance behaviour of seals in the field is not caused by longer dive times but by animals moving away. However, the data available on the effects of anthropogenic noise on pinniped behaviour are limited.

The grey seal and the harbour or common seal, are both resident in UK waters and occur regularly over large parts of the North Sea (SCOS, 2009).

Seals may travel past the VDP2 and VDP3 areas towards foraging grounds, but grey seal density around the area to be decommissioned diminishes with distance offshore. In offshore regions of Quadrant 47 between 0 and 50 grey seals, and in Quadrants 48 and 49, between 0 and 100 grey seals could be present per 25 km^2 at any one point in time (Section 4).

Harbour seals have been observed in high concentrations in The Wash National Nature Reserve which supports one of the largest populations in England and are also more likely to be found further offshore in the area to be decommissioned. It is likely that they are travelling to this area from haul-out sites in The Wash to forage for food. In the VDP2 and VDP3 offshore area of Quadrants 47 and 48 between 10 and 150 harbour seals per 25 km^2 could be present at any one point in time, and in Quadrant 49 between 0 and 100 harbour seals per 25 km^2 could be present at any one point in time (Section 4).

9.4.3 Cetaceans

Cetaceans use sound for navigation, communication and prey detection. Anthropogenic underwater noise has the potential to impact on marine mammals (JNCC, 2017c; Southall *et al.,* 2007; Richardson *et al.,* 1995) including cetaceans.

The main cetacean species occurring in VDP2 and VDP3 decommissioning areas (Quadrants 47, 48 and 49) are white-beaked dolphin and harbour porpoise, with sightings occurring throughout the year (Section 4). Further species observed in the surrounding areas include the Atlantic white-sided dolphin, minke whale, long-finned pilot whale, bottlenose dolphin and common dolphin (Section 4).

There are major differences in the hearing capabilities of the different marine mammal species and, consequently, vulnerability to impact from underwater noise differs between species. Southall *et al.* (2007) originally established a classification based upon the hearing types of different marine mammal species. These thresholds have then been recently updated by the National Oceanic and Atmospheric Administration (NOAA) in 2018 (NMFS, 2018; Table 9.2).

The infield infrastructure is located within the Southern North Sea candidate SAC (cSAC). The site is designated due to the populations of harbour porpoise, and Annex II species, in the area (JNCC, 2018d) and covers an area of 36,951km^2. This area supports an estimated 17.5% of the UK North Sea Management Unit (MU) population. Approximately two thirds of the site, the northern part, is recognised as important for porpoises during the summer season, whilst the southern part support persistently higher densities during the winter.

Table 9.2: Cetacean functional hearing group

Frequency range	Estimated auditory bandwidth	Species sighted in VDP2 and VDP3 areas for the planned period of activities
Low-frequency (LF) cetaceans	7 Hz – 35 kHz	Minke whale Long-finned pilot whale
Mid-frequency (MF) cetaceans	150 Hz – 160 kHz	White-beaked dolphin Atlantic white-sided dolphin Bottlenose dolphin Common dolphin
High-frequency (HF) cetaceans	275 Hz – 160 kHz	Harbour porpoise

Sources: UKDMAP, 1998; NMFS, 2018.

9.5 Prediction of Injury and Behavioural Zones

In accordance to JNCC guidelines, the Marsh-Schulkin model (Schulkin and Mercer, 1985) was used to predict the distance from the activities beyond which the sound level would be too low for injury under NOAA thresholds (NMFS, 2018). In addition, avoidance zones for specific species were investigated using Southall criteria (Southall *et al*., 2007).

9.5.1 Assessment using National Marine Fisheries Standards (2016 and 2018)

In September 2016, the National Marine Fisheries Service (NMFS), part of the NOAA published a document 'Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts' (NMFS, 2016) which includes an amended set of injury thresholds and an amended set of frequency 'weightings' to compensate for the different sensitivities of groups of mammals (referred to as NOAA Guidelines hereafter). This has since been widely adopted as preferable to the use of the Southall et al. (2007) thresholds for injury and it is noted that the document includes work by many of the same team contributing to the Southall et al. paper. The NOAA guidelines do not amend the thresholds or approach to the assessment of disturbance, only injury, using the metrics of peak sound pressure level (SPL) and cumulative sound exposure level (SELcum). These were supplemented in 2018 by an update ('Version 2.0' NMFS, 2018), which does not change the thresholds, but which gives further interpretation on their use.

The underwater noise propagation has been modelled taking into account of the NOAA thresholds for injury relating to peak levels, and for the weighting functions for LF, MF and HF cetaceans, and PW pinnipeds. This has been done by altering the source level frequency/amplitude profile and using the same noise propagation assumptions, since the received level equals the source level minus the transmission loss, and the transmission loss (calculated by third-octave frequency) has not altered.

This has been used to predict cumulative sound exposure levels over 24 hours for animals starting near the source and moving away. This is a theoretical assumption which does not necessarily reflect complex animal behaviour or the continuous nature of the noise exposure, but one which is repeatable and clear using an assumption that the animal begins at 10 m from the source and moves away at a swim speed of 2.5 m/s, which is within the lower range of swim speeds for such animals.

9.5.2 Assessment using Southall et al. (2007) thresholds

In accordance to JNCC guidelines (JNCC, 2017c), the Marsh-Schulkin model (Schulkin and Mercer, 1985) was used to predict the distance from the activities beyond which the sound level would be too low for likely avoidance reactions under the Southall criteria (Southall *et al*., 2007).

9.5.3 Modelling results

Table 9-3 summarises the results and shows that no animals accumulate a dose that exceeds the non-impulsive injury thresholds put forward by NOAA in their 2016 and 2018 guidelines. However, the noise threshold for an avoidance reaction may be exceeded during vessel operations for all species up to 28.5 km. The potential disturbance radius area calculated were based on the distance it takes for the noise level to decrease to levels below the avoidance threshold. Disturbance in this context refers to the behavioural reaction of individuals as discussed in Southall *et al.* (2007) and not to a legal interpretation of disturbance under the Habitats Regulations, which (through ongoing legal interpretation) has included longer term detrimental effects in the wider population and the effect on conservation status.

Table 9-3: Predicted frequencies causing greatest effect and radii within which likely injury and disturbance may occur for each species category relating to NOAA 2016 and 2018 acoustic thresholds for injury and Southall 2007 acoustic thresholds for disturbance[1;2]

NOAA species	Injury threshold (dB)	Disturb. threshold (dB)	Weighted source level RMS (dB)[1]	Frequencies causing greatest effect (kHz)	Maximum radii of injury zone (m)	Max radii of likely disturb. zone (km)
Low-frequency (LF) cetaceans	199	120	184.4	0.63	<1	28.5
Mid-frequency (MF) cetaceans	198	120	168.3	10	<1	28.5
High-frequency (HF) cetaceans	173	120	164.2	10	<1	28.5
Phocid pinnipeds (PW) (underwater)	201	120	179.4	2.5	<1	28.5

Note: [1]The peak source level of 3 is used as a proxy for RMS; [2] Some of the sources didn’t have components in the high frequencies (source spectra range covered up to 10 kHz).

The area potentially above a level of 120 dB re 1µPa is presented in Figure 9.1. A distance of 25-30 km between the edge of this area and the median location (449.59973, 5922.481145 km UTM zone 31 N). The area predicted to be above 120 dB re 1µPa is 1,598 km^2.

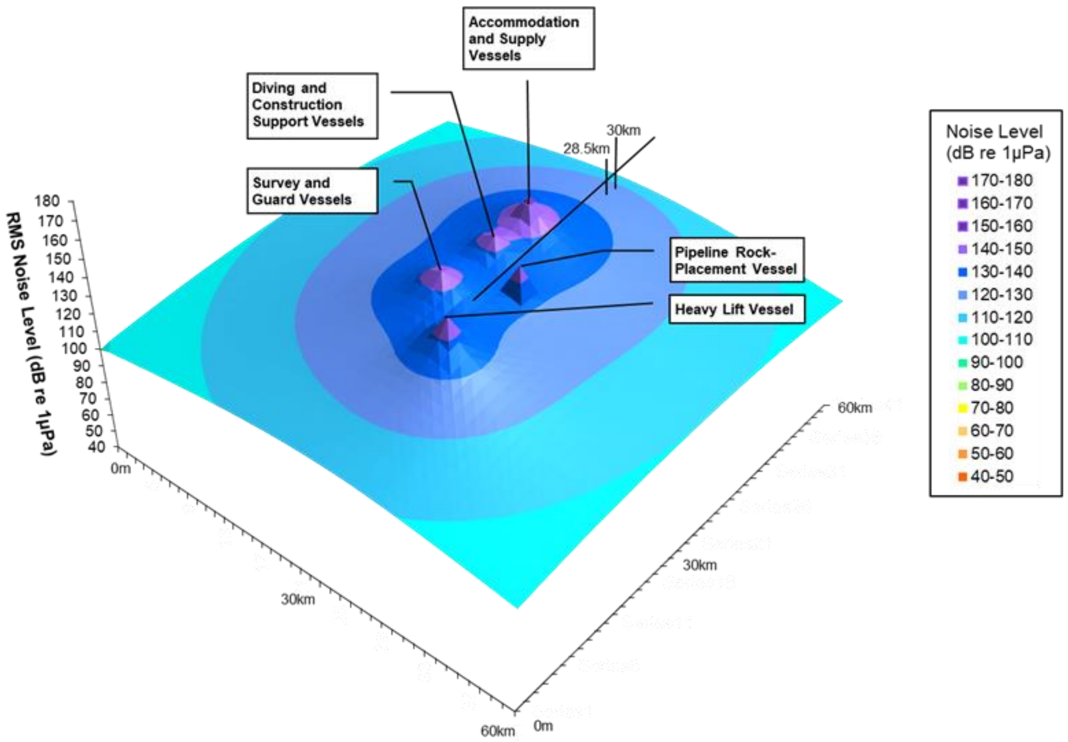

Figure 9.1: Illustration of predicted continuous noise levels and distance to area of potential avoidance reactions from the median location

Figure 9.2 displays the RMS noise levels along the maximum cross-section through the decommissioning structure locations.

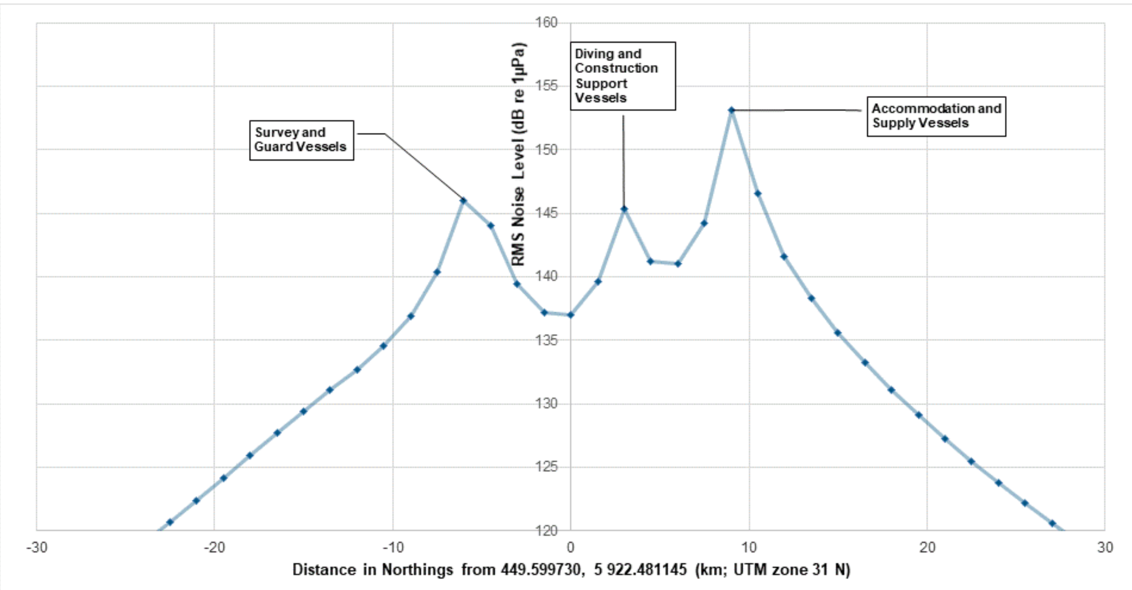

Figure 9.2: RMS noise levels along the maximum cross-section

9.6 Transboundary and Cumulative Impacts

In both VDP2 and VDP3 areas, the closest platform (Platform BC) to the median line is located, approximately 45 km west of the UK/ Netherlands median line. At this distance noise levels from vessels, the greatest source of sound associated with the decommissioning of the VDP2 and VDP3 infrastructure, would attenuate to a level lower than that likely to cause injury or temporary displacement to any cetacean species. Therefore, there is unlikely to be a transboundary impact from the noise generated by the proposed decommissioning operations at VDP2 and VDP3 areas.

Twelve platforms or subsea structures are located within 5 km from VDP2 and VDP3 export pipeline (PL27/161) and infield infrastructure (Section 5.2). The nearest non-ConocoPhillips infrastructure is Skiff platform operated by Shell, located in Block 48/20, 0.3 km north from the export pipeline. Of note is that only the Ganymede ZD platform is located at 4.7 km SW to the Victor JM platform (Section 5.2). All the other platforms and subsea structures are located close to pipelines PL27/161 and PL2643/2644, where the decommissioning activities will be limited.

Given the location of the proposed works, and the limited impact of VDP2 and VDP3 noise related decommissioning activities, no cumulative impacts (resulting from cumulative sound sources) are anticipated with other oil and gas installations or fields.

The VDP2 and VDP3 infrastructure is located within areas of lease by the Crown Estate for offshore activity relating to aggregates, windfarms and dreading (Section 5.3). Within the area of interest, there are a total of six active aggregate extraction sites and three application sites which all lie seaward of the 6 nm limit. Of note, for the most recently published statistics, of the 163 km^2 licensed for dredging within the Humber Region, only 18 km^2 was actually dredged (Section 5.3). Three windfarms are consented in the vicinity of the VDP2 and VDP3 infrastructure (Section 5.3).The Race Bank wind farm (Blocks 47/24 and 47/25) is located 2.2 km south from the export pipeline PL27, the Dudgeon wind farm (Block 48/22) is located 5.2 km south from the export pipeline PL27 and the Triton Knoll wind farm (Blocks 47/19, 47/20 and 48/16) is located 5.6 km north from pipeline PL27. Also consented is the Triton Knoll export cable route, located in Blocks 47/19 and 47/20, which will cross pipeline PL27(Section 5.3).

Source levels at frequencies below 500 Hz from dredger vessels are generally in line with those expected for a cargo ship travelling at modest speed (MALSF, 2011). It is worth mentioning that the elevated broadband noise is dependent on the aggregate type being extracted (gravel generating higher noise levels than sand) (MALSF, 2011). In addition, due to the limited impact of vessel noise highlighted by the noise modelling assessment, no cumulative impacts from aggregate extraction activity would be expected.

9.7 Mitigation Measures

Appropriate mitigation measures, in accordance with the relevant JNCC guidelines (2017c), should be implemented during the proposed decommissioning operations (Table 9.3). Noise generated from vessel activities are generally not considered by JNCC (2017c) to pose a high risk of injury. The noise impact assessment undertaken supports this view, showing that it is unlikely there would be significant impact on any marine species. Consequently, it is considered unlikely that mitigation measures will be required beyond those listed in Table 9.3.

Table 9.2: Planned mitigation measures

Potential source of impact	Planned mitigation measures
Underwater noise from decommissioning activities	Machinery and equipment will be in good working order and well-maintained. Helicopter maintenance will be undertaken by contractors in line with manufacturers and regulatory requirements. The number of vessels utilising DP would be minimised where possible, taking into account mitigation proposed for other receptors.

9.8 Conclusions

Sound levels associated with the decommissioning of the VDP2 and VDP3 infrastructure would attenuate to ambient levels within a few kilometres of the sound source.

As such, it is unlikely that sound produced by the VDP2 and VDP3 decommissioning activities would have an effect on fish behaviour that would be noticeable at a population level when considering the limited spatial extent of the sound generated and the generally fluid, mobile nature of fish populations.

Records indicate previous sightings of up to seven cetacean species in the vicinity of VDP2 and VDP3 areas across the year. Grey and harbour seals have been recorded in maximum densities of 0 to 100 and 10 to 150 animals in 25 km^2 grid, respectively. However the higher observations are nearer shore where there will be limited decommissioning activities. These species are all subject to regulatory protection from injury and disturbance.

A worst-case scenario for the modelling of underwater vessel noise has been undertaken for the VDP 2 and VDP3 decommissioning considering five point source locations and eight vessels. This represents the maximum vessel number that may be at VDP2 and VDP3 areas at any one time. The subsea noise levels generated by surface vessels used during the decommissioning operations are not predicted to result in physiological damage to marine mammals. Depending on ambient noise levels, sensitive marine mammals may be locally displaced by, or exhibit behavioural reactions to, vessel noise within a radius of 25-30 km of the continuous noise source during the offshore decommissioning activities at VDP2 and VDP3 areas. Such vessel operations are not unusual in the context of the Southern North Sea and the sources will begin and end gradually with the arrival and movement of vessels, rather than presenting any sudden, unusual noise events. The area where an avoidance reaction might be expected using the Southall *et al.* criterion is approximately 1,600 km^2 which represents 4.3% of the cSAC area and 0.8% of the UK MU population assuming they are uniformly distributed. The proposals would not appear to hinder general passage of animals through the area. The individual and cumulative impacts from decommissioning activities at VDP2 and VDP3 are therefore not considered significant at a conservation level.

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10.0 SEABED IMPACTS

This section discusses the potential short and long-term environmental impacts associated with seabed disturbance resulting from the proposed VDP2 and VDP3 decommissioning activities. The VDP2 and VDP3 decommissioning activities that will impact the seabed will be confined to the decommissioning of offshore infrastructure (platforms, subsea installations and connecting pipelines/ umbilical).

10.1 Regulatory Context

Seabed disturbance resulting from the proposed VDP2 and VDP3 decommissioning activities will be managed in accordance with current legislation and standards as detailed within Appendix A.

10.2 Approach

VDP2 and VDP3 include the decommissioning of eight surface installations, five subsea structures, two export pipelines, 15 infield pipelines, 2 umbilical, 30 wells, and associated mattresses and grout bags. These activities will require work below, at, or near the seabed which may result in disturbance to seabed sediments and background sediment concentrations. Table 10.1 summarises the short and long-term environmental impacts associated with seabed disturbance during the proposed VDP2 and VDP3 decommissioning activities.

Table 10.1: Summary of potential sources of seabed disturbance and resultant environmental impacts during VDP2 and VDP3 decommissioning activities

Decommissioning activity outcome	Seabed sediment environmental impact		
	Release of contaminants	Burial and smothering	Change in habitat
Presence of the pipelines and mattresses decommissioned in situ	Long-term	-	-
Full removal of topsides	Not applicable		
Full removal of jackets	-	Short-term	-
Removal of manifolds	-	Short-term	-
Removal of tee-pieces	-	Short-term	-
Removal of pigging skid	-	Short-term	-
Rock-placement over pipeline ends, manifold and pigging skid areas	-	Long-term	Long-term
Rock-placement (rock berms) for AWV support	-	Long-term	Long-term
Anchoring activities	-	Short-term	-
Overtrawl surveys	-	Short-term	

The proposed VDP2 and VDP3 activities will also require the operation of a jack-up AWV (Section 3.8). Vessels with DP capability will be used as a priority where noise is not deemed to be an issue. However, anchors may be required to support vessels carrying out heavy lifting operations, such as the removal of the topsides and jacket by HLV.

10.3 Sources of Potential Impacts

The following represent worst-case scenarios for VDP2 and VDP3 operations and will require work at, below or near the seabed:

- Cutting operations below the seabed for the eight jackets to allow full removal, including potential excavation activities to enable access for a Remotely Operated Vehicle (ROV) and/ or cutting tool (short-term impact);
- Anchoring of a HLV during lifting activities (short-term impact);
- Cutting operations and possible excavation below the seabed for the two manifold, two tee-pieces and pigging skid to allow full removal (short-term impact);
- Excavation and rock-placement below and on the seabed to cover pipeline ends (long-term impact);
- Rock-placement to support positioning of a jack-up AWV at the eight platform locations (long-term impact);
- Decommissioning the two export pipelines, 14 infield pipelines, one umbilical, and associated mattresses/ grout bags in situ (long-term impact); and
- Slow release of contaminants from pipelines decommissioned in situ as they degrade over time. The source of the contamination would be the degradation products of the pipeline, NORM scale and any entrained heavy metals and any hydrocarbons or heavy metals associated with residual solids (long-term impact).
- Overtrawl surveys undertaken post decommissioning to ensure seabed is clear of obstructions. The Overtrawl trial will most likely be undertaken with a version of the SFF Overtrawl gear which is a steel mesh net which is trawled over the seabed and will snag on any obstructions and flatten any seabed features which have presented themselves as a result of decommissioning activities, such as mud berms (short-term impact).

Structures and materials to be removed or deposited as part of VDP2 and VDP3 and the approximate seabed area of disturbance of the North Norfolk Sandbanks and Saturn Reef SAC are presented in Table 10.2. It is recognised that the VDP2 and VDP3 infrastructure is also within the Southern North Sea cSAC, however as the designation of this cSAC is primarily for the conservation of harbour porpoise, seabed impact is not considered as significant. As previously discussed, the decommissioning programme will leave the pipelines in situ and result in the release of chemical contaminants as the steel pipelines, their coatings and any residual scale degrades. This will however be a gradual release of small quantities over a long period of time (Costain, 2014b).

10.3.1 Jacket removal

As stated in Section 3, under OSPAR 98/3, the only option available for the eight surface installations is full removal.

The piles on all eight jackets will be removed to approximately 3.0 m below the seabed and should be suitable for removal via internal cutting methods. However, access will only be confirmed when internal camera 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. Sediment will be excavated by a work class ROV and will be deposited down-current of the jacket piles, where it will undergo natural dispersal with minimal/ short-term impact on surrounding seabed area.

If excavation of the footings is needed, removal of the eight jackets under VDP2 and VDP3 will impact a maximum seabed area of, approximately, 0.00068 km^2 (Table 10.2). Due to the proximity of the excavation there may be some overlap in the sediment deposition and this footprint is therefore an overestimate. However due to the dynamic nature of the seabed in this area dispersion of the sediment is expected to be rapid.

The cut jackets will be removed from the seabed in a single lift and transported to shore by HLV or SLV for dismantlement, disposal and recycling. Jacket removal operations are scheduled to commence in Q2 2017, with each removal operation expected to take approximately two weeks.

Table 10.2: Structures and materials with the potential to impact on the seabed as part of VDP2 and VDP3 – Jacket Removal

DP	Installation	Dimensions	Seabed impact (km^2)	Percentage of SAC seabed impacted	Approximate distance (km) to nearest sandbank within SAC
VDP2	Viking KD	0.000154 km^2 x 3 piles	0.000462	0.00000128	5 (Indefatigable)
	Viking LD	0.000154 km^2 x 3 piles	0.000462	0.00000128	0.05 (Indefatigable)
	Viking AR	0.000154 km^2 x 6 piles	0.000924	0.00000256	2.5 (Indefatigable)
	Viking BA	0.000154 km^2 x 4 piles	0.000616	0.00000171	1.5 (Indefatigable)
	Viking BC	0.000154 km^2 x 8 piles	0.001232	0.00000342	1.5 (Indefatigable)
	Viking BP	0.000154 km^2 x 8 piles	0.001232	0.00000342	1.5 (Indefatigable)
	Viking BD	0.000154 km^2 x 8 piles	0.001232	0.00000342	1.5 (Indefatigable)
VDP3	Victor JD	0.000154 km^2 x 4 piles	0.000616	0.00000171	1.6 (Swarte)
Jacket removal total			*0.006776*	*0.00001881*	

Notes: (1) Jacket removal assumptions based on a worst-case scenario excavation of a 14 m diameter pit (0.000154 km^2) around each platform pile; (2) North Norfolk Sandbanks and Saturn Reef SAC seabed area is 3,603 km^2.

10.3.2 Subsea structures removal

As discussed in Section 3 the five subsea structures are to be fully removed from the seabed under VDP2 and VDP3. Removal of the subsea structures along with associated mattresses and grout bags will be undertaken after the cutting of the pipelines. The structures will be lifted onto a DSV and the operations are expected to take approximately a day per structure.

Removal of the subsea structures from the seabed will result in a short-term impact to a seabed area of approximately, 0.003688 km^2 (Table 10.3). Once removed, ConocoPhillips will place rock on the seabed over the manifold and pigging skid locations and associated pipeline cut ends. The placement of rock on the seabed to cover these three seabed locations is a long-term impact and is discussed further in Sections 10.3.4 and 10.4.2.

10.3.3 Anchoring of lifting vessel(s)

ConocoPhillips anticipate that a HLV that requires anchors to maintain its position may be required during the proposed lifting activities. To calculate a worst-case anchoring scenario, the calculations have been based on:

- HLV vessel operation with a maximum eight point mooring system;
- Two vessel operations at each satellite location (jacket and topside lifts);
- Six vessel operations at each hub location (jacket and topside lifts);

- Anchor dimensions of 4.1 x 4.8 m, (based on a 10-tonne (10,000 kg) ‘flipper delta’ anchor); and
- A chain length of 1,250 m, a maximum seabed contact length of 975 m and an average chain width of 0.076 m.

Anchoring the AWV at the eight VDP2 and VDP3 installation locations, will impact a total seabed area of, approximately, 0.006 km^2 (Table 10.4).

Table 10.3: Structures and materials with the potential to impact on the seabed as part of VDP2 and VDP3 – Subsea structures

DP	Structure	Dimensions	Seabed impact (km^2)	Percentage of SAC seabed impacted
VDP2	Vixen VM manifold	0.0114 km x 0.0114 km x 1 manifold	0.0001299	0.00000361
	Vixen VM/ Victoria SM tee-piece	0.0080 km x 0.0065 km x 1 tee-piece	0.0000520	0.00000144
	Viking KD/ Viking LD tee-piece	0.0053 km x 0.0012 km x 1 tee-piece	0.0000064	0.00000018
	Concrete mattresses	0.0060 km x 0.0030 km x 143 mattresses	0.0025740	0.00007144
VDP3	Victor JM manifold	0.0213 km x 0.0123 km x 1 manifold	0.0002620	0.00000727
	Victor JM pigging skid	0.0073 km x 0.0046 km x 1 pigging skid	0.0000336	0.00000093
	Concrete mattresses	0.0060 km x 0.0030 km x 35 mattresses	0.0006300	0.00001749
Subsea structure removal total			*0.0036879*	*0.00010236*

Notes: (1) Tee-pieces and pigging skid with protective structures; (2) North Norfolk Sandbanks and Saturn Reef SAC seabed area is 3,603 km^2.

Table 10.4: Structures and materials with the potential to impact on the seabed as part of VDP2 and VDP3 – Anchoring of HLV

DP	Structure	Dimensions	Seabed impact (km^2)	Percentage of SCACseabed impacted
VDP2	Anchor	(0.0041 km x 0.0048 km) x 8 anchors x 7 locations	0.00110	0.000031
	Chain	(0.975 km x 0.000076 km) x 8 anchors x 7 locations	0.00415	0.000115
VDP3	Anchor	(0.0041 km x 0.0048 km) x 8 anchors x 1 locations	0.00016	0.000004
	Chain	(0.975 km x 0.000076 km) x 8 anchors x 1 locations	0.00059	0.000016
Anchoring total			*0.00600*	*0.000166*

Note: North Norfolk Sandbanks and Saturn Reef SAC seabed area is 3,603 km^2.

10.3.4 Rock-placement on decommissioned pipelines and subsea structures

As part of pipeline decommissioning, an estimated four metres will be removed from the ends of each pipeline, leaving some of the pipeline exposed. The VDP2 pipeline cutting activities include the disconnection of the gas and methanol pipelines that were left connected to the Viking BD platform under VDP1. Where required, sediment will be excavated by a work class ROV and will be deposited down-current of the pipeline ends, where it will undergo natural dispersal with minimal/ short-term impact on surrounding seabed area.

The recommended option for decommissioning the pipelines and umbilical in situ under VDP2 and VDP3 (Section 3) is to place graded rock over of the pipeline ends, producing a tapered berm. Where the pipeline is on the seabed and is not buried, the berm will be have a 3:1 profile providing a burial depth over the top of the pipeline to at least 0.6 m. This tapered rock berm will have an estimated footprint of 1.8×10^{-5} km^2.

Where pipeline ends are already buried, the intention would be to excavate to allow access for the cut, the pipeline end would then be covered to a height of 0.6 m above the top of the pipeline and any remaining trench would be left to naturally backfill. The backfilling of the excavation is expected to occur in a relatively short time as a result of the dynamic seabed conditions present across the decommissioning areas. Existing stabilisation features (mattresses, grout bags and rock-placement) will be decommissioned in situ to minimise the amount of additional rock-placement required.

In addition, ConocoPhillips intend to place rock over the cut pipeline ends and over the seabed where the two tee-pieces and the pigging skids have been removed. The rock will be placed on the seabed, producing a tapered berm based on a 3:1 profile providing a burial depth over the top of the pipeline to at least 0.6 m.

ConocoPhillips estimate that 0.000452 km^2 of the seabed will be impacted in the long-term from the installation of rock on the seabed to cover the pipeline ends, tee-pieces and pigging skid locations (Table 10.5).

Table 10.5: Structures and materials with the potential to impact on the seabed as part of VDP2 and VDP3 – Pipeline and subsea structure rock-placement

DP	Material	Dimensions	Seabed impact (km^2)	Percentage of SAC seabed impacted
VDP2	Rock placed at 5 VDP1 pipeline cuts at Viking BD	0.000018 km^2 x 5 cuts	0.000090	0.0000025
	Rock placed at 9 pipeline cuts	0.000018 km^2 x 9 cuts	0.000162	0.0000045
	Rock placed at 3 pipeline cuts at TGT to Viking AR to Viking BP	0.000018 km^2 x 3 cuts	0.000054	0.0000015
	Rock placed over the Vixen VM/ Victoria SM tee-piece location	0.000070 km^2 x 1 location	0.000070	0.0000019
	Rock placed over the Viking KD/ Viking LD tee-piece location	0.000024 km^2 x 1 location	0.000024	0.0000007
VDP3	Rock placed at 3 pipeline cuts	0.000018 km^2 x 3 cuts	0.000054	0.0000015
	Rock placed over the Victor JM pigging skid location	0.000052 km^2 x 1 location	0.000052	0.0000014
Pipeline rock-placement total			*0.000506*	*0.0000140*

Notes: (1) Piggybacked pipelines PL211/PL 212 will be cut at the Victor JD under VDP3, however, the ends terminating at the Viking BD platform will be cut under VDP2; (2) VDP2 pipeline cutting activities include ten (five gas and five piggybacked methanol) pipelines that were left connected to the Viking BD platform under VDP1; (3) North Norfolk Sandbanks and Saturn Reef SAC seabed area is 3,603 km^2.

10.3.5 Stabilisation of the accommodation work vessel

It is anticipated that stabilising rock berms will be required to provide extra support for the AWVs jack-up legs when working at seven of the eight platform locations. The rock will be placed at four adjoining locations on the seabed as rock berms to support the four AWV jack-up legs.

The amount of rock required (and therefore footprint) is dependent on local bathymetry and sediment structure at each platform site. Site specific assessments are currently ongoing for VDP2 and VDP3 (Section 3.8). Initial assessments for VDP1 and LDP1 have provided an indication of the worst case mass (34,000 tonnes) of rock required. The worst case mass of rock that will be required at the eight VDP2 and VDP3 locations will therefore be 136,000 tonnes. ConocoPhillips estimate that 0.0316 km^2 of the seabed will be impacted from the installation of the rock berms at the eight installation locations (Table 10.6).

A direction for deposits application will be submitted to the BEIS to seek approval for the commencement of the rock-placement operations at each platform location. The volume of rock and site specific berm design will be detailed within each application, and will be based on the final SSA results for each installation location.

Table 10.6: Structures and materials with the potential to impact on the seabed as part of VDP2 and VDP3 – AWV rock-placement

DP	Material	Dimension	Seabed impact (km^2)	Percentage of SAC seabed impacted
VDP2	Rock at Viking KD	34,000 tonnes x 1 location	0.0079	0.00022
	Rock at Viking LD	34,000 tonnes x 1 location	0.0079	0.00022
	Rock at Viking AR	34,000 tonnes x 1 location	0.0079	0.00022
VDP3	Rock at Victor JD	34,000 tonnes x 1 location	0.0079	0.00022
AWV rock-placement total			*0.0316*	*0.00088*

Notes: Dimensions of rock berms and quantities of rock required for each of the satellite platforms will be site-specific and currently under assessment. Worst case rock berm estimate for VDP1 and LDP1 used to ensure that a worst case impact is presented.
North Norfolk Sandbanks and Saturn Reef SAC seabed area is 3,603 km^2.

10.3.6 Structures decommissioned in situ

Following the removal of 4 m of pipelines from each cut end, the remaining VDP2 and VDP3 pipelines and associated pipeline support materials will be decommissioned in situ. The approximate area of seabed affected by decommissioning the gas and piggybacked methanol pipelines and umbilical (and any stabilisation materials) in situ is estimated to be 2.2051 km^2 (Table 10.7).

Table 10.7: Structures and materials with the potential to impact on the seabed as part of VDP2 and VDP3 – Structures decommissioned in situ

DP	Structure	Dimensions	Seabed impact (km^2)	Percentage of SACs seabed impacted *	Approximate length (km) pipeline with a sanbank feature within an SAC
VDP2	PL27/ PL161	134.895 km x 0.010 km	1.3489*	0.034158	7.5
	PL88/ PL134	10.89 km x 0.010 km	0.1089	0.003022	3.5
	PL1571/ PL1573	13.59 km x 0.010 km	0.1359	0.003771	2.7
	PL1572/ PL1574	0.99 km x 0.010 km	0.0099	0.000275	0.05
	PL2643/ PL2644	27.49 km x 0.010 km	0.2749	0.007630	3.3
	PL1767/ PL1768	8.69 km x 0.010 km	0.0869	0.002412	2.3
VDP3	PL211/ PL212	13.49 km x 0.010 km	0.1349	0.003744	2.5
	PL1095/ PL1096	5.09 km x 0.010 km	0.0509	0.001413	1.2
	UM1	5.39 km x 0.010 km	0.0539	0.001496	1.2
Structures decommissioned in situ total			*2.2051*	*0.057921*	-

Notes: (1) Dimensions are estimated based on a 10 m wide pipeline corridor accounting for the presence of the piggybacked methanol pipeline and any pipeline stabilisation features. The pipeline ends to be removed (4 m length at each cut end) have been subtracted from the length of each pipeline; (2) North Norfolk Sandbanks and Saturn Reef SAC seabed area is 3,603 km^2; (3) Inner Dowsing, Race Bank and North Ridge SAC seabed area is 845 km^2.

**Only 25 km of PL27/ PL161 is located within the North Norfolk Sandbanks and Saturn Reef SAC, therefore 0.25 km² of the pipelines will occur within the SAC. This equates to 0.006939% of the North Norfolk Sandbanks and Saturn Reef SAC.*
Only 23 km of PL27/ PL161 is located within the Inner Dowsing, Race Bank and North Ridge SAC, therefore 0.23 km² of the pipelines will occur within the SAC. This equates to 0.027219% of the Inner Dowsing, Race Bank and North Ridge SAC.
Based on this, 48 km/ 0.48 km² of PL27/ PL161 will impact a combined 0.034158% of North Norfolk Sandbanks and Saturn Reef and Inner Dowsing, Race Bank and North Ridge SACs.

10.3.7 Overtrawl survey work post-decommissioning

Following all of the decommissioning activities a post-decommissioning overtrawl survey will be conducted within any 500m exclusion zone and over infrastructure or potential areas with a residual snagging risk to demonstrate overtrawl success and flatten out any excavation marks. These activities will impact the seabed due to the type of gear being used. This is a steel mesh mat which is towed in contact with the seabed. The approximate area of seabed which will be surveyed is estimated to be 29.9 km^2 and is presented in Table 10.8.

Table 10.8: Estimated overtrawl survey area

DP	Structure	[1]Dimensions	Seabed impact (km^2)	[2]Percentage of SACs seabed impacted	Approximate length (km) pipeline with a sanbank feature within an SAC
VDP2	7 platform and 1 subsea manifold,	8 x 0.785 km^2	6.2800	0.17430	-
	PL27/ PL161	134.895 km x 0.100 km	13.4895*	0.34158*	7.5
	PL88/ PL134	10.89 km x 0.100 km	1.0890	0.03022	3.5
	PL1571/ PL1573	13.59 km x 0.100 km	1.3590	0.03771	2.7
	PL1572/ PL1574	0.99 km x 0.100 km	0.0990	0.00275	0.05
	PL2643/ PL2644	27.49 km x 100 km	2.7490	0.07630	3.3
	PL1767/ PL1768	8.69 km x 0.100 km	0.8690	0.02412	2.3
VDP3	1 platform and 1 subsea manifold	2 x 0.785 km^2	1.5700	0.04357	-
	PL211/ PL212	13.49 km x 0.100 km	1.3490	0.03744	2.5
	PL1095/ PL1096	5.09 km x 0.100 km	0.5090	0.01413	1.2
	UM1	5.39 km x 0.100 km	0.5390	0.01496	1.2
Structures decommissioned in situ total			*29.9015*	*0.79707*	-

Notes: (1) Dimensions are estimated based on the following: Pipelines - 100 m wide pipeline survey corridor; and Safety zones – 500m safety zone equating to an area of 0.785km^2 per zone.; (2) North Norfolk Sandbanks and Saturn Reef SAC seabed area is 3,603 km^2; (3) Inner Dowsing, Race Bank and North Ridge SAC seabed area is 845 km^2.

**Only 25 km of PL27/ PL161 is located within the North Norfolk Sandbanks and Saturn Reef SAC, therefore 2.5 km^2 of the pipelines will occur within the SAC. This equates to 0.069387% of the North Norfolk Sandbanks and Saturn Reef SAC.*
Only 23 km of PL27/ PL161 is located within the Inner Dowsing, Race Bank and North Ridge SAC, therefore 2.3 km^2 of the pipelines will occur within the SAC. This equates to 0.272189% of the Inner Dowsing, Race Bank and North Ridge SAC.
Based on this, 48 km/ 0.48 km^2 of PL27/ PL161 will impact a combined 0.341576% of North Norfolk Sandbanks and Saturn Reef and Inner Dowsing, Race Bank and North Ridge SACs.

10.4 Short and Long-Term Impacts

The seabed impacts resulting from the decommissioning activities associated with VDP2 and VDP3 can be classified as short or long-term. Short-term impacts can be defined as those which have transient impacts lasting a few days to a few years. Long-term impacts are those which will continue to have an impact for decades to centuries following decommissioning.

10.4.1 Short-term impacts

Cutting, excavation and anchoring activities will be transient and will have a short-term impact on the local benthic environment in the VDP2 and VDP3 areas. The likely short-term impacts arising from these activities can be summarised as:

- Sediment disturbance (Section 10.5.1); and
- Fauna disturbance (Section 10.5.2).

10.4.2 Long-term impacts

Long-term seabed impacts relate to the presence and physical/ chemical breakdown of the in situ pipelines, mattresses, grout bags and rock-placement over pipeline ends and the rock berms for AWV support. The likely long-term impacts arising from these activities can be summarised as:

- Habitat change (Section 10.6.1.3).
- Seabed morphological change (Section 10.6.2); and
- Fauna disturbance (Section 10.6.3).

10.5 Short-Term Impacts on Sensitive Receptors

The following sections provide an overview of the spatial and temporal extent of the short- term impacts based on the current understanding of the seabed environment in the North Norfolk Sandbanks and Saturn Reef SAC. Decommissioning environmental surveys undertaken around the VDP1 and LDP1 infield facilities provide an indication of the seabed sediments and sediment chemistry these are similar to those found in the VDP2 and VDP3 area (Section 4).

10.5.1 Sediment disturbance

This dynamic seabed environment of the North Norfolk Sandbanks and Saturn Reef is characterised by large and small sand waves, megaripples, and small exposed shoal areas. The dynamic nature of the seabed is also indicated by a number of existing features of the seabed, including:

- Areas of scour around oil and gas structures and the wrecks observed during the 2013 surveys (Section 4);
- The silt and clay content of the seabed sediments, which is restricted to less than 15% (Fugro, 2014a and 2014b); and
- The redistribution of drill cuttings piles from around VDP1 and LDP1 wellheads in the vicinity of the VDP2 and VDP3 installations, indicating a lack of concentrated cuttings piles at the platform locations.

Sediments in the offshore Viking area comprise fine to coarse sands, often silty and with variable amounts of shell fragments and occasional pebbles and cobbles (Section 4). Sediments around Viking AR are very poorly to moderately well sorted, medium sand to very fine gravel. The highly dynamic marine environment restricts the silt and clay content to less than 15% (Fugro, 2014a and 2014b). Levels of clay and organic matter around Viking AR were low, 0.3% and 0.5%, respectively.

The concentration of total hydrocarbons were found to be similar across within the Viking survey area (ranging from 0.5 to 5.5 $\mu g g^{-1}$) and are lower than background levels recorded during SNS environmental surveys undertaken between 1975 and 1995

(Section 4; Table 4.2; Fugro, 2014a). Metal concentrations in the Viking area sediments are expected to be relatively constant and within the range of natural background concentrations for the region, as identified in the VDP1 and LDP1 surveys (Section 4; Table 4.2; Fugro, 2014a).

Removal of the manifolds, tee-pieces, pigging skid, excavation around the jacket legs from the seabed, excavation at the pipeline ends, anchoring of lifting vessels and overtrawl survey areas, will physically disturb the sediment in the offshore VDP2 and VDP3 area. The disturbance to the sediments will be short-term, localised and confined to an estimated area of impact of 29.918 km^2 (Table 10.9). This represents 0.673% of the total area of the combined SACs (4,448 km^2).

Table 10.9: Structures, materials and activities with the short-term potential to impact on the seabed as part of VDP2 and VDP3 decommissioning operations

Structures and materials with the short-term potential to impact on the seabed as part of VDP2 and VDP3	Seabed impact (km^2)	Percentage of SAC seabed (4,448 km^2)* impacted	Table reference
Jacket removal total	*0.0068*	*0.00015*	Table 10.2
Subsea structures removal total	*0.0037*	*0.00008*	Table 10.3
Anchoring of HLV total	*0.0060*	*0.00014*	Table 10.4
Overtrawl survey area	*29.9015*	*0.67225*	Table 10.8
Total short-term seabed impact	***29.9180***	***0.67262***	**-**

* Combined area of both the North Norfolk and Saturn Reef SAC and Inner Dowsing, Race Bank and North Ridge SAC is 4,448 km^2 (3,603km^2 and 845 km^2 respectively)

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 dynamic marine environment (Section 4) in this area 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 primarily 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, as indicated by the lack of drill cuttings piles around the surveyed VDP1 and LDP1 wellheads within the SAC (Section 4), the deposition resulting from the VDP2 and VDP3 decommissioning activities is likely to be comparable to the background sediment redistribution processes.

Areas of dredging on sandbanks which are subject to naturally high sediment mobility may disappear within a few tidal cycles (Hill *et al.,* 2011). 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, 2012).

Long-term analysis at the Sean Gas Field in Block 49/25a (Thompson *et al*., 2011) suggests that wave conditions are strong enough to resuspend medium sand all year round, with peaks indicating resuspension 51% and 60% of the time in January and March, and generally increased potential resuspension in the winter months from September to March. Following completion of the proposed VDP2 and VDP3 offshore 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.

10.5.2 Fauna disturbance

Fauna living on and around the seabed sediments are expected to be typical for this area of the SNS. Fauna specific to the VDP1 and LDP1 areas, provide an indication of the VDP2 and VDP3 fauna likely to occur in the study area.

As described in Section 4, benthic fauna in the Viking area is typical for the general area, sediment type and water depth. The polychaetes *Ophelia borealis*, *Nephtys cirrosa*, several species of *Spio* and crustacean from the genera *Bathyporeia* and *Urothoe,* all typical of the mobile sand and coarser sediments present across the Viking area (Fugro, 2014a and 2014b).

The VDP2 and VDP3 offshore infrastructure are located within spawning grounds for mackerel, cod, plaice, lemon sole, sole, sandeel, sprat, herring and *Nephrops* (Section 4).

Removal of the manifolds, tee-pieces, pigging skids and jackets from the seabed, the anchoring of lifting vessels and any overtrawl survey work will physically disturb the benthic fauna living on or in the sediment. The disturbance to the benthic fauna will be short-term, localised and confined to an estimated area of impact of 29.918 km^2 (Table 10.9).

The proposed activities will cause some direct impact to fauna living on and in the sediments. Mortality is more likely in non-mobile benthic organisms whereas mobile benthic organisms may be able to move away from the area of disturbance and so be able to return once operations have ceased. 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 (Dernie *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 (such as those prevalent in the VDP2 and VDP3 areas) had the most rapid recovery rate 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 VDP2 and VDP3 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. Studies of the impacts from anchoring indicate that the faunal recovery from the processes of anchor scarring, anchor mounds and cable scrape is likely to be relatively rapid (1 to 5 years) (DECC, 2011b). Based on the dynamic characteristics of the seabed in the VDP2 and VDP3 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 activities. However, fish are highly mobile organisms and are likely to avoid areas of resuspended 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 sediments are expected to be within background levels (Fugro, 2014a and 2014b) 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.

10.6 Long-term Impacts on Sensitive Receptors

The following sections describe the footprint of the existing pipelines and supporting materials within the VDP2 and VDP3 areas and the additional footprint that could be created due to the introduction of further rock-placement.

10.6.1 Habitat change

Habitat change will result from the introduction of hard substrate (rock-placement) into a predominantly soft substrate environment.

The infrastructure to be decommissioned is located within the North Norfolk Sandbanks and Saturn Reef SAC (Section 4; JNCC, 2017a). Annex I habitats occurring within this SAC include sandbanks that radiate northeast parallel to the Norfolk coast. Also present are Annex I biogenic reef habitats formed by the polychaete worm *S. spinulosa*. *S. spinulosa* was identified in several historical survey reports within and adjacent to the areas containing the VDP2 and VDP3 infrastructure (Conoco, 1998 and 2002; ConocoPhillips, 2005 and 2008; Venture, 2006). The reports indicated that a series of small patches of *S. spinulosa* were observed on an otherwise fine sand environment to the west of the Viking ED platform, however these aggregations were limited and did not elevate above the seabed surface (BMT Cordah, 2014). Consequently, they did not constitute a *S. spinulosa* reef as defined by JNCC (Gubbay, 2007). However, analysis of the ROV inspection footage for the VDP2 and VDP3 pipelines identified large aggregations of *S. spinulosa,* notably at KP18 of pipeline PL27, located within the North Norfolk Sandbanks and Saturn Reef SAC (BMT Cordah, 2015c; Section 4.2). This sighting of *S. spinulosa* is located 18 km from the cutting, removal and rock-placement operations for the Viking AR platform, PL27/ PL161 and PL88/ PL134, and therefore unlikely to be impacted by the proposed operations. However, initial indications form footage of the 2015 surveys of the same KP point show that these areas of *S. spinulosa* appear to have been damaged, removed or buried by surrounding sediment, further adding the evidence of the dynamic nature of the seabed environment.

The proposed rock-placement over the pipeline ends for the three subsea structures, the piggybacked pipelines and umbilical, and the placement of rock berm support for the AWV adjacent to the eight installation locations will result in a modification of the substrate and habitat type in the local area (0.032 km^2; Tables 10.5 and Table 10.6) that is not likely to constitute a significant impact. This represents a small proportion (approximately 0.0009%) of the total area of the North Norfolk Sandbanks and Saturn Reef SAC which has a seabed area of 3,603 km^2.

The decommissioning in situ of the VDP2 and VDP3 mattresses and grout bags will reduce the amount of new material needed to be introduced into the SAC. If these 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. Based on a berm width of 12 m (to enable coverage of the mattress area and to incorporate a 3:1 slope), this would equate to placement within the

SAC additional rock with an estimated footprint of 0.00216 km^2. Further to this, the impact of removing the 178 (6 m x 3 m) mattresses currently in situ at VDP2 and VDP3 may disturb a minimum of 3.2 x 10^{-3} km^2 of overlying sediment.

The existing mattress protection over the pipelines will remain in situ as part of the VDP2 and VDP3 programmes. As organisms associated with hard substrates will be naturally present in the area, the mattresses and areas of rock-placement provide a relatively small additional rocky habitat for epibenthic organisms. The seabed feature that will result from the rock-placement may also provide habitats for crevice-dwelling fish (e.g., ling, conger eel and wolf fish) and crustaceans (e.g., squat lobsters and crabs) and may attract fish species to the site (Lissner *et al.,* 1991). However, there is the possibility that these structures may be covered by sediment over time.

10.6.2 Seabed morphological change

Morphological change of the seabed in the VDP2 and VDP3 areas (further to the natural seabed dynamics evident in these areas) may result from the presence of the pipelines and associated protection material decommissioned in situ and rock placed on the seabed to provide support for the AWV jack-up legs. This section outlines the footprint remaining in both areas due to the decommissioning of this infrastructure in situ, the placement of the rock and analyses the potential for this infrastructure to contribute to morphological change. Morphological change is discussed in context with current knowledge of seabed dynamics in the North Norfolk Sandbanks and Saturn Reef SAC and the Inner Dowsing, Race Bank and North Ridge SAC.

The footprint resulting from leaving the pipelines and associated supporting material in situ in the VDP2 and VDP3 areas is estimated to be 2.205 km^2 (Table 10.9), representing 0.05% of the combined North Norfolk Sandbanks and Saturn Reef SC (3,603 km^2) and Inner Dowsing, Race Bank and North Ridge SAC (854 km^2). The introduction of rock (to cover pipeline ends, subsea structure area and as support for the AWV) to the VDP2 and VDP3 area will increase the long-term footprint by 0.032 km^2 (<0.01% of the combined SACs), resulting in a total long-term footprint of 2.237 km^2 (0.05% of the combined SACs) (Table 10.10).

Table 10.10: Structures and materials with the long-term potential to impact on the seabed as part of VDP2 and VDP3

Structures and materials with the long-term potential to impact on the seabed as part of VDP2 and VDP3	Seabed impact (km^2)	Percentage of SACs seabed impacted*	Table reference
Pipeline and subsea structures rock-placement total	*0.000506*	*0.000011*	Table 10.5
AWV rock-placement total	*0.031600*	*0.000710*	Table 10.6
Structures decommissioned in situ total	*2.205150*	*0.049576*	Table 10.7
Total long-term seabed impact	***2.237256***	***0.050297***	**-**

* Combined area of both the North Norfolk and Saturn Reef SAC and Inner Dowsing, Race Bank and North Ridge SAC is 4,448 km^2 (3,603km^2 and 845 km^2 respectively)

The long term presence of the pipelines and existing support materials and the introduction of rock berms for the pipeline ends and for the jack-up AWV, could influence sediment dynamics in the VDP2 and VDP3 areas. Areas of scour have been observed on the lee side of oil and gas structures, and wrecks observed during the 2013 surveys

(Section 4) and similar occurrences may result from the introduction of a hard substrate (rock-placement). These areas of scour are minimal, and recent surveys of the pipelines (Fugro 2014 a, b, c and d) have shown that the majority of pipelines and associated stabilisation materials remain buried (Section 3; ConocoPhillips, 2014b).

To assess the potential for long-term cumulative impacts on sediment dynamics from the existing pipelines and associated support structures, ConocoPhillips 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 examined for evidence of exposed pipelines, and of any apparent damage or alteration to the form and function of the sandbank. The data found that seabed surface features such as ripple marks continued uninterrupted across the sediment overlying the pipelines (Senergy Floyds, 2008). The results indicated that the presence of the VDP2 and VDP3 pipelines, mattresses and grout bags are unlikely to compromise the integrity of the North Norfolk Sandbanks and Saturn Reef SAC and the Inner Dowsing, Race Bank and North Ridge SAC. In addition the presence of monopiles on Scroby Sands Wind Farm, which is located in a highly mobile environment have not been shown to influence the overall form and function of the sandbank (Cefas, 2006).

10.6.3 Fauna disturbance

Structural degradation of the pipeline and mattresses in the VDP2 and VDP3 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 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. Pathways from the pipelines to the receptors would be via the interstitial spaces in seabed sediments, overlying rock-placement where applicable and the water column. Any failure is anticipated to begin to occur after many decades and is expected to take up to 500 years to fully degrade (Costain, 2014b). The release of degradation products is expected to occur at a slow rate and therefore expected to have a minimal impact on the surrounding environment.

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.

The following sections outline the degradation products associated with each of these components. The potential impacts of the release of these products on benthic fauna and ecosystems are also addressed below. The impacts of the products (hydrocarbons and chemicals) released to sea during the flushing of the pipelines will be addressed in Section 12 (Discharges to Sea).

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 metal content of the scale taken from a Viking GD Xmas tree provides an indication of the composition of the pipeline scale present in the VDP2 and VDP3 pipelines (Scotoil, 2014). The metals found to be present in the scale include Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Mercury (Hg), Nickel (Ni) and Zinc (Zn). The chemical components of the carbon steel in the pipelines found in VDP2 and VDP3 are shown in Table 10.11. The bulk constituent of the steel is likely to be iron.

Table 10.11: Pipeline steel chemical components (Source: Costain, 2014b)

Element	Composition (maximum %)
Iron (Fe)	Bulk
Manganese (Mn)	1.85
Carbon (C)	0.22
Phosphorus (P)	0.025
Sulphur (S)	0.015
Titanium (Ti), Niobium (Nb), Vanadium (V)	Combined <0.15

The pipelines were cathodically protected with zinc bracelet anodes. The cathodic protection system operates on the principle that the anodes will decay in preference to the pipeline material. A typical composition of a zinc anode used in the North Sea is provided in Table 10.12. According to visual survey footage undertaken in the VDP2 and VDP3 area, the majority of the anodes are already fully degraded and the remaining few are partially or heavily degraded (Fugro 2014a, b, c and d; ConocoPhillips, 2014b). Most of the chemicals associated with these anodes have therefore already been released into the surrounding environment.

Table 10.12: Zinc anode components

Element	Composition (maximum %)
Zinc (Zn)	Bulk
Aluminium (Al)	0.1 – 0.5
Copper (Cu)	0.05
Cadmium (Cd)	0.025 – 0.07
Lead (Pb)	0.006
Iron (Fe)	0.005
Other	0.1

Source: Costain, 2014c

The heavy metal input from the anodes is relatively minor when compared to the inputs from the steel. Table 10.12 shows that with the exception of zinc, many of the other components are only present in trace quantities. Hg, Cd, Pb, Cr, Cu, Zn and Ni are potentially the most environmentally hazardous materials identified in North Sea pipelines of a similar construction (MPE, 1999). Above a threshold, these metals are toxic to marine organisms and can bioaccumulate. This threshold is dependent on variables in the environment including the rate of release (determining the concentration in the surrounding water), the temperature and salinity of the water, presence of other metals and the bioavailability of a metal (which depends strongly on its chemical speciation).

Metals are chemical elements which will not degrade further once discharged to seawater. As free cations, the natural states of metals in seawater have almost indefinite solubility and will quickly dilute to non-toxic concentrations. Metals may also complex with inorganic constituents of seawater such as sulfate. Corrosion and degradation depends on a multitude of variables and as such it is not possible to predict the rate of release of metals or other contaminants to the environment. Prediction of the rates of corrosion is further complicated by the unknown durability of their anticorrosion and concrete coating systems.

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 behavior, 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 levels 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. *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 visual confirmation of the occurrence of *S. spinulosa* on various sections of pipeline confirms that the species can survive on pipelines and associated subsea structures.

Along buried pipeline corridors there may be accumulations of heavy metals in the sediments. These sediments are also likely to form bonds with these metals, making them less bioavailable to marine organisms (MPE, 1999). 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 (i.e., 60 to 100 years) (HSE, 1997; Costain, 2014b). The area that could be biologically impacted would likely be limited to a few metres on either side of the pipeline.

Naturally Occurring Radioactive Material (NORM)

The presence of NORM contaminated scale was reported in the scale taken from Viking and 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, 2015). 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, 2015).

Polycyclic Aromatic Hydrocarbons

The base material 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 polycyclic aromatic hydrocarbons (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. PAHs are almost insoluble and only become available to marine organism 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 in 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 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-life 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.

Plastics

The majority of the pipelines and umbilical in the VDP2 and VDP3 areas will be coated with a plastic layer (polyethylene, polypropylene, 3 Layer Polyethylene (3PLE) and Fusion Bonded Epoxy (FBE)) (BMT Cordah. 2015c). FBE and 3PLE 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 toxicity and subsequent environmental effect of leaving these plastics in place would not be significant (MPE, 1999).

10.7 Cumulative and Transboundary Impacts

Following completion of the VDP2 and VDP3 activities, the total maximum seabed impact is expected to be approximately 32.16 km^2 which represents 0.72% of the North Norfolk Sandbanks and Saturn Reef SAC and the Inner Dowsing, Race Bank and North Ridge SAC (Table 10.13).

Table 10.13: Structures and materials with the potential to impact on the seabed as part of VDP2 and VDP3

Structures and materials with potential to impact on the seabed as part of VDP2 and VDP3	Seabed impact (km^2)	Percentage of SACs seabed impacted*	Table reference
Surface installation removal total	*0.006776*	*0.000152*	Table 10.2
Subsea structures removal total	*0.003688*	*0.000083*	Table 10.3
Anchoring of HLV total	*0.006002*	*0.000139*	Table 10.4
Pipeline and subsea structures rock-placement total	*0.000506*	*0.000014*	Table 10.5
AWV rock-placement total	*0.031600*	*0.000710*	Table 10.6
Structures decommissioned in situ total	*2.205150*	*0.049576*	Table 10.7
Overtrawl survey area	*29.910500*	*0.672448*	Table 10.8
Total VDP2 and VDP3 seabed impact	***32.164222***	***0.723122***	**-**

* Combined area of both the North Norfolk and Saturn Reef SAC and Inner Dowsing, Race Bank and North Ridge SAC is 4,448 km^2 (3,603km^2 and 845 km^2 respectively)

Out with the scope of VDP2 and VDP3 there are also currently 62 platforms, one buoy, 37 subsea structures and 121 subsea pipelines within the SAC, all with varying dimensions and therefore footprints. Based on the lack of information available regarding the physical extent of the footprint, the estimated lifespan and the planned method of decommissioning of these installations, it is difficult to quantify the level of cumulative impact from the existing infrastructure within the SAC.

In addition to decommissioning activities, stabilisation work has and will be undertaken by ConocoPhillips at other locations within the SAC. Information regarding tonnage and/ or footprint of rock-placement/ gravel deposits has been provided (where available) in Table 10.14.

Table 10.14: ConocoPhillips stabilisation works in the North Norfolk Sandbanks and Saturn Reef SAC having a potential cumulative impact on the seabed

Block and facility	Year of installation	Seabed stabilisation laid	Seabed impact (km^2)	Percentage of SAC seabed impacted**
48/25, 49/16, 49/17 and 49/21: VDP1 and LDP1	2015	135,800 tonnes of rock/ gravel	0.0546	0.00122
49/16: North Valiant 1 PD	2014	11,000 tonnes of rock/ gravel ranging in size from 11 to 22 mm	0.0033	0.00007
49/16: Vanguard QD	2013	8,000 tonnes of rock/ gravel ranging in size from 5 to 20 cm	0.0024	0.00005
49/21: South Valiant TD	2014	30,000 tonnes of rock/ gravel ranging in size from 11 to 22 mm	0.0052	0.00012
49/16: LOGGS PA and North Valiant 1 PD	2014	Seven frond mats laid to counteract scour*	0.0126	0.00028
Total area of impact from ConocoPhillips stabilisation works in the SAC			***0.0781***	***0.00174***

*Dimensions of frond mats based on the dimensions of a typical North Sea concrete mattress (6 x 3 m)

Source: ConocoPhillips, 2014c; ConocoPhillips, 2015b

** Combined area of both the North Norfolk and Saturn Reef SAC and Inner Dowsing, Race Bank and North Ridge SAC is 4,448 km^2 (3,603km^2 and 845 km^2 respectively)

In addition to ConocoPhillips' activities occurring in the North Norfolk Sandbanks and Saturn Reef SAC, proposed and current deposit consent applications submitted to BEIS by other operators indicate further activities are, and will be, undertaken in the SAC. Information provided in Table 10.15 provides details of the level of other oil and gas activity currently within the SAC.

Table 10.15: Recent works by other operators in the North Norfolk Sandbanks and Saturn Reef SAC having a potential cumulative impact on the seabed

Operator	Block	Information source/ BEIS reference
Shell U.K. Limited	48/14	Drilling EIA Direction (Deposit Consent). DRA/172.
	48/8	Pipeline EIA Direction (Deposit Consent). PLA/88.
	49/14b	Marine Licence for Well Intervention. WIA/164
	49/14b	Production EIA Direction (Deposit Consent). PRA/166.
Shell U.K. Exploration and Production Limited	48/19	Production EIA Direction (Deposit Consent). PRA/85.
	49/26	Production EIA Direction (Deposit Consent). PRA/84.
Perenco UK Limited	48/7b	Drilling EIA Direction (Deposit Consent). DRA/142.
	49/28	Pipeline EIA Direction. PLA/145.
	49/23	Pipeline EIA Direction (Deposit Consent). PLA/138.
	49/27a	Production EIA Direction (Deposit Consent). PRA/30.
	49/28	Decommissioning Marine Licence. DCA/7.
Perenco Gas (UK) Limited	49/27	Pipeline EIA Direction (Deposit Consent). PLA/115.
	49/9b	Standalone Marine Licence. SA/263.
E.ON Exploration and Production Limited	48/02	Well Intervention Marine Licence. WIA/73.
Centrica Resources Limited	48/07c	Marine Licence and EIA Direction (Deposit Consent). WIA/30.
Centrica Production Nederland B.V.	49/10c	Pipeline Marine Licence (Deposit Consent) PLA/208
Tullow Oil SK Limited	49/26a	Pipeline Marine Licence (Deposit Consent) PLA/163
	49/28	Pipeline Marine Licence (Deposit Consent) PLA/167
	49/28	Pipeline Marine Licence (Deposit Consent) PLA/168
Centrica North Sea Gas Limited	49/10c	Well intervention Marine Licence (Removal) Xmas Tree WIA/254

Source: ConocoPhillips, 2017

Table 10.16 presents the cumulative long-term (rock-placement and structures decommissioned in situ) seabed impact on the North Norfolk Sandbanks and Saturn Reef SAC and the Inner Dowsing, Race Bank and North Ridge SAC as a result of ConocoPhillips proposed VDP2 and VDP3 activities, combined with stabilisation work undertaken by ConocoPhillips within the North Norfolk Sandbanks and Saturn Reef SAC. The total maximum cumulative long-term seabed impact as a result of ConocoPhillips activities is expected to be 2.4 km^2, which represents 0.05% of the North Norfolk Sandbanks and Saturn Reef SAC and the Inner Dowsing, Race Bank and North Ridge SAC.

Table 10.16 illustrates that the ConocoPhillips VDP2 and VDP3 activities, in combination with the ongoing and previous stabilisation works, will increase the long-term seabed impact within the wider SAC area. However, decommissioning the majority of the subsea VDP2 and VDP3 infrastructure in situ, with minimal introduction of additional material into the SAC minimises the cumulative impact of these activities.

Table 10.16: Cumulative long-term impact from ConocoPhillips decommissioning and stabilisation works occurring within the SACs

ConocoPhillips activity occurring in the SAC	Year of activities	Seabed impact (km^2)	Percentage of SAC seabed impacted
VDP2 and VDP3 long-term seabed impacts (Table 10.10)	2016 to 2018	2.24	0.050
Stabilisation works associated with Activities in the SACs (various projects) (Table 10.14)	2013 to 2018	0.08	0.002
VDP1 and LDP1 decommissioned footprint (exc items captured in Table 10.14) long-term impacts	2013 to 2018	0.08	0.002
Total area of impact from ConocoPhillips work in the SAC		***2.40***	***0.054***

As described in Section 5, there are a total of six active aggregate extraction sites and three application sites which all lie seaward of the 6 nm limit and within 10 km of the VDP2 and VDP3 infrastructure (Crown Estate, 2017; MMO, 2017). Removal of the platforms is not expected to impact this resource.

Table 10.17 illustrates that the ConocoPhillips VDP2 and VDP3 rock-placement activities, in combination with the ongoing and previous stabilisation works, will add 0.107 km^2 of new material to the seabed. However, this area of new material will cover a very small portion of the extensive protective area, and will have a negligible impact on any future aggregate activities in the area.

Table 10.17: ConocoPhillips VDP2 and VDP3 rock-placement activities and stabilisation works occurring within the SACs

ConocoPhillips activity occurring in the SAC	Year of activities	Seabed impact (km^2)	Percentage of SAC seabed impacted
VDP2 and VDP3 pipeline rock-placement impacts (Table 10.5)	2016 to 2018	0.000506	0.00001
VDP2 and VDP3 AWV rock-placement impacts (Table 10.6)	2016 to 201	0.0316	0.000710
Stabilisation works (Table 10.13)	2013/ 2014	0.07810	0.001756
Total area of impact from ConocoPhillips work in the SAC		***0.110206***	***0.002476***

The VDP2 and VDP3 activities (are located 45 km west of the UK/ Netherlands median line. Decommissioning activities are not anticipated to create any transboundary impacts.

10.8 Mitigation Measures

Mitigation measures to minimise seabed impacts within the VDP2 and VDP3 areas are detailed within Table 10.18.

Table 10.18: Planned mitigation measures

Potential sources of impact	Planned mitigation measures
Subsea equipment cutting, excavation and lifting	• 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 will be used preferentially where access is available
Anchoring activities	• All anchors would be completely removed from the seabed at the end of the decommissioning operations.
Rock-placement	• A rock-placement vessel or ROVSV (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 controlled fall pipe equipped with cameras, profilers, pipe tracker and other sensors as required. 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 on the seabed 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 decommissioning in situ 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 and the profile of the AWV rock berms 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.

10.9 Conclusions

The cutting and lifting of the eight VDP2 and VDP3 jackets and the five subsea structures will create some temporary, short-term disturbance of the seabed sediments, over an estimated area of 29.918 km^2. This disturbance will be relatively small and occur due to the excavation of the seabed (where required), the manoeuvring of the ROV, and the use of cutting equipment. These activities will be controlled to minimise excavation activity and to ensure accurate placement of cutting and lifting thereby minimising the risk of sediment disturbance.

Anchoring an HLV would result in a footprint of 0.006 km^2 within the SAC. All anchors would be removed from the seabed following decommissioning operations and given the dynamic seabed conditions, recovery of the seabed and associated fauna is expected to be rapid (approximately a year).

Rock-placement activities associated with the in situ decommissioning of pipelines and the laying of rock berms for the AWV stabilisation will impact the sediment through long-term, localised modification of the seabed over an estimated area of 0.032 km^2 and a transient physical disturbance caused by suspension of material into the water column. This impact will be mitigated by controlled rock-placement to minimise seabed footprint. The rock berm profiles will allow fishing nets to trawl over the rock unobstructed.

The rate of colonisation of new rock material is difficult to predict, but as organisms associated with hard substrates will be naturally present in the area, the mattresses and areas of rock-placement provide a relatively small additional habitat for epibenthic rock-dwelling organisms. The decommissioning of the current pipeline stabilisation materials in situ will also reduce the amount of additional material needed to be introduced into the SAC and will reduce the amount of seabed disturbance associated with their removal. There largest area of disturbance is attributed with the overtrawl surveys which are to be conducted to ensure the seabed is safe for other users of the sea and is a requirement under the BEIS guidance. This is however a short-term impact which is expected to pose minimal effect on the SAC as the activity is similar to that caused by current fishing practices, of which the wider area is subject to. This impact is also not anticipated to be significantly different to a large winter storm, which in shallow seas such as those found at the VDP2 and VDP3 decommissioning areas, which would result in the movement and distribution of seabed and existing features.

The footprint resulting from leaving the pipelines and associated structures and supporting material in situ is estimated to be 2.205 km^2. Long-term degradation of the pipelines and mattresses will introduce chemical contaminants to the sediment and water column over an extended period. These chemicals are not expected to rise above background levels in the water column or result in long-term toxicity to marine organisms. It is anticipated that failure of the pipelines due to through-wall degradation would only begin to occur after many decades.

Overall, the VDP2 and VDP3 infrastructure are expected to create a maximum long-term seabed impact of 2.244 km^2, representing 0.05% of the combined total area of the North Norfolk Sandbanks and Saturn Reef SAC and the Inner Dowsing, Race Bank and North Ridge SAC.

11.0 DISCHARGES TO SEA

This section discusses the potential planned discharges to sea resulting from VDP2 and VDP3 decommissioning operations. Potential impacts to seabed sediments, including the associated benthic fauna are reviewed in Section 10. Any unplanned discharges during accidental events are not included, but presented in Section 13.

11.1 Regulatory Context

Discharges to sea generated from the decommissioning of the VDP2 and VDP3 facilities will be managed in accordance with current legislation and standards as detailed within Appendix A.

11.2 Approach

During the decommissioning of the VDP2 and VDP3 infrastructure and the associated vessel operations, the following subsurface activities or decommissioning strategies may lead to contaminated fluids and/ or solids entering the marine environment:

- Instantaneous discharge of contaminants during pipeline cutting and removal operations; and
- Long-term release of residual contaminants in subsea pipelines, through pipeline degradation over time.

This section assesses the type of potential contaminant, the magnitude of impacts to sensitive receptors and outlines the mitigation measures that ConocoPhillips will put in place.

ConocoPhillips will ensure that every effort is made to achieve an acceptable level of cleanliness to meet the intent of current Health and Safety Executive (HSE) and BEIS guidance. The decommissioning guidelines (DECC, 2011a; BEIS, 2018) encourage operators to utilise the Offshore Petroleum Activities ((OPPC) Oil Pollution Prevention and Control) Regulations 2005 Guidance Notes, in the first instance when assessing the potential for discharges to sea during operations (DECC, 2014b).

During production, OSPAR Recommendation 2001/1 requires all installations to achieve a 30 mg/l performance standard for entrained oil in water intentionally discharged or unavoidably released to sea; compliance is achieved through Oil Discharge Permits as described in the OPPC guidance. The concentration of dispersed oil in water as averaged over a monthly period must not exceed 30 mg/l, whereas the maximum permitted concentration must not exceed 100 mg/l at any time.

Such releases are most likely to occur during pipeline cutting. It will be difficult to accurately monitor concentrations that escape during this process, so in consultation with BEIS, a predicted level of cleanliness will be targeted during cleaning operations. The current intention is to flush all pipelines to a target cleanliness. The one exception to this is PL161 described in Section 3.8.7.

11.3 Sources of Potential Impacts

The following section provides an overview of the two main subsurface discharge streams (excluding accidental), that may have an environmental impact; namely the remaining gas pipelines and piggybacked methanol lines. ConocoPhillips do not foresee the opportunity for any contaminants to be discharged during the removal of topside infrastructure. All pipelines and tanks will be drained and then nitrogen purged prior to disassembly. Any solid contaminants remaining will be skipped and shipped.

The section will also consider both the immediate or short-term subsurface discharges from decommissioning activities and the potential for long-term release through in situ pipeline degradation.

11.3.1 Potential contaminants in gas pipelines

The gas pipelines contain a residual mixture of produced water, gas condensate, iron oxides, produced sand and other minerals/ trace elements. An accurate estimation of fluids or solids remaining in pipelines and pipework is difficult. The fluid volumes for all of the VDP2 and VDP3 pipelines are presented in Table 11.1.

The offshore pipelines connecting the satellite and hub platforms will be initially flushed with seawater followed by the use of gel/ foam pigs to remove mobile hydrocarbons with minimal removal of solids. The flushing direction will be from the satellite platform to the Viking Bravo Hub Complex. The flushing fluids will be filtered and mobile solids separated offshore. These solids would be collected for onward shipment to shore for treatment/ disposal. With the exception of gas pipelines (and piggybacked methanol lines) PL88 and PL27, the pipeline flushing fluids would be re-injected downhole, via well BD03. The seawater flushes and gel runs will not remove all of the solids from the pipelines. It is likely that in some of the pipelines residual contaminated sands and NORM scale may be left in the pipelines. The pipelines will be flooded with seawater following the cleaning operations.

The PL88 gas pipeline between Viking AR and Viking BP will be purged with nitrogen back to Viking AR, with the pipeline contents fed into PL27 (the Viking AR to TGT gas export pipeline). The PL88 gas pipeline will then be flushed with seawater followed by the use of gel/ foam pigs with the pipeline contents treated at Viking AR before being discharged to sea.

The PL27 gas pipeline will be flushed back to TGT for discharge via the effluent pipe. Prior to discharge, the flushed PL27 pipeline contents will be treated at TGT to meet current effluent discharge permit requirements.

After the identification of an anomaly on PL134, detailed in Sections 3.4.5 and 3.8.7, the remaining MeOH and corrosion inhibitor (CI) contents, estimated at 17 m^3 of MeOH and 0.085 m^3 of CI, within PL134 are to be displaced down the Viking AR riser using untreated seawater. This seawater is to be pumped from the Viking AR platform at a maximum pumping rate of 130 l/min (with assumed equivalent discharge rate of 30 l/min). Sufficient volumes of seawater are to be pumped down the PL134 platform riser to provide a safe clearance for the riser disconnects with the pipeline inventory to be discharged through the anomaly site 96.2 m east of KP 3.842 measured from Viking AR riser. To present the worst case discharge, the permit reflects 100% discharge to sea of the remaining pipeline inventory.

As anomalies in PL161 have been identified (see Sections 3.4.5 and 3.8.7) the remaining MeOH and corrosion inhibitor within the pipeline between the Viking AR platform and the blockage location (~10km from Viking AR riser) are to be displaced down the Viking AR riser using untreated seawater pumped from the Viking AR platform. Seawater will be pumped at a rate of 130 l/mins (with assumed equivalent discharge rate of 30 l/min). Sufficient volumes of seawater are to be pumped down the PL134 platform riser to provide a safe clearance for the riser disconnects with the pipeline inventory to be discharged through the anomaly site (128 km from TGT and 10 km from Viking AR riser). To present the worst case discharge, the permit reflects 100% discharge to sea of the remaining pipeline inventory (42 m^3 MeOH and 0.021 m^3 corrosion inhibitor KI-5351. It is proposed that the remaining inventory will be discharged to the marine environment under a chemical permit and appropriate risk assessment.

11.3.2 Potential contaminants in piggybacked methanol lines

The fluid volumes for all of the VDP2 and VDP3 methanol lines are presented in Table 11.1. Residual fluids within the piggybacked lines will include methanol and corrosion inhibitors. No solids are expected to occur in these lines (Costain, 2014a).

Table 11.1: Estimated VDP2 and VDP3 pipeline fluid volumes

Decommissioning Programme	Pipeline number	Fluid conveyed	Direction of flush	Pipeline			
				Length (km)	Nominal bore (mm)	ID (mm)	Volume (m^3)
VDP2	PL27	Gas	AR to TGT	134.9	711.20	676.20	48,420.80
	PL161	Methanol		134.9	76.20	73.66	574.57
	PL88	Gas	BP to AR	10.9	609.60	577.86	2,858.65
	PL134	Methanol		10.9	76.20	73.66	46.45
	PL1571 PL1572	Gas	KD/ LD to BD*	13.7	406.40	362.00	1,409.31
	PL1573 PL1574	Methanol		13.7	76.20	63.90	43.91
	PL2643	Gas	BP to LOGGS	27.5	406.40	380.80	3,122.16
	PL2644	Methanol		27.5	76.20	66.70	96.04
	PL1767	Gas	VM to BD	8.7	254.00	241.25	397.49
	PL1768	Methanol and control fluids	BD to VM**	2 x 8.7	114.30	2 x 19	4.94
VDP3	PL0211	Gas	JD to BD	13.5	406.40	371.44	1,462.85
	PL0212	Methanol		13.5	76.20	58.42	36.19
	PL1095	Gas	JM to JD	5.1	340.80	290.25	337.28
	PL1096	Methanol		5.1	76.20	63.90	16.35

***** Combined volume of KD to BD pipeline and LD riser
****** The proposed method of cleaning the methanol hoses within the VM umbilical is to flush from BD and decant the methanol & flushing fluid into the gas pipeline at the subsea skid.

11.4 Predicted Residual Contaminants

The following contaminants are identified as likely to enter the marine environment as a result of strategies currently presented for the decommissioning process. The majority will result from the short term instantaneous release of material or fluid following a removal action, or the long term slow release of a contaminant through the degradation of infrastructure decommissioned in situ.

11.4.1 Chemicals

The only permitted chemicals are found in the methanol lines. The methanol lines will be flushed and the contents disposed of the via re-injection into well BD03. Following flushing it is anticipated that there should be no chemicals left within the methanol lines. However should there be any residual traces of chemicals left in the lines, these would not pose any significant risk to the marine environment as all of these chemicals are on the PLONOR List. As such, all the relevant eco-toxicological information has already been submitted to the regulator.

11.4.2 NORM scale

Evidence presented from TGT surveys and cleaning/ disposal certificates and from topside pipework removed during early P&A work, suggests the presence of NORM contaminated scale (Scotoil, 2003) in the gas pipelines. No NORM contaminated waste will be discharged to the marine environment. ConocoPhillips has an existing 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 Environment Agency. Radiochemical analysis of Viking and LOGGS infrastructure has recorded Radium 226, Actinium 228, Polonium 210, Lead 210 and Thorium 228 (Scotoil, 2003). Solid wastes are discussed in detail in Section 14.

11.4.3 Heavy metals

Traces of the following heavy metals have been recorded in scale deposits within the Viking structures: arsenic, cadmium, chromium, copper, mercury, nickel and zinc (Scotoil, 2003). It has been assumed that similar heavy metals will be present in the pipework which has been exposed to production fluids, however quantities are not known. Further information on the toxicity and impacts of these trace elements is provided in Section 10.

11.4.4 Entrained hydrocarbons

During decommissioning activities such as pipeline cutting, there is the opportunity for small quantities of entrained fluids contaminated with hydrocarbons to enter the marine environment. Contaminants include residual hydrocarbons, along with dissolved organic and inorganic compounds that were present in the geological formation. The impact of discharging this fluid to the environment is dependent on a number of physical, chemical and biological processes including: volume and density of discharge, dilution, volatilisation or low molecular weight hydrocarbons and biodegradation of organic compounds. Hydrocarbons do not affect all components of marine ecosystems equally (OSPAR, 2009). A summary of key eco-toxicological effects is presented in Table 11.2.

Table 11.2: Summary of key eco-toxicological impacts resulting from hydrocarbon discharged to the environment

Receptor	Eco-toxicological impact
Planktonic organisms	Can experience toxic effects from oil in water; the high turnover of populations renders plankton relatively unaffected.
Invertebrates	Sensitivity varies greatly; corals among the most sensitive. Shellfish may accumulate oil residues with attendant secondary effects, particularly relating to health.
Fish	Eggs and larvae more susceptible to toxic effects than adults; hydrocarbons may accumulate in adult tissues - may affect health/taint flesh.
Birds	Large quantities may coat feathers reducing buoyancy and insulation, leading to increased mortality. Exposure to potential toxic effects from ingesting oil with food or from preening. May also affect breeding success.
Marine mammals	Leads to skin/ eye irritation. Exposure to potential toxic effects from ingesting oil with food.

The toxicity of oil contaminated water has also been investigated in laboratory tests using a number of taxa, including algae, invertebrates and fish. Such studies have found that entrained water is non-toxic after a 20-fold dilution factor (Somerville *et al*., 1987). Any significant effects would be limited to a small area around the discharge or release point. During operations, the fluids released should have only residual amounts of entrained hydrocarbons, based on reaching a level of 30 ppm within the arrival fluid during cleaning. This should rapidly disperse/ evaporate, presenting minimal likelihood of long term persistence. Due to the low volumes and concentrations being discharged, the potential for bioaccumulation is low.

Hydrocarbon components and their effect on the environment

Potential toxic components from residual fluids include polycyclic aromatic hydrocarbons (PAHs) and alkylphenols. These compounds are more likely to have a detrimental impact on organisms living within the water column.

- PAHs - Evidence of carcinogenicity, mutagenicity or teratogenicity attributable to PAHs in the marine environment is limited. Studies have shown that caged blue mussels accumulate PAH; with levels decreasing with increasing distance from the discharge point (Sundt *et al*., 2008). Water column monitoring in the Dutch sector has shown an accumulation of the PAH naphthalene in blue mussels up to 1,000 m from a platform (Foekema *et al.,* 1998). Given the marine organisms' short exposure times, the overall risk posed by aromatic substances is very low (OGP, 2002).
- Alkylphenols - These are natural constituents of hydrocarbons found in oil entrained waters that can be toxic to marine organisms; as such they fulfil OSPAR criteria for potential persistence and bioaccumulation (OSPAR, 2009). Risk assessments undertaken on alkylphenols in produced water have indicated an insignificant risk on reproduction at the population level of cod, saithe and haddock (OGP, 2005). Sophisticated models consistently demonstrate that Predicted No Effect Concentrations are quickly attained into the water column, and that the exposure times of organisms to key contaminants are too short to induce a significant threat to marine ecosystems from contaminated fluid discharges (OGP, 2005).

Dilution in the water column

Compounds in residual fluids lost to the marine environment undergo weathering which tends to reduce their concentration in the receiving environment and decrease potential toxicity to marine organisms (Neff, 1987). Residual fluids will dilute readily dependent on the rate of introduction and local hydrographic conditions. Rates of 30 to 100-fold occur within the first few tens of metres of the discharge point, and at distances 50 to 1,000 metres of this point, rates of 1,000 to 100,000 times are typical (OGP, 2005).

During the first hours after release, dilution is the predominant mechanism in concentration reduction. Similar entrained waste streams such as produced water present a 100-fold dilution factor within 50 m of the discharge point (Somerville *et al*., 1987). After it is discharged, contaminated fluids will be first diluted by the turbulence close to the discharge point, and then widely dispersed by marine currents. Due to the low levels of contaminants discharged and the rapid dispersion in the environment, long-term or chronic effects are therefore unlikely.

11.4.5 Pipeline construction materials

The VDP2 and VDP3 pipelines have detailed component inventories. Pipeline construction includes the following materials: steel, concrete, coal tar and plastic (D3 Consulting, 2015). Component parts have the potential to enter the marine environment through deterioration and degradation over time. Short-term or long-term impacts from these materials are considered in detail in Section 10.

11.5 Short and Long-Term Impacts from Residual Contaminants

The impact of contaminants within the marine environment and that of sensitive receptors, for the purpose of this study, are separated into short-term/ immediate impacts (primarily caused by the physical decommissioning of the pipelines), and the long-term impacts associated with the degradation and deterioration of the pipelines decommissioned in situ over time.

11.5.1 Short-term impacts

On cutting the pipeline ends, it is anticipated that any trapped or entrained hydrocarbons will be slowly released, as the system is not pressurised. Owing to the small volume/ low concentration of hydrocarbons and the expected nature of release, it is expected that any hydrocarbons present will disperse within a short distance of the release point, and its impact will be short lived.

11.5.2 Long-term impacts

As the pipelines will be decommissioned in situ, it is anticipated that following cleaning of the pipelines some residual hydrocarbons, scale and sediments will remain in situ. This material will be released gradually after through-wall corrosion occurs and the integrity of the pipelines progressively fails. Any failure is anticipated to begin to occur over a long period (i.e., >60 years) (HSE, 1997; Costain, 2014b). Pathways from the pipelines to the receptors would be via the interstitial spaces in seabed sediments, overlying rock-placement where applicable and the water column. Release would therefore be gradual and prolonged such that the effects on the receiving marine environment are considered to be negligible. The potential chemical effects from degradation of the pipeline and its coatings are discussed in Section 10.

11.6 Impacts on Sensitive Receptors

The potential for short-term and long-term impacts are assessed for the major taxonomic groups relevant to the southern North Sea marine environment, to determine the potential scale of interaction within the vicinity of the discharge.

11.6.1 Plankton

Some localised toxicity to planktonic organisms may result from the release of fluids contaminated with entrained hydrocarbons during and after the proposed decommissioning operations. The localised release of such fluids is likely to become rapidly diluted within the water column to levels below concentrations known to cause lethal or sub-lethal effects to the planktonic community (Lee and Neff, 2011; Neff, 2002).

Consequently, a short-term release of any remaining contaminated fluid does not present a risk to the planktonic community. The long term impacts of released contaminants are negligible due to the dilution factor, the low concentrations released and the time frame involved.

11.6.2 Benthic environment

The slow release of contaminated fluids has the potential to cause long-term impacts from exposure of benthic organisms to potentially harmful chemicals (DTI, 2001). The extent of these impacts depends on location of the organism to the seabed, concentrations, dispersion rates, current speed and dilution (Lee and Neff, 2011).

It is anticipated that any contaminated fluids released during and after the proposed decommissioning activities will dilute to levels that are too low to cause significant harm to benthic organisms. Therefore, it is unlikely that benthic organisms will be impacted.

The release of solid contaminants and their impacts on the benthic fauna was discussed in Section 10.

11.6.3 Fish and shellfish

As pelagic finfish are highly mobile, it is unlikely that there will be an impact on the finfish community. In a mesocosm study on the impacts of produced water on finfish, no negative impacts were observed (Gamble *et al*., 1987). There is a low probability of fish, shellfish or other epibenthic organisms in the water column being impacted by residual fluid or solid contaminants due to the expected low concentrations of hydrocarbons or chemical contaminants in the seawater. There is the possibility that fish and shellfish may be exposed to chemical and/ or metal contaminants through their feeding on benthic organisms that have been exposed to low levels of contaminants. However, this food web exposure would be of a low concentration and localized, and would only impact individual organisms with little or no impact to the species' populations in the area.

11.6.4 Protected habitats and species

The VDP2 and VDP3 infrastructure to be decommissioned are located within the North Norfolk Sandbanks and Saturn Reef SAC (Section 4; JNCC, 2017a). Further, the PL27/ PL161 pipelines extend from this SAC to the landfall at TGT, crossing the Inner Dowsing, Race Bank and North Ridge SAC. Annex I habitats occurring within both these SAC's include sandbanks and biogenic reef habitats formed by the polychaete worm *S. spinulosa* (Section 4). As discussed in Section 10, the short or long-term release of contaminated fluids or solids is expected to have a negligible impact on either Annex I due to the energetic hydrodynamic regime and the low volumes of residual fluids predicted.

Annex II species sighted within the VDP2 and VDP3 decommissioning areas (UKCS Quadrants 47, 48 and 49) include the harbour porpoise, bottlenose dolphin and the harbour and grey seals. Sea lampreys may also be present in the area. The short-term release of contaminated fluids or solids is unlikely to have an effect on any of the Annex II species noted. With the exception of the harbour porpoise, all species have been observed in low numbers/ abundance. The high mobility of all these species suggests that no discernible impact on individuals or populations should be observed.

Long-term impacts on Annex I habitats are predicted to be negligible due to the extent of habitat, the dynamic water regime and the volumes and concentrations likely to be lost over time. Long-term impacts to Annex II species of concern to the area are equally unlikely to have any effect, due to the limited number of individuals frequenting the area, the likely pathways of contamination and the mobile nature of the five species (sea lamprey, harbour porpoise, bottlenose dolphin, harbour seal and grey seal).

11.7 Cumulative and Transboundary Impacts

The predicted small release of contaminated fluids during cutting operations is the only potential short term or immediate impact during the decommissioning process. As the discharge rates for oil in water are estimated to be less than 30 ppm following the cleaning and flushing regime, the impact to the local environment will be negligible and temporary. Therefore the potential for cumulative impacts is greatly reduced.

Previous monitoring programmes in regions with high densities of offshore installations and significant volumes of entrained water discharges, have confirmed the presence of constituent compounds around the offshore installations, they have not however identified any negative environmental effects (Bakke *et.al*, 2013). In the North Sea, surveys of contaminants in fish tissue have not revealed elevated levels of contaminants from entrained fluids (OSPAR, 2009). Similar results have been found for the Gulf of Mexico (OGP, 2005).

ConocoPhillips believe that these decommissioning activities will not present a measurable cumulative impact to the local environment due to the following reasons:

- Regulatory requirements ensure that discharges to sea are limited with thresholds similar to those applied during production periods;
- Operators are required to reduce to as low as reasonably possible (ALARP), the opportunity for discharges to enter the marine environment; and
- The distances both spatial and temporal, between operations and the dilution factors recorded for fluid contaminants will prevent cumulative short term impacts.

The long-term cumulative effects have also been considered, to account for the degradation and eventual collapse of the pipelines decommissioned in situ. Again it is not thought that these will lead to a significant cumulative impact, as release rates will be over a long period (several decades to centuries), of small volumes or amounts, and potentially locked within the surrounding sediments if the pipelines remain buried over time.

The VDP2 and VDP3 infrastructure are located, approximately, 45 km west of the UK/ Netherlands median line and since all identified impacts would be localised and within UK waters, no transboundary impacts are anticipated for either short term or long-term impacts.

11.8 Mitigation Measures

The key mitigation strategies proposed for potential discharges as highlighted in Section 11.3 are presented in Table 11.3 below.

Table 11.3: Planned mitigation measures

Potential source of impact	Planned mitigation measures
Residual hydrocarbons or solids in pipelines and subsea pipework	Cleaning of pipelines during the decommissioning process, including: • Flushing pipelines with sea water and gel pigging. • Re-injection of contaminated fluids from the gas pipelines. • Removal of any mobilised solid wastes for skip and ship. Disposal of waste transported onshore for disposal will be provided by an approved waste management contractor, in compliance with ConocoPhillips existing standards, policies and procedures. • Release of residual contaminants from the long term degradation of the pipeline decommissioned in situ.
Residual fluids in piggybacked methanol lines	• Cleaning of pipelines during the decommissioning process. • Wherever possible recovered clean methanol will be reused during Viking decommissioning operations. Disposal of waste transported onshore for disposal will be provided by an approved waste management contractor, in compliance with ConocoPhillips existing standards, policies and procedures.

11.9 Conclusions

For both the short-term/ immediate impacts during decommissioning operations, and during the long-term degradation of the pipelines decommissioned in situ, the release of residual fluids and chemical contaminants will result in localised effects which are not expected to be significant. These are not anticipated to have any discernible impact on the wider marine environment cumulatively or in combination with other activities.

12.0 SOCIETAL IMPACTS

This section discusses the potential short and long-term societal impacts associated with the decommissioning the VDP2 and VDP3 infrastructure. The measures taken or planned by ConocoPhillips to minimise these impacts are detailed in Section 12.6.

12.1 Regulatory Context

Societal impacts generated from the proposed decommissioning activities will be managed in accordance with current legislation, guidelines and standards, as detailed in Appendix A.

12.2 Approach

During the risk assessment process (Section 7) and comparative assessment for the selected decommissioning options the following issues were noted as having a societal impact:

- An increase in vessel collision risk between the decommissioning vessels and other users of the sea; and
- Damage or loss of fishing gear/ vessels from potential snagging hazards on the seabed.

The impacts described in the following sections are similar for both the VDP2 and VDP3 decommissioning areas, and therefore, an assessment considering both programs was conducted with any additional site specific details highlighted.

12.3 Sources of Potential Impacts

The following provides a description of the two issues identified as having a societal impact as a result of the proposed decommissioning operations.

12.3.1 Decommissioning vessel presence

There may be the potential for short-term impacts as a result of disruption to previously established shipping operations in the area, while decommissioning vessels carry out surveys, remove infrastructure and undertake rock-placement activities. For the duration of the proposed activities, the physical presence of the decommissioning vessels will increase the current vessel activity in the vicinity of the VDP2 and VDP3 infrastructure.

A maximum of eight vessels may be present at any one time within the VDP2 and VDP3 decommissioning areas to undertake structure removal and rock-placement operations. The type of vessels present could include:

- DSV;
- CSVs;
- HLV;
- AWV;
- Supply vessels;
- Rock-placement/ trenching vessel;
- Pipe reel/ lay vessels; and
- Survey vessels.

12.3.2 Potential snagging hazards

The physical presence of the pipelines, rock-placement, seabed depressions/ anchor scars and mattresses/ 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 loss of the fishing vessel itself.

Conversely, as the decommissioning activities proceed there will be a positive impact. New areas of sea will become available to fisheries through the removal of the 500 m safety exclusion zones that currently surround the eight VDP2 and VDP3 platforms.

As detailed in Section 3, the pipelines, mattresses and grout bags are to be decommissioned in situ, with the pipeline ends protected with rock-placement or re-trenched. For the purposes of this assessment, a worst-case has been used involving the use of rock-placement on pipeline ends, rather than re-trenching.

There is the potential for a number of depressions and berms to be left on the seabed following decommissioning. These would arise from:

- Anchoring the HLV;
- Deploying the AWV spud cans (where rock-placement is not necessary); and
- Excavation at the platform footings to enable these to be severed from the seabed, if internal cutting is not possible.

ConocoPhillips are undertaking SSAs to determine whether rock-placement will be required on the seabed at the AWV locations, to protect against possible punch-through and seabed scour at the AWV spud can locations. Initial SSAs undertaken at the VDP1 platform locations have indicated rock-placement (rock berms) will be required at several of the VDP1 platform locations. As a result, for a worst case it has been assumed that rock-placement will be used at the three satellite platforms and the AR riser platform under VDP2 and VDP3 (Section 3 and Section 10). Rock berms associated with the AWV will be left in situ following the completion of the decommissioning activities.

The final SSAs will be provided as supporting documentation in the direction for deposits applications which will be submitted to the BEIS to seek approval for the commencement of the rock-placement operations at each platform location. The volume of rock and site specific berm design will be detailed within each application, and will be based on the final SSA results.

12.4 Impacts on Receptors

Receptors potentially impacted by the proposed decommissioning activities may include:

- Commercial shipping (cargo, oil and gas related, windfarm support/ construction, etc); and
- Commercial fishing.

12.4.1 Commercial shipping

Commercial shipping traffic density within the 14 UKCS blocks associated with the VDP2 and VDP3 infrastructure (Blocks 47/17, 47/18, 47/19, 47/20, 48/16, 48/17, 48/18, 48/19, 48/20, 49/11, 49/12, 49/16, 49/17 and 49/22) range from very low to very high (Section 5.4).

The eight VDP2 and VDP3 platforms located in Blocks 49/12, 49/16, 49/17 and 49/22 experience high, moderate, very low and very low vessel densities, respectively (Section 5.4). Although data from BEIS indicates high vessel activity in Block 49/12 (which corresponds to Viking AR and Viking KD), AIS data for 2011 and 2012 indicate that this block is relatively low with a small increase in vessel density towards the north of the block associated with passenger and cargo vessels. Moderate vessel density in Block 49/16 is concentrated in the south west of the block, in proximity of the LOGGS end of pipeline PL2643. The remainder of the block indicates a low density of vessel traffic (MMO, 2014; ACCSEAS, 2014).

Approximately 1,550 vessels per year are thought to pass in the vicinity of the VDP2 and VDP3 offshore decommissioning area. The shipping channels in the vicinity of VDP2 and VDP3 are well established and vessel traffic associated with oil and gas infrastructure in the area is well understood. The use of historic shipping data for the decommissioning area (Section 5.4) provides an indication of the expected vessel activity.

Several shipping routes transect the PL27/ PL161 pipelines as they approach the TGT terminal, resulting in very high vessel traffic for Blocks 47/18, 47/19, 47/20 and 48/16. These routes have a range of average yearly density from 90 to 250 vessels per 2 km^2 (MMO, 2014).

However as the PL27/ PL161 pipelines are to be decommissioned in situ the only increase in vessel traffic will be associated with surveys along the pipeline and vessel movements associated with the removal of the Viking AR topside and jacket.

The majority of VDP2 and VDP3 vessel activities will be concentrated around the eight platforms and within their existing 500 m safety exclusion zones. It is assumed that these will remain in place until the structures are removed. With this and the proposed mitigation measures (Section 12.6), no significant impacts to shipping are anticipated as a result of the proposed decommissioning activities.

12.4.2 Commercial fishing

With respect to commercial fishing, there is the potential for snagging hazards from seabed obstructions (pipelines, rock-placement, seabed depressions/ anchor scars and mattresses/ grout bags) and increased collision potential based on increased vessel numbers operating in the vicinity of the decommissioning area (Section 12.4.1).

Vessel collision risk

As discussed in Section 12.4.1, the majority of decommissioning vessel activity will be conducted within the platforms' 500 m safety exclusion zones; these exclusions will remain for the duration of the decommissioning activities. Vessel activity that may occur outside of the exclusion zones will be associated with:

- Site specific surveys conducted before decommissioning operations commence;
- Post-decommissioning survey work; and
- Debris cleaning/ overtrawl activities.

These activities will be short in duration and accompanied by the required notifications to mariners, therefore mitigating potential impact to a negligible level of significance.

Snagging hazards

Of most concern to commercial fishing is the potential risk for snagging posed by pipelines, rock-placement, seabed depressions/ anchor scars and mattresses/ grout bags decommissioned in situ.

Pipelines decommissioned in situ pipelines and rock-placement

The predominant fishing method in the decommissioning area is beam trawl (Section 5.1). Traditional open beam gear comprises a cylindrical steel beam up to 12.0 m in length from which a net and associated steel 'tickler' chains are attached. The total weight of this gear can vary from five to eight tonnes. These vessels tow this heavy gear at speeds of up to seven knots. The combination of large horsepower vessels, relatively fast towing speeds and heavy gear creates a considerable potential for interaction between the gear and infrastructure (Brown and May, 2015). These interactions could result in damage to both the fishing gear and the decommissioned pipelines. However, due to the vessel parameters mentioned earlier and the majority of the pipelines having relatively small diameters (2 inch to 16 inch), the potential for any strike between fishing gear and pipeline resulting in a vessel coming fast and in turn sinking, is low. Pipelines PL27 and PL88 have larger diameters of 28 inch and 24 inch, respectively. These may pose a greater snagging risk to commercial fishermen should sections of the pipeline become exposed over time or develop significant spans (greater than 0.8 m and of longer than 10 m length).

In addition, the Dutch fleet have begun to change fishing gear types towards a pulse/ SumWing® beam which is a considerably lighter beam gear, similar in shape to a hydrofoil. Some versions of this equipment have been modified to include an electronic trailing tickler system. This lighter gear has a higher risk of snagging due to its construction and as such fisheries utilising this gear have currently been avoiding areas where there are known pipelines or potential snagging risks (Brown and May, 2014). It is anticipated that these fisheries will maintain their avoidance of this area post-decommissioning, resulting in no additional loss to current fishing grounds or practices.

Furthermore, VMS data indicates the majority of fishing effort by the Dutch fleet is targeted outside of the decommissioning areas (Section 5); these data are representative of vessels over 15 m in length and as such, account for the majority of the vessels working in this offshore area. However, moderate fishing activity occurs along the PL27/ PL161 pipelines in close proximity to shore. This is a combination of static and mobile fishing gear used primarily by small (<15 m overall length) vessels.

ConocoPhillips intends to decommission the pipelines included in VDP2 and VDP3 in situ with minimum intervention along the pipeline length. The pipelines have been on the seabed for between 8 and 40 years and are marked on fishing charts. The fisheries have been aware of their presence and have been continuing to use the surrounding seabed area without severe incident.

Pipeline surveys and subsea inspections undertaken between 2006 and 2016 have indicated that although the seabed is dynamic in nature and some spanning is evident, there are only three pipelines which have shown spans which meet the requirements of a reportable span as defined by FishSafe (BMT Cordah, 2015c). These three cases are within the current 500 m safety zones associated with these pipelines and in close proximity to the platform approaches. One of these spans was reported for PL1095 in the same location over subsequent years, while the span on PL211 showed evidence of repeated burial and re-exposure across the survey years (BMT Cordah, 2015c). The span on PL134 was identified in a 2016 subsea inspection, the pipeline section was found to be displaced from its original position with the maximum distance off-line being 96.2 m. Although there are areas of spanning and exposure along the lengths of the pipelines, evidence within the Viking Field where similar sections have been surveyed regularly have shown that observed spans/ exposures are covered and re-exposed over time (BMT Cordah, 2015c; Costain, 2014a).

Although rock-placement on the cut pipeline ends is proposed as a worst-case for the purpose of this assessment, the risk posed is minimal. The area covered by the rock-placement at each pipe end is approximately 1.8 x 10^{-5} km^2, requiring approximately 25 tonnes of rock per pipeline end. In addition, two pipeline tee-pieces and a pigging skid will be removed, and the area of removal covered with a rock berm to reduce snagging risk from any cut pipeline ends or mattress debris (Section 3). This rock-placement will be graded and selected for a size that is most suitable for the fishing gear used in the area to allow overtrawlability with minimal adverse impact.

<u>Mattresses/ grout bags and AWV associated rock-placement</u>

Each pipeline has associated mattresses and grout bags that ConocoPhillips intends to decommission in situ without further intervention. Details of these are summarised in the following sub-sections. Mattresses may present snagging hazards to fishing gear depending on the burial status, design and state of degradation.

Mattresses have proven a successful means of pipeline stabilisation across both decommissioning areas. Many of these mattresses are currently buried/ partially buried and based on the dynamic nature of the seabed there exists the potential for them to become exposed. These mattresses have been put in place to maintain the stability of the buried pipeline. If they were to be removed, additional rock-placement would need to be installed to maintain the stability of the pipelines, preventing the potential for more serious spanning of the decommissioned in situ pipelines in the future.

Deposition of rock-placement to aid stabilisation of the AWV has been assumed as a worst case for the three satellite platforms and AR platform locations (Section 3).Depending on the height of the AWV stabilisation material above the seabed surface and the angle of the rock berm slope, the rock-placement profile may present an obstacle to fishing gear which may get tangled, snagged or damaged during normal fishing operations. There is also the potential for scour pits to develop around these rock berms. Depending on the height of the rock-placement and the speed of the prevailing currents, these pits could become large and pose a potential risk to trawl doors or beams which could get stuck in the edge of the pit or on the edge of an eroded rock-placement.

ConocoPhillips anticipate, as a worse case, each rock berm will be designed to be 4.0 m in thickness, with a slope gradient of 1 in 5 applied to the berm.

For the commencement of the rock-placement operations at each platform location, the final SSAs will be provided as supporting documentation with the environmental assessments for deposits applications to BEIS. The volume of rock and site specific berm design will be detailed within each application, and will be based on the final SSA results.

Following removal of the AWV a proportion of rock berm will be pressed into the seabed with the weight of the AWV. ConocoPhillips estimate each spud can will penetrate approximately 1.5 m of a 4.0 m high rock berm, with the main bearing area fully embedded (ConocoPhillips, 2015a). However, areas of rock berm will remain on the seabed surface. Removal of the rock-placement following the completion of the cleaning activities at each platform site will not be practical; however notification will be issued to fishermen and other users of the sea as to the location of these areas of rock-placement.

Recent visual survey observations of the Viking Field pipelines indicate that rock-placement may collapse over time and in many of the pipeline cases these rock berms have been buried or partially buried with sediment (BMT Cordah, 2015c). Based on these observations, ConocoPhillips anticipate that the rock berms left in situ following the AWV activities will naturally settle and collapse over time with the mobile seabed sediments in the area expected to bury the remaining profile.

Based on the mitigation measures described in Section 12.6, the risk to fisheries is assessed to be medium but the likelihood of impact is low. The overall impact is therefore expected to be minor.

Seabed depressions/ anchor scars

The decommissioning activities will result in a number of seabed depressions and anchor scars. If rock-placement is not necessary for stabilisation, depressions may result from the removal of the jacket and from the associated jack-up legs of the AWV.

The use of a HLV at each of the eight platforms has the potential to create anchor scars on the seabed (Section 10). Seabed impacts based on a series of 10 tonne ‘flipper delta’ anchors with a total chain length of 1,250 m and a maximum contact length of 975 m were assessed in Section 10.

ConocoPhillips intends, where free from obstructions, to remove the jacket from the seabed by means of internal cuts to sever the pile connections in the seabed. However where this is not possible due to internal obstructions, the seabed around these piles will need to be excavated to allow access for an external cutting tool. As surveys have not been carried out to date on potential obstructions within the jacket piles, a worst case estimate has been based on external cutting of all of the jacket structures 3.0 m below the seabed. This will require an excavation to 4.0 m with a sloped edge to ensure the pit walls are stable. The slope will depend on soil type and current/ tide conditions. Based on experience from the ConocoPhillips Subsea Team, an approximately 30 degree slope will be needed, resulting in a circular excavation of 14.0 m diameter and depth of 4.0 m in the centre and tapered up to the seabed. As the seabed is very dynamic, sandwaves are anticipated to naturally infill the depression within 1 to 5 years (DECC, 2011a; Loe, 2010).

The cleaning and engineering down of the platform topsides will be undertaken using an AWV jack-up vessel or jack-up rig. There is the potential that some of the platform sites will have a sediment structure which will allow the deployment of the legs without the requirement for a rock pad. In these situations there will be a depression left on the seabed once the jack-up vessel moves off site. For the purposes of this ES, ConocoPhillips have based the assessment on an AWV with four jack-up legs, each with a spud can footprint of 3×10^{-5} km^2. The vessel specifications used in the assessment estimate that for sites not needing a rock berm the maximum protrusion into the seabed would be 3.5 m.

Based on the dynamic nature of the environment in the vicinity of these platforms it is anticipated that these depressions will backfill naturally over time. Section 10.5.1 refers to the natural recovery of anchor scars and similar depressions between 1 and 5 years, depending on the environmental conditions present (Loe, 2010; DECC, 2011a; Hill *et al.*, 2011; Thompson *et al.,* 2011). Overtrawl trials would be undertaken to ensure there are no berms or snagging issues associated with these depressions, identifying the location of the jack-up legs and anchor deployments within the area.

After decommissioning the VDP2 and VDP3 platforms, the 500 m exclusions zones around these structures will be removed allowing access to the areas protected by rock-placement. As these will be identified on navigation charts, have a relatively small footprint and are composed of graded rock, the potential risk to snagging fishing gear is considered low to negligible.

The VDP2 and VDP3 pipelines and umbilical comprise an approximate total length of 224 km. The burial and exposure status of these pipelines are summarised in Section 3. The majority of the pipelines have a low percentage of exposure, with the exceptions being PL88 (22.5% exposed) and PL1572 (33.3% exposed). As previously stated, the project specific burial study indicated that the location and size of the exposed and spanned sections can potentially change over time (BMT Cordah, 2015c). The results presented in Section 3 show the most recent survey with the longest pipeline length surveyed. Even with the changes in position and size, over time the percentage of exposure is relatively stable (BMT Cordah, 2015c). Based on the mitigation measures presented in Section 12.6, the risk to commercial fishing from the VDP2 and VDP3 pipelines is assessed to be minor.

The estimated number of mattresses associated with the VDP2 and VDP3 infrastructure is summarised in Section 3. Mattress dimensions are assumed to be 6 x 3 m. A post-decommissioning survey will be conducted to accurately ascertain the current position of the mattresses and a post-decommissioning monitoring programme will be agreed with BEIS. The exposed/ partially exposed mattresses, identified through surveys of the pipelines cover a total area of 3.2×10^{-3} km^2, however due to the dynamic nature of the seabed (Section 4) there is potential that the burial status of these mattresses may change over time. It should also be noted however that a number of these mattresses were designed with integrated frond mats. These were designed to help reduce the seabed current and retain sediments to help maintain burial. From survey video footage it is evident that this has been successful in maintaining complete or partial burial of these mattress types. Based on the mitigation proposed (Section 12.6) and the level of current fishing activity in the area, the risk to fishers snagging gear on exposed mattresses is assessed to be minor.

12.5 Cumulative and Transboundary Impacts

There are a number of existing oil and gas installations within close proximity to the VDP2 and VDP3 infrastructure. Cumulative impacts to fisheries may occur if the extent of an area impacted is significant with respect to the total area available for fishing.

There will be a cumulative impact associated with the rock-placement (Section 10); however, a small proportion of the area covered by the additional rock will be offset by the area of seabed released for use by fisheries through the removal of the 500 m safety exclusion zones at each of the eight platform locations.

The combined extent of the small areas of mattresses/ grout bags and of exposed pipeline is relatively insignificant in comparison to the available fishing grounds in the area, and therefore cumulative impacts are not anticipated.

As the decommissioning activities proceed, new areas of sea will become available to fisheries, reducing the overall cumulative impact to fisheries offsetting a proportion of the area lost to fisheries by the introduction of rock-placement material.

The pipelines, mattresses and associated rock-placement are all localised and within UKCS waters, so there will be no transboundary impacts.

12.6 Mitigation Measures for VDP2 and VDP3 Areas

Mitigation measures to minimise societal impacts are detailed in Table 12.3. All of the decommissioning activities other than survey work will be conducted within the current 500 m safety exclusion zones and so the use of guard vessels is not deemed necessary.

Table 12.3: Planned mitigation measures

Potential sources of impact	Planned mitigation measures
Physical presence of decommissioning vessels causing potential interference to other users of the sea.	• Prior to commencement of operations, the appropriate notifications will be made and maritime notices posted. • All vessel activities will be in accordance with national and international regulations. • Appropriate navigation aids will be used in accordance with the consent to locate conditions to ensure other users of the sea are made aware of the presence of vessels. • Use of designated transit routes for all decommissioning vessels. • Continual use of AIS vessel identification. • 24 hour manned bridge policy.
Damage to or loss of gear as a result of subsea obstructions, decommissioned in situ, posing potential snagging risks.	• The use of a fall pipe on the rock-placement vessel and the use of ROV supervision during rock-placement operations will ensure correct rock-placement. • On-going consultation with fisheries representatives. • The placement of rock will be designed to be overtrawlable. • Post-decommissioning seabed clearance and an overtrawlability survey.
Long-term environmental impacts of the physical presence of the pipelines, mattresses and rock-placement on the seabed.	• Post decommissioning survey to accurately map the location of subsea structures decommissioned in situ. • Potential post-decommissioning monitoring (for up to10 years) of routes of the buried pipeline routes will be discussed as part of any future monitoring programme agreed with BEIS. • Potential remedial intervention in the event issues arise with the pipeline interacting with other users.

12.7 Conclusions

The transient loss of access for vessels during the decommissioning operation is unlikely to have a significant impact on other sea users (i.e., commercial shipping and fishing). This is because the majority of the proposed decommissioning activities will occur within the 500 m safety exclusion zones around each of the eight platforms.

The pipelines decommissioned in situ will be surveyed post-decommissioning to accurately record their location and status. This information will be included in navigational charts and passed on to representatives of the fishing community (e.g. NFFO, SFF, ANIFPO and NIFPO). The VDP2 and VDP3 pipelines have been present on the seabed for a many years (1971 to present) with fishermen are aware of their presence. To date, there have been no recorded issues/ interactions between these pipelines and other users of the sea. As locations of the pipelines are known and occupy a relatively small area of seabed the potential risk of impact on fisheries from the decommissioning operations is assessed as minor.

There is the potential that fisheries access to small areas of seabed may be compromised due to the presence of rock-placement or mattresses decommissioned in situ. Previous overtrawl tests have indicated that the risk from rock-placement is minimal but that areas covered by mattresses may pose some minor risk of loss or damage to fishing gear. ConocoPhillips therefore propose to mitigate against this through a series of measures including a post-decommissioning survey to accurately record the seabed position of the mattresses/ grout bags and include the locations on navigational charts, and to conduct any future monitoring programmes agreed with BEIS. Representatives of the fishing community will be consulted at all relevant stages of project as it develops. Overall, the impact for the fishing community is assessed to be minor.

There are no negative cumulative or transboundary societal impacts. The decommissioning of the eight platforms may result in a positive impact to other users of the sea by removal of subsea infrastructure and making available additional fishing grounds as the 500 m safety exclusion zones are removed around the installations.

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13.0 ACCIDENTAL EVENTS

This section evaluates the potential impacts of accidental events and the proposed mitigation measures ConocoPhillips will implement to; reduce the probability of occurrence, and ensure that the impact to the environment is reduced as low as reasonably practicable.

With regard to offshore decommissioning operations, three types of accidental event present the most likely worst-case impacts to the environment:

- Hydrocarbon release;
- Chemical spill; and
- Dropped objects.

13.1 Regulatory Context

The consequences of potential oil or chemical releases from the proposed VDP2 and VDP3 decommissioning activities will be managed in accordance with current legislation and standards as detailed within Appendix A.

13.2 Hydrocarbon Releases - Approach

This sub-section examines the potential impacts of an accidental hydrocarbon release occurring during the proposed decommissioning activities. The potential risk from one of these three accidental events is similar for both VDP2 and VDP3 and therefore a single assessment was conducted for both programmes with any additional site specific details highlighted.

13.2.1 Sources of potential impacts

All offshore activities carry the potential risk of a hydrocarbon loss to the marine environment. During the period from 1975 to 2005, a total of 16,930 tonnes of oil was discharged from 5,225 individual spill events in the UKCS (UKOOA, 2006). Analysis of spill data between 1975 to 2005 identified that:

- 46% of spill records related to crude oil;
- 18% to diesel; and
- The remaining 36% to condensates, hydraulic oils, oily waters and other materials (UKOOA, 2006).

During 2012 on the UKCS, a total of 248 oil spills were reported to DECC (now BEIS), of which 8% were greater than 455 litres (ACOPS, 2014).

The potential sources of hydrocarbon spillages from the VDP2 and VDP3 infrastructure have been identified through knowledge and experience developed from ConocoPhillips oil and gas operations in the North Sea. Based on this knowledge the following scenarios have been identified for the proposed activities:

- Worst-case sinking of a vessel due to collision, releasing diesel to the sea;
- Diesel spill from a vessel;
- Loss of fluids from subsea structures, pipelines or topsides;
- Accidental bunkering fuel (diesel or aviation) spillage during refuelling; and
- Diesel storage tank loss.

Despite the small probability of a vessel collision occurring and considering that the subsea infrastructure and topsides are expected not to contain hydrocarbon fluids, the possibility of hydrocarbon spillages and the impacts on sensitive receptors have been investigated in detail in the following sections.

Oil behaviour at sea

When oil is released to the marine environment, it is subjected to a number of processes including: spreading, evaporation, dissolution, emulsification, natural dispersion, photo-oxidation, sedimentation and biodegradation (Table 13.1).

Table 13.1: Overview of the main weathering fates of oil at sea

Weathering process	Description of weathering fate
Evaporation	Lighter components of oil evaporate to the atmosphere.
Dispersion	Waves and turbulence at the sea surface can cause a slick to break up into fragments and droplets of varying sizes which become mixed into the upper levels of the water column.
Emulsification	Emulsification occurs as a result of physical mixing promoted by wave action. The emulsion formed is usually very viscous and more persistent than the original oil and formation of emulsions causes the volume of the slick to increase between three and four times and slows and delays the other processes which cause the oil to dissipate.
Dissolution	Some compounds in oil are water soluble and will dissolve into the surrounding water.
Oxidation	Oils react chemically with oxygen either breaking down into soluble products or forming persistent tars. This process is promoted by sunlight.
Sedimentation	Sinking is usually caused by the adhesion of sediment particles or organic matter to the oil. In contrast to offshore, shallow waters are often laden with suspended solids providing favourable conditions for sedimentation.
Biodegradation	Sea water contains a range of micro-organisms that can partially or completely breakdown the oil to water soluble compounds (and eventually to carbon dioxide and water).

Source: DTI, 2001

The processes of spreading, evaporation, dispersion, emulsification and dissolution are most important early on in a spill whilst oxidation, sedimentation and biodegradation are more important in later stages. The behaviour of crude oil released at depth will depend on the immediate physical characteristics of the release, on subsequent plume dispersion processes and metocean conditions (DTI, 2001).

Hydrocarbon properties

The fate and effect of a spill is dependent on the chemical and physical properties of the hydrocarbons. Hydrocarbons used in, or produced by the VDP2 and VDP3 fields include diesel, aviation fuel and condensate.

The VDP2 and VDP3 condensate specific gravities range from 0.766 to 0.804 and have APIs ranging between 53.23˚ and 44.5˚. Consequently these condensates are classified as ITOPF Group I oils. Group I oils (non-persistent) tend to dissipate completely through evaporation within a few hours and do not normally form an emulsion (ITOPF, 2012).

Diesel and aviation fuel have very high levels of volatile components, evaporating quickly on release. The low asphaltene content in these fuels prevent emulsification, reducing persistence of them in the marine environment. Whilst diesel oil is a more persistent hydrocarbon than the condensate, its characteristics and subsequent behaviour when released means that it may not represent a significant threat to the environment when compared to a crude oil spill.

13.2.2 Impact assessment and oil spill modelling

An accidental hydrocarbon release can result in a complex and dynamic pattern of pollution distribution and impact in the marine environment. As there are a variety of natural and anthropogenic factors that could influence an accidental spill, each spill is unique. Long-term effects reported range from none detected (e.g., after the Ekofisk blow-out in 1977) to chemical contamination but no acute biological effects detectable (e.g., after the wreck of the Braer in 1993) (DTI, 2001). The extent of an environmental impact of a spill depends on several factors including:

- Location and time of the spill;
- Spill volume;
- Hydrocarbon properties;
- Prevailing weather/ metocean conditions;
- Environmental sensitivities; and
- Efficacy of the contingency plans.

Overview of the modelling undertaken

Oil spill modelling has previously been undertaken for the VDP2 and VDP3 areas and is included within the Offshore Southern North Sea Field and Onshore OPEPs. Both of these documents have been approved by the regulator (ConocoPhillips, 2015c and 2015d). All spill scenarios undertaken for the VDP2 and VDP3 areas were modelled using the Oil Spill Contingency and Response (OSCAR) model Version 7 (V7).

Condensate from the ConocoPhillips wells is not characterised sufficiently for use with the OSCAR model. Diesel was therefore used as an analogue due to its greater persistence and to be in-line with current BEIS OPEP Guidance (BEIS, 2016).

Oil spill modelling scenarios presented within the Offshore Southern North Sea Field and Onshore OPEPs and relevant to the VDP2 and VDP3 decommissioning operations are summarised below with modelling inputs presented in Table 13.2.

- Scenario 11a: Loss of inventory from PL27 pipeline at LOGGS PR. This scenario was modelled as an instantaneous subsea release of marine diesel at the seabed from the PL27 pipeline.
- Scenario 11b: Loss of inventory from PL27 at pipeline mid-point. This scenario was modelled as an instantaneous subsea release of marine diesel at the seabed from the PL27 pipeline.
- Scenario 11c: Loss of inventory from PL27 pipeline, 15 km from coast. This scenario was modelled as an instantaneous subsea release of marine diesel at the seabed from the PL27 pipeline.
- Scenario 12: Loss of diesel (fuel and bunker diesel inventory) from a Platform Support Vessel (PSV) at the Vulcan RD platform. The Vulcan RD was loss of at the western most asset in the Viking/ LOGGS modelling group (closest to UK shoreline).

Table 13.2: SNS worst-case modelling scenarios and results relevant to VDP2 and VDP3

Modelling scenario*	Modelled release rate/ quantity	First median line crossed		Landfall beached		
		Location and % probability	Time and season	1. Shortest beaching time 2. Location 3. Season	1. Beaching location 2. Season 3. Highest % probability of beaching	Max. volume beached at any season and location
Scenario 11a	191 m^3 instantaneous	Does not cross	Does not cross	Does not beach	Does not beach	Does not beach
Scenario 11b				1. 4 day 18 hours 2. Spring 3. Norfolk UK	1. Norfolk, UK 2. Spring 3. <1%	<1m^3
Scenario 11c				1. 15 hours 2. Winter 3. Linc. UK	1. Norfolk, UK 2. Spring 3. 45%	45m^3
Scenario 12	925 m^3 instantaneous	• Netherlands • 5%	• 1 day 14 hours • Spring	1. 2 day 5 hour 2. Winter 3. Norfolk, UK	1. Norfolk, UK 2. Summer 3. 8%	468m^3
Scenario 13	803 m^3 instantaneous	• Netherlands • 5%	• 2 day 6 hours • Autumn	1. 1 day 18 hour 2. Spring 3. Norfolk, UK	1. Norfolk, UK 2. Spring 3. 10%	418m^3
Scenario 14		• Netherlands • 7%	• 20 hours • Autumn	1. 3 day 15 hour, 2. Spring, 3. Norfolk, UK	1. Norfolk, UK 2. Summer 3. 5%	100.9m^3

***modelling scenario descriptions are detailed in Section 13.2.2

Sources: ConocoPhillips, 2015c and 2015d

- Scenario 13: Loss of diesel from decommissioning jack-up mobile offshore drilling unit (MODU) at Vulcan UR. Vulcan represents the closest platform in the LOGGS/ Viking assets to the UK shoreline.
- Scenario 14: Loss of diesel from a jack-up MODU at Viking DD platform. Viking DD represents the closest platform in the LOGGS/ Viking assets to the international median line.

The modelling results as presented in Table 13.2 suggest that other than a pipeline loss from LOGGS PR (Scenario 11a), beaching may occur in all scenarios. Transboundary impacts were not predicted for the PL27 pipeline inventory releases (Scenarios 11a, b, and c). Due to hydrocarbon characteristics, the majority of the released hydrocarbons are expected to be dispersed or evaporated.

It should be noted that the volumes likely to be present in the VDP2 and VDP3 infrastructure during the proposed decommissioning operations are expected to be lower than the worst-case volume modelled, and so the results represent a highly conservative indication of the potential effects of an accidental hydrocarbon release.

13.2.3 Impacts on sensitive receptors

The potential for short-term and long-term impacts are assessed for the major taxonomic groups relevant to the southern North Sea marine environment, to determine the potential scale of interaction within the vicinity of an accidental spill. Socioeconomic and shoreline impacts are also described below.

Biological receptors

Although there is only a small likelihood of a hydrocarbon spill from VDP2 and VDP3, there is a potential risk to organisms in the immediate marine environment if a spill were to occur. Table 13.3 summarises the potential effects of an oil spill to marine life during the VDP2 and VDP3 decommissioning operations.

As the majority of spills are likely to be on the surface, both planktonic and benthic communities are less likely to be influenced by an accidental spill. Other communities including fish, birds and marine mammals may incur more significant impacts. For a detailed description of the environmental sensitivities in VDP2 and VDP3 areas, please refer to Section 4 and Section 5.

Shoreline impact

Spill modelling undertaken for the Offshore Southern North Sea Field and Onshore OPEPs (ConocoPhillips, 2015c and 2015d) that are relevant for VDP2 and VDP3, predict that diesel spills may reach the UK and Netherlands coastlines (Table 13.2).

The actual hydrocarbon volume remaining on the platforms following cessation of production activities will be residual; therefore it is unlikely that the low volume will result in a coastline impact. In addition, the actual characteristics of condensate will result in a lesser impact than the marine diesel modelled.

Table 13.3: Summary of potential impacts to main biological receptors in the VDP2 and VDP3 decommissioning area

Biological receptor	Impacts to biological receptors at risk in the VDP2 and VDP3 area
Plankton	Localised effects to plankton community due to toxicity. Impacts on communities are unlikely due to natural variability, high turnover and seasonal fluctuation.
Benthos	The impact from the condensate or diesel to benthic species or the seabed would be localised. Benthic communities may be affected by gross contamination, with recovery taking several years. Mortality would be dependent on oil sensitivity potentially leading to structural change in the community. The subsurface release of condensate or the surface release of diesel is unlikely to impact benthic communities and therefore the risk is considered minimal.
Fish, spawning and nursery grounds	Nine species of fish and shellfish spawn in the decommissioning area. The plaice and sandeel spawning areas are considered to be a part of important spawning areas for these species, with a relative high intensity spawning recorded (Ellis *et al*., 2010; Coull, *et al.,* 1998). The VDP2 and VDP3 infrastructure also coincide with nursery grounds for seventeen species of fish and shellfish (Aires *et al.*, 2014; Ellis *et al.,* 2010; Coull, *et al.,* 1998). These species are present throughout the year. Adult fish are expected to avoid the affected area, but if affected, hydrocarbons may result in tainting of the fish, and hence in a reduction of commercial value. Eggs and larvae may be affected, but such effects are generally not considered to be ecologically important because eggs and larvae are distributed over large sea areas. Demersal species may be influenced by habitat pollution.
Seabirds	The overall seabird sensitivity to surface pollution is high across the decommissioning area, (JNCC, 2017a). Generally in the coastal waters periods of high to very high seabird sensitivity to oil pollution occurs during February, April and August to December (Section 4). For the remainder of the year, seabird vulnerability in the coastal area ranges from moderate to low. In the offshore waters, periods of high to very high seabird vulnerability occur during February to April and August to December, with moderate to low vulnerability occurring throughout the remainder of the year (Section 4). Physical fouling of feathers, damage to eyes and toxic effects of ingesting hydrocarbons can result in direct and indirect fatalities. Effects would depend on species present, their abundance, reliance on particular prey species and the time of year. Diving birds such as auks and gannets are particularly susceptible. Species most affected may be guillemots, razorbills and puffins that spend large periods of time on the water, particularly during the moulting season when they become flightless (Webb et al., 2015).
Marine mammals	The main cetacean species occurring in the decommissioning area are white-beaked dolphin and harbour porpoise, with sightings occurring throughout the year. Further species observed in the surrounding areas include white-sided dolphin, minke whale, long-finned pilot whale, bottlenose dolphin and common dolphin (Reid *et al*., 2003; UKDMAP, 1998) (Section 4). Harbour and grey seals have been observed in varying densities throughout the decommissioning area (Jones *et al*., 2015; Section 4) Potential effects may include inhalation of toxic vapours, eye/ skin irritation and bioaccumulation. Ingestion of oil can damage the digestive system or affect liver and kidney function. Loss of insulation through fouling of the fur of young seals and otters increases the risk of hypothermia. Oil contamination can impact food resources directly through prey loss or indirectly through bioaccumulation. However it is expected that marine mammals would avoid the area if a spill were to occur.

Table 13.3 (continued): Summary of potential impacts to main biological receptors in the VDP2 and VDP3 decommissioning area

Biological receptor	Impacts to biological receptors at risk in the VDP2 and VDP3 area
Offshore protected habitats and species	The decommissioning area is located within two SACs designated for their sandbanks which are slightly covered by seawater all the time, and for their *S. spinulosa* reef habitats. No designated MCZs coincide with the VDP2 and VDP3 facilities, however three rMCZ coincide with the VDP2 and VDP3 infrastructure: Lincs Belt rMCZ, Silver Pit rMCZ and Wash Approach rMCZ. Annex II species sighted within the decommissioning area include the harbour porpoise, bottlenose dolphins, harbour and grey seals. Harbour porpoise occur throughout the year with high to very high sightings occurring in March and May to September, while bottlenose dolphin have only been sighted in low numbers in August and November. Harbour and grey seals have been observed in varying densities throughout the decommissioning area.
Inshore protected habitats and species	Inshore waters are described in detail in Section 4. Probability of contamination within coastal/ inshore waters ranges dependent on the spill scenario. The highest probability of beaching (45%) is predicted for Scenario 11c (Table 13.2). All other probabilities do not exceed10% from the scenarios modelled. All beaching scenarios are recorded along the Norfolk coastline. Key conservation areas for this region and their priority species or habitats are recorded in Section 4. The most likely community to be effected in the unlikely event of oil beaching would be the impact to foraging or rafting seabirds in inshore waters.

Socioeconomic receptors

A number of socioeconomic receptor may be impacted by a potential spill from the proposed decommissioning activities and are described in Table 13.4.

Table 13.4: Summary of main socioeconomic receptors

Socioeconomic receptor	Impacts to socioeconomic receptors at risk in the VDP2 and VDP3 area
Fisheries	Fishing is one of the primary economic activities in the EU and it supports other shore-based activities including fish processing and boat construction. The impacts to offshore fishing are limited to the period that oil remains on the surface as access to fishing grounds would be limited. There is the potential for fish that come into contact with oil to become tainted precluding commercial sale. There is no UKCS evidence of any long-term effects of oil spills on offshore fisheries. The UK landings within the decommissioning area are relatively low, with the exception of the shellfish species in the coastal/ inshore waters, and demersal species in the Viking AR and Viking KD area (Section 5).
Tourism	Coastal tourism can be adversely affected by oil pollution events owing to reduced amenity value. Impact can be further influenced by public perception and media coverage. Due to the offshore location of the VDP2 and VDP3 infrastructure (>100 km) suggests that there is unlikely to be any impact on tourism.
Shipping	Shipping density in the decommissioning area ranges from very low to very high (DECC, 2014a). Shipping lanes are used by shuttle tankers, supply and standby vessels serving the offshore oil installations in the area. Although all may potentially be impacted by an oil spill, the impacts likely last only while oil is on the sea surface, as this may restrict access. However, it is unlikely that there will be any long-term impacts on this industry.
Oil and gas	The oil and gas industry is well established in the North Sea. Although the receptors may potentially be impacted by an oil spill, the impacts would likely last only whilst there is oil on the sea surface, as this may restrict access to installations for instance However, it is unlikely that there will be any long-term impacts on this industry.

13.2.4 Cumulative and transboundary impacts

Residual, cumulative and transboundary impacts expected as a result of an accidental oil spill event are summarised in the following sub-sections.

Cumulative impacts

Cumulative effects arising from the proposed decommissioning activities have the potential to act additively with VDP1 and LDP1, and from other oil and gas activities. The VDP2 and VDP3 area is an extensively developed area, including both existing activities and new activities, and may act additively with those of other human activities (e.g., fishing and marine transport of crude oil and refined products) (DTI, 2004).

Any hydrocarbon discharge as a result of the proposed decommissioning activities would be expected to disperse rapidly in the immediate environment without the potential to combine with other discharges from concurrent incidents. It is difficult to predict whether the impacts from an oil spill to the marine ecology of the affected area would be cumulative. This would depend on previous disturbances or releases at specific locations. Cumulative effects of overlapping "footprints" for detectable contamination or biological effects are considered to be unlikely. No significant synergistic effects are currently identified (DTI, 2004).

Transboundary impacts

There is a very low probability that a hydrocarbon spill would cross into international sectors such as the Netherlands, Belgium, Denmark or France sectors. Modelling predicts that a diesel spill will only cross the median line in extreme conditions, i.e., continuous 30 knot wind blowing in the direction of the median line.

In the event of an oil spill entering the English Channel, it may be necessary to implement the Mancheplan (Anglo-French Joint Maritime Contingency Plan). Under the Bonn Agreement, the English Channel is a zone of joint responsibility between France and the UK. The Mancheplan covers counter pollution and rescue operations. The Maritime Coastguard Agency (MCA) Counter Pollution and Response Branch also have agreements with equivalent organisations in other North Sea coastal states, under the Bonn Agreement 1983. Applicable international arrangements are further described in Appendix A.

13.2.5 Mitigation measures

Mitigation and management primarily focus on preventing or minimising the probability of an accidental spill and secondly, reducing the consequences of the event through optimum and efficient containment and release response. During decommissioning, minor non-routine and emergency events such as minor leaks, drips and spills from machinery and hoses on the platform, from vessels or at onshore sites, could cause a localised impact. The accidental release of small quantities of oil would be minimised as far as possible through appropriate management procedures and mitigation measures. The effects of such releases could be rectified quickly on site and they would be managed through vigilance, operational, inspection and emergency procedures, and specific safeguards such as on-site clean-up equipment and containment measures. For these reasons, such minor events have been excluded from this assessment as they will be managed under normal operational procedures and controls.

The response to all spills is detailed in the Offshore Southern North Sea Field and Onshore OPEPs (ConocoPhillips, 2015c and 2015d). Table 13.5 lists the planned measures to prevent or reduce the likelihood of a spill occurring during the proposed decommissioning activities. Based on the estimated volumes of diesel and condensate, the ConocoPhillips response capability for both counter pollution and containment is capable of providing an appropriate level of response to a spill. The mitigation measures and contingency plans in place would consider all foreseeable spill risks and would ensure that the spill risk is reduced to as low as reasonably practicable.

Table 13.5: Oil spill preventative measures for likely spill scenarios occurring during decommissioning activities

Potential source of impact	Planned mitigation measures
All oil spills	The inventories will be minimised prior to removal and transport to disposal yard. In addition, the use of pipeline capping for instance, could be stated to avoid a release during the transportation. The Offshore Southern North Sea Field and Onshore OPEPs have been produced in accordance with the Merchant Shipping (Oil Pollution Preparedness, Response & Co-operation Convention) Regulations 1998 and the Offshore Installations (Emergency Pollution Control) Regulations 2002. The OPEPs detail responsibilities for initial response and longer term management, and will be updated as needed to reflect any change in operations and activities associated with decommissioning. There are three planned levels of response, depending on the size of the spill: • Tier 1 - standby vessel equipped with dispersants and spraying equipment; • Tier 2 - air surveillance and dispersant spraying through Oil Spill Response Ltd. (OSRL); and • Tier 3 - clean-up equipment and specialist staff available through OSRL. In addition, ConocoPhillips have specialist oil spill response services provided by OSRL and are members of the Oil Pollution Operator's Liability Fund (OPOL).
Vessel collision	Local shipping traffic would be informed of proposed decommissioning activities and a standby/ support vessel would monitor shipping traffic at all times.
Spill from a vessel beyond the 500 m exclusion zone	In the event of an accidental spill to sea, vessels will implement their SOPEP.

13.2.6 Conclusions

The conclusions from the impact assessment for an accidental hydrocarbon release are that the:

- Worst-case scenario at the decommissioning area would result from a loss of diesel from on-site vessels or collision;
- Condensate and diesel spills will disperse and dilute quickly, with no significant impact to coastlines;
- Probability of a hydrocarbon spill occurring is low and will not contribute to the overall spill risk in the area; and,
- Response in the OPEPs will provide the direction to effectively manage the spill in case of an accidental event.

13.3 Chemical Releases - Approach

An accidental chemical release can result in a complex and dynamic pattern of pollution distribution and impact to the marine environment. The number of factors that could influence an accidental chemical spill, both natural and anthropogenic, renders each spill unique. Potential sources of impact are presented in the following sub-sections, and include a review of the sensitive receptors that may be influenced. In many cases, both impacts and receptors have been detailed in the hydrocarbon release section (Section 13.2). Where the chemical release impacts differ from those described in the hydrocarbon release section, they will be discussed in further detail.

13.3.1 Methodology

As part of the decommissioning process it is important to consider the magnitude of a potential chemical spill and assess the effects of such an unplanned event on key sensitive receptors.

13.3.2 Sources of potential impact

Technical failure remains the leading cause of chemical spills in the North Sea. The primary sources of loss to the environment are from spills of hydraulic fluids or chemicals. From the proposed decommissioning activities, the most likely incident would be the accidental loss of fluids during subsea or topsides removal.

13.3.3 Impacts on sensitive receptors

Chemical release into the marine environment may impact sensitive receptors in different ways, depending on the following factors:

- Spill volume;
- Depth of release;
- Chemical toxicity;
- Chemical solubility;
- Persistence in the environment;
- Biodegradability of the compound;
- Potential for bioaccumulation in the food chain; and
- Partitioning of individual components.

Biological receptors

Section 4 and Table 13.3 provide a comprehensive description of the biological receptors in the decommissioning area sensitive to potential chemical spills. Due to the rapid dispersion and dilution of chemicals upon discharge or release, few biological receptors are noticeably impacted. The most sensitive receptors are the planktonic communities.

Plankton (phytoplankton, zooplankton and fish larvae) are likely to come into direct contact with discharged chemicals, with zooplankton appearing to be the most vulnerable particularly at the early stages of development. However, the impact of a chemical spill is not likely to impact beyond the immediate vicinity of the discharge point because:

- The likely credible maximum volume of chemicals that may be subject to a spill event would be very low;
- Discharge is likely to be dispersed and diluted rapidly by the receiving environment;

- Many of the compounds are volatile or soluble and are removed from the water by evaporation and dilution; and,
- Biological Oxygen Demand (BOD) is likely to be within the capacity of ambient oxygen levels.

Socioeconomic receptors

The main socioeconomic receptors relevant to a hydrocarbon spill are presented in Table 13.4 and in most cases; this information is also pertinent to chemical spills. Dispersion, dilution and potentially very small volumes spilt will result in localised impact areas. No significant socioeconomic impacts are foreseen for fisheries, tourism, oil and gas, or shipping.

13.3.4 Cumulative and transboundary impacts

The majority of chemical spills are unlikely to result in an environmental impact due to a combination of rapid dispersion and dilution of the chemicals and the depth and distance from shore (>100 km) of the VDP2 and VDP3 infrastructure. The potentially spilt volumes are unlikely to pose any noticeable risk to residual, cumulative or transboundary impacts.

13.3.5 Mitigation measures

The impacts of all the chemicals that may be used or discharged offshore during decommissioning will be assessed and reported to BEIS in a relevant permit application. Chemicals in pipelines will be flushed and returned to the platform for disposal as described in Section 11.

The proposed mitigation measures to reduce the likelihood of chemical spills to the environment are presented in Table 13.6.

Table 13.6: Planned mitigation measures

Potential source of impact	Planned mitigation measures
Chemical spills from VDP2 and VDP3 decommissioning activities	• ConocoPhillips will conduct all operations in a controlled manner with trained personnel using suitable equipment. All vessels will have suitable skill kits and an efficient spill response process is in place. • ConocoPhillips routinely swap out perishable equipment such as hoses, and is implemented by a management programme in order to ensure their integrity. • Prior to transfer, visual checks are undertaken by trained personnel in communication with the standby vessel. • Observed leaks are reported and dealt with immediately by competent personnel and reported to the appropriate authorities.

13.3.6 Conclusions

The conclusions from the impact assessment for a chemical release are:

- Chemical spills will disperse and dilute quickly, with only localised effects to planktonic communities;
- Probability of a chemical spill occurring is low and will not significantly add to the overall spill risk in the area.

13.4 Dropped Objects - Approach

There is the potential for the loss of objects during the decommissioning process. Depending on the size of the objects they may present a hazard to shipping and subsea infrastructure, and to fishing activities such as trawling. Dropped objects may also impact on the seabed community within the drop zone. Dropped objects can vary in size from tools to large sections of topsides infrastructure or the loss of a vessel.

13.4.1 Sources of potential impact

The likely worst case scenario which imposes the greatest environmental and socioeconomic impact for a dropped object would be the loss of a large section of jacket or topsides from the removal phase of the project. As a result of an accident, a section of the upper jacket or topsides could fall to the seabed during the latter stages of the cutting operations or whilst being transferred to a vessel. This type of event may cause localised effects in the water column, on the seabed or to the benthos. The extent and severity of these effects would depend on the object lost and the amount of seabed and sediment disturbed.

13.4.2 Impacts on sensitive receptors

Potential impacts on biological and socioeconomic receptors from of an accidental dropped object are described in the following paragraphs.

Biological receptors

In the event of a dropped object, the dominant receptors are the infaunal and epibenthic communities within the drop zone. Comprehensive surveys have provided a detailed description of the resident benthic community for the Viking area. Recent surveys have also allowed a comparison of community composition against historical surveys undertaken during the operational life of the field. Section 4 presents a summary of the project specific surveys undertaken.

Whilst the impact of a dropped object on the immediate drop zone may be significant, the effect is likely to be localised. The benthic community beyond 500 m from VDP2 and VDP3 infrastructure is indicative of and comparable in diversity and composition with surrounding areas of the North Sea (as detailed in Section 4). Therefore the impact of a dropped object would have no significant impact on the wider community. No other biological receptors would be impacted by a dropped object.

Socioeconomic receptors

There is a potential to transport the jackets overboard of the HLV which would require passing above live pipelines. However, the probability that a jacket would be lost above a live pipeline is very low.

In addition, any dropped objects will be recovered during decommissioning operations and an independent seabed debris clearance and overtrawlability survey conducted once decommissioning operations have been completed to verify that a clean seabed has been left (excluding infrastructure that is expected to remain in place). No impacts relating to other socioeconomic receptors have been identified from dropped objects.

13.4.3 Cumulative and transboundary impacts

In case of a potential loss of objects during the decommissioning process, the impacts will be temporary and will only cause disturbance to a localised area of seabed and the associated water column. They will not have any residual effects and will not contribute to cumulative or transboundary impacts.

13.4.4 Mitigation measures

Appropriate mitigation measures in the event of a dropped object should be implemented during the proposed decommissioning operations (Table 13.7).

Table 13.7: Planned mitigation measures

Potential source of impact	Planned mitigation measures
Dropped object event from VDP2 and VDP3 decommissioning activities	• Where practicable all efforts will be made by ConocoPhillips to minimise the number of dropped objects. During the cleaning and preparation for removals programme, items will be secured to prevent loss wherever practicable. • Post-decommissioning surveys will be undertaken to assess the presence and potential recoverability of any lost objects from VDP2 and VDP3 infrastructure wherever practicable. The recovery of such debris will be undertaken to minimise the impact on the environment and to minimise the risk to other users of the sea wherever possible.

13.4.5 Conclusions

The conclusions from the impact assessment for a dropped object include:

- Worst case scenario would be the loss of a major portion of the jacket or topsides during lifting operations;
- Depending on the size of the item, dropped objects may present a hazard to shipping and subsea infrastructure and fishing activities such as trawling; and,
- Post decommissioning surveys will provide locations of dropped objects and assist in their removal where practicable.

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14.0 WASTE

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 VDP2 and VDP3 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 BEIS Guidance Notes under the Petroleum Act 1998 (DECC, 2011a), the disposal of such installations should be governed by the precautionary principle. ConocoPhillips 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.

14.1 Waste Generation

ConocoPhillips will follow the principles of the waste hierarchy as described in Section 14.3. Typical non-hazardous waste will include scrap metals (steel, aluminium and copper), concrete and plastics that are not cross-contaminated with hazardous waste and can therefore be removed and recovered for reuse, recycling or landfill. Hazardous waste will include oil contaminated materials and chemicals. Many types of hazardous waste generated during decommissioning are routinely generated during production and maintenance of offshore installations. However, the decommissioning process may generate significantly greater quantities of both non-hazardous and hazardous waste when compared to routine operations and as such requires appropriate management.

An estimate of the different types of materials and quantities in the VDP2 and VDP3 infrastructure to be decommissioned, are detailed in Section 3.

14.1.1 Radioactive waste

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 (Appendix A). The Environmental Permitting (England and Wales) Regulations 2010 (as amended) regulates the handling, storage, transfer and disposal of such waste. ConocoPhillips has an existing 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. ConocoPhillips will work to current NORM procedures in existence for SNS Operations (ConocoPhillips, 2015e; ConocoPhillips, 2015f).

14.1.2 Wastes generated during Engineering Down Cleaning

During EDC, all topside systems will be depressurised, purged, flushed and rendered safe for removal operations. Pipework and tanks will be drained to remove sources of potential spills of oils and other fluids. Diesel and lubricating oils will be drained and returned to shore for disposal. Mobilised solids filtered from the pipeline flushing will be removed and sent to a fully permitted onshore treatment facility.

14.2 Regulatory Context

There is no waste related legislation that specifically covers decommissioning activities, however some aspects of existing waste legislation are relevant (Appendix A).

Whether a material or substance is 'waste' is determined by EU law. The EU Waste Framework Directive (WFD) (2006/12/EC) defines 'directive waste' as "any substance or object in the categories set out in Annex I of the Directive which the holder discards or intends or is required to discard". Annex I provides a list of definitions and includes a general category – "Any materials, substances or products which are not contained in the above categories".

The responsibility for waste management lies with the producer or duty holder to decide whether a substance or object is waste. The action of removal and transfer of redundant installations and infrastructures to shore falls within the legal definition of waste. The responsibility for determining whether a substance or object is waste lies with the Operator.

Having determined the substance or object is waste, subsequent storage, handling, transfer and treatment of the waste generated is then governed by a number of regulations. An overview of the legislation is available in Appendix A.

If the selected disposal yard is in a country outside of the UK, the waste will be dealt with in line with the receiving countries waste legislation.

14.3 Waste Management

The waste hierarchy is a conceptual framework which ranks the options for dealing with waste in terms of their sustainability (Figure 14.1). For the onshore treatment and disposal of VDP2 and VDP3 material, ConocoPhillips will follow the principles of the waste hierarchy in order to minimise waste production.

The waste hierarchy is a key element in OSPAR Decision 98/3 and BEIS Guidance Notes (DECC, 2011a) and requires that the decommissioning decisions are consistent with the waste hierarchy. ConocoPhillips recognises that, in line with the waste hierarchy, the reuse of an installation or its components is first in the order of preferred decommissioning options. However, as the majority of the VDP2 and VDP3 infrastructure are obsolete and/or in a degraded condition, they are not considered suitable for safe re-use. The majority of jacket and topside material will therefore be recycled with pipelines and mattresses decommissioned in situ. During cutting operations, there may be a requirement to remove some concrete mattresses and grout bags. Although the quantity of this material is currently unknown, it will be fully quantified in future consent applications. A small number of mattresses may also be removed to gain access to sever the pipelines at the eight platforms, the exact quantities will be detailed in subsequent consent applications.

Source: http://www.sepa.org.uk/waste/moving_towards_zero_waste/waste_hierarchy.aspx

Figure 14.1: The waste hierarchy

Non-hazardous materials, such as scrap metal, concrete, and plastics not contaminated with hazardous waste, will be removed and, where possible, be reused or recycled (with the exception of the pipelines remaining in situ). Other non-hazardous waste which cannot be reused or recycled will be disposed of to a landfill site. Concrete accounts for the greatest proportion of materials inventory for VDP2, whilst steel represents the largest weight from VDP3.

Where necessary, hazardous waste resulting from the dismantling of the VDP2 and VDP3 facilities will be pre-treated to reduce hazardous properties or, in some cases, render it non-hazardous prior to recycling or landfilling. Under the Landfill Directive, pre-treatment will be necessary for most hazardous wastes which are destined to be disposed of to landfill site.

Tables 14.1 and 14.2 outline the fate of decommissioned material for VDP2 and VDP3 respectively, whilst Figure 14.2 and Figure 14.3 represents the ideal disposal routes for materials.

Table 14.1: Proposed fate of VDP2 materials

VDP2 infrastructure	Facility	Recommended decommissioning option	Destination
Jackets	Seven jackets	Full removal (reverse installation and piece-small)	• Recycling • Landfill
Topsides	Seven topsides	Full removal (single lift)	• Recycling • Reused • Incinerated • Landfill • Treatment for NORM (contaminated pipework)
Pipelines	• One x 28 inch gas pipeline • One x 24 inch gas pipeline • Four x 16 inch gas pipeline • One x 10 gas pipeline • Six x 3 inch methanol pipelines • One x 4.5 inch methanol and control fluid pipeline	Decommission majority in situ and remove pipeline ends by cut and lift	• Decommissioned in situ • Recycling (pipeline ends) • Treatment for NORM (pipeline ends) • Landfill (pipeline ends)
Subsea infrastructure	• One manifold • Two tee-pieces • 139 mattresses (*)	Full removal (cut and lift)	• Recycled
		Current state	• Decommissioned in situ

Note: (*) estimated number based on observations of ROV survey footage

Table 14.2: Proposed fate of VDP3 materials

VDP3 infrastructure	Facility	Recommended decommissioning option	Destination
Jackets	One jacket	Full removal (reverse installation and piece-small)	• Recycling • Landfill
Topsides	One topside	Full removal (single lift)	• Recycling • Recondition and re-use • Incinerated • Landfill • Treatment for NORM (contaminated pipework)
Pipelines and umbilical	• One x 16 inch gas pipeline • One x 12 inch gas pipeline • Two x 3 inch methanol pipelines • One 4 inch umbilical	Decommission majority in situ and remove pipeline ends by cut and lift	• Decommissioned in situ • Recycling (pipeline ends) • Treatment for NORM (pipeline ends) • Landfill (pipeline ends)
Subsea infrastructure	• One manifold • One pigging skid	Full removal (cut and lift)	• Recycling
	35 mattresses (*)	Current state	• Decommissioned in situ

Note: (*) estimated number based on observations of ROV survey footage

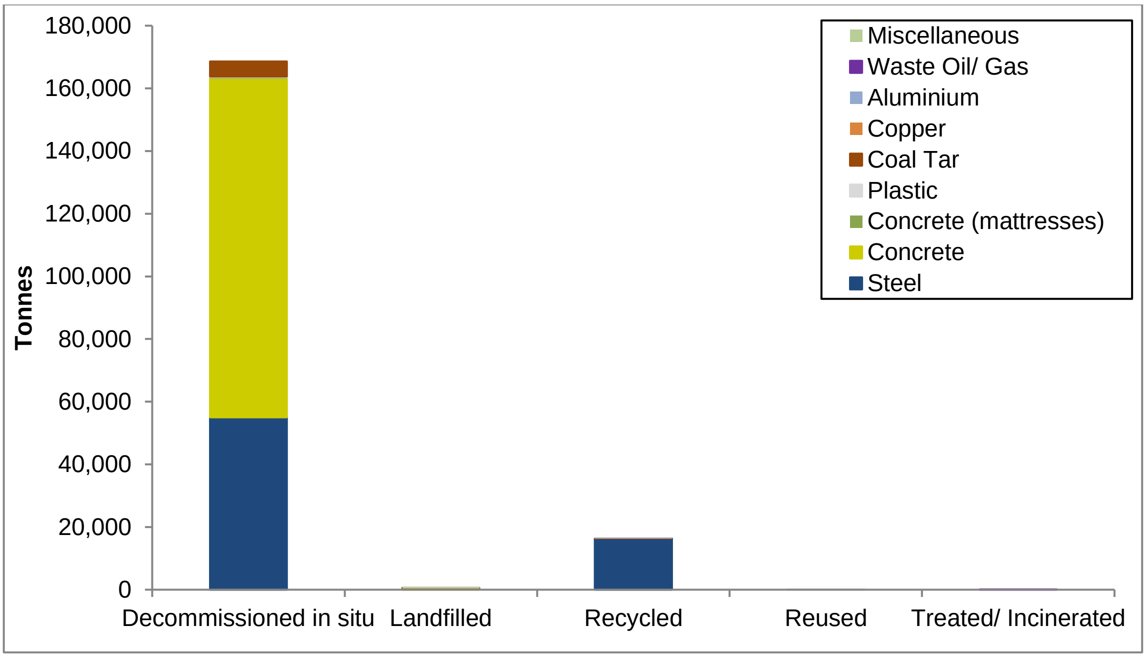

Figure 14.2: Bar chart of the estimated tonnage and predicted disposal routes of decommissioned material from VDP2

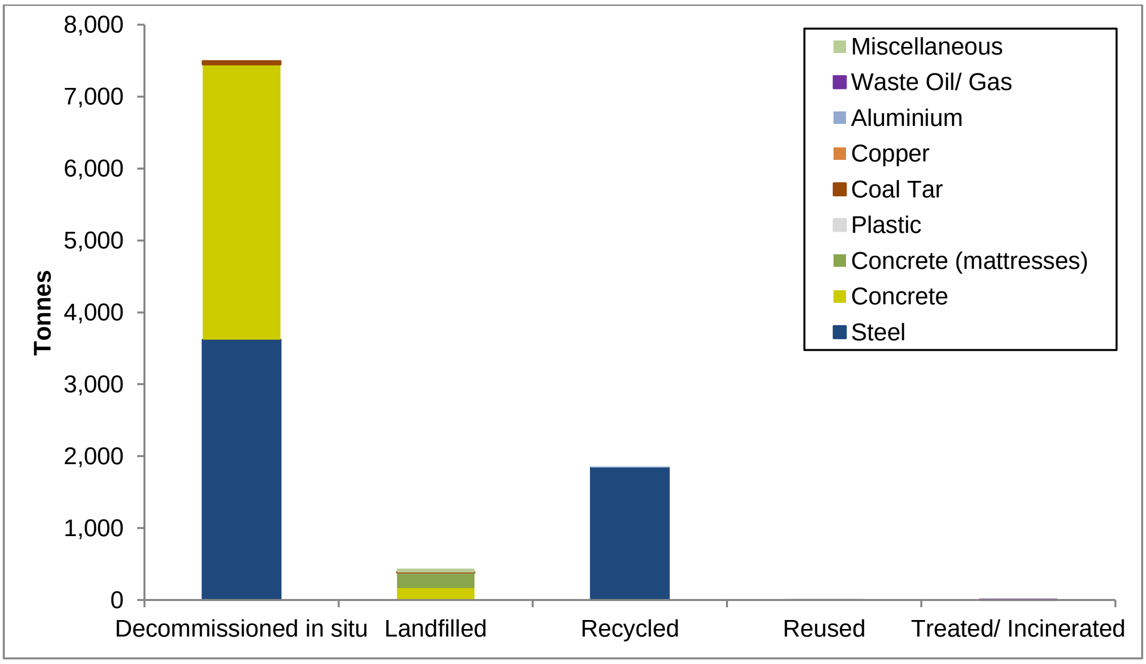

Figure 14.3: Bar chart of the estimated tonnage and predicted disposal routes of decommissioned material from VDP3

The estimated percentages of material expected to be disposed of in landfill, recycled, reused, decommissioned in situ and for further treatment/ incineration are shown in Figures 14.4 and 14.5. The majority of pipeline materials are likely to be decommissioned in situ with jackets and topsides being largely recycled. Only a small amount of material from VDP2 and VDP3 (between 847 and 433 tonnes, respectively), is expected to be sent to landfill. The estimated quantities of materials expected to be sent for reuse are small and have therefore been omitted from the figures.

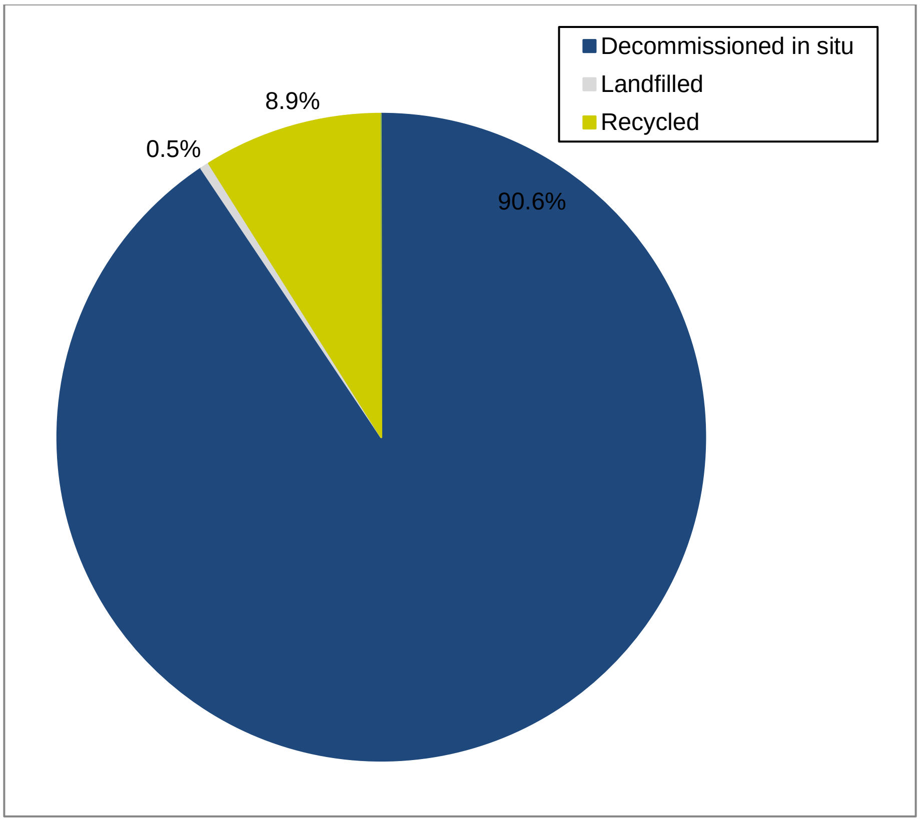

Figure 14.4: Pie chart of estimated VDP2 disposal route percentages

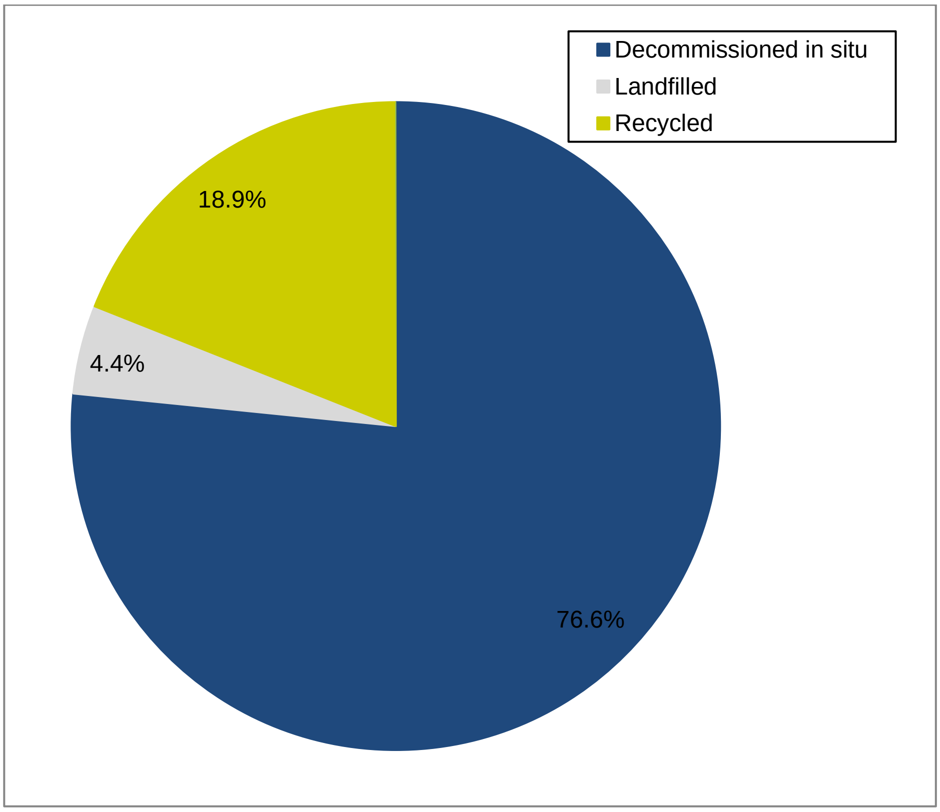

Figure 14.5: Pie chart of estimated VDP3 disposal route percentages

The management of waste generated from operations and drilling activities has been addressed by ConocoPhillips through an ISO14001 certified Environmental Management System (EMS) (as presented in Section 15). The EMS includes a documented procedure for waste management which is designed to ensure that all waste generated during the ConocoPhillips offshore activities are managed according to the Company's Health, Safety and Environment (HSE) policy and relevant legislation.

Specifications to manage the waste generated during decommissioning will conform to the requirements of the ConocoPhillips EMS (ConocoPhillips, 2015g) as follows:

- Undertake a review of the EMS and update it to ensure that significant environmental impacts and legislative requirements, as a result of waste generation and treatment during decommissioning, are adequately recorded and assessed, and any requirements for operational controls or other management actions are identified.
- Prepare a Waste Management Plan for each Decommissioning Programme.

14.3.1 Environmental management system

Sustainable Development is a key consideration when conducting business. For ConocoPhillips this is about conducting business while promoting economic growth, a healthy environment and vibrant communities, now and into the future. The ConocoPhillips world-wide and UK Health Safety and Environmental Polices are implemented in the UK through an independently verified EMS which covers all activities carried out by ConocoPhillips both onshore and offshore. The underlying policies, processes and EMS are described in more detail in Section 15.

14.3.2 Contractor management

Waste management activities include the handling, storage and treatment of waste offshore, the transfer of waste to a waste treatment or dismantling yard for further storage, handling and treatment as appropriate, and then further transfer to the final disposal or treatment point. These activities will be conducted by contractors and sub-contractors on behalf of ConocoPhillips using their own waste management system. The waste contractors/ sub-contractors will also undertake all necessary paperwork including the tracking of wastes, accounting and identification of wastes, wastes generated per asset and waste segregation. Although ConocoPhillips will not be undertaking the actual physical work, the legal liability, i.e. Duty of Care, for all waste generated from decommissioning remains with ConocoPhillips for the duration of the programme.

The selection and management of contractors by ConocoPhillips is managed through the contractor control processes and procedures. Specific targets to maximise re-use and recycling, minimisation of waste to landfill, and the use of innovative solutions with contractors/ sub-contractors would be agreed at this stage and included in the disposal yards contract. Specific actions to support the management and minimisation of waste generated by contractors during decommissioning will include:

- Ensuring that waste management issues are covered within the contractor interface documents; and
- Engaging with contractors to identify effective technical solutions that support waste minimisation with the reuse and recycling of waste, if possible.

The procedures and processes for waste and contractor management will be embedded in the EMS, detailing actions, roles and responsibilities of personnel from within ConocoPhillips and the various contractors working on an individual decommissioning project. Specific audit/ monitoring schedules will be set up as part of the disposal yard contract award and will comply with the ConocoPhillips Corporate Waste Disposition Standard.

14.3.3 Measuring and monitoring performance

Measuring and monitoring performance is an important element of an EMS and ConocoPhillips already has a number of mechanisms in place to do this (ConocoPhillips, 2015g). With respect to the management and minimisation of waste during the decommissioning of the VDP2 and VDP3 infrastructure, the key areas for action:

- Monitoring legislative compliance; and
- Measuring performance against stated targets.

A range of methods will be used to ensure effective monitoring of waste management activities including, for example, auditing of contractors and disposal sites, monthly waste statistic summaries and the use of disposable yards materials tracking tools.

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15.0 ENVIRONMENTAL MANAGEMENT

The ConocoPhillips world-wide and UK HSE Policies are implemented in the UK through an independently verified EMS which covers all activities carried out by ConocoPhillips both onshore and offshore. This meets the requirements of OSPAR Recommendation 2003/5 which promotes the use and implementation of EMSs by the offshore industry. VDP2 and VDP3 activities will be carried out in accordance with the ConocoPhillips EMS (ConocoPhillips, 2015g).

This section introduces relevant ConocoPhillips corporate policies and details by which ConocoPhillips will manage the environmental aspects of the VDP2 and VDP3 decommissioning activities. This section also catalogues the commitments made in support of the decommissioning proposals and provides a delivery mechanism for these commitments.

15.1 Health, Safety and Environmental Policy

ConocoPhillips takes all reasonable precautions to achieve the goal of harm-free operations. The ConocoPhillips (U.K.) HSE Policy (Figure 15.1) presents the company's public commitment to conducting business in a manner that protects the health and safety of people and preserves the integrity of the environment within which it operates. It is endorsed by top management who are responsible for ensuring its implementation. Line managers have primary responsibility for ensuring compliance with the Policy and for effective communication of the policy commitments and requirements to their staff.

The HSE Management System Standard provides corporate expectations for the business' HSE Management System which is the primary tool used to execute the commitments made in the HSE Policy. The HSE Management System adheres to a continuous improvement lifecycle and includes key elements such as risk assessment, incident and near miss reporting and investigation, HSE training, audits and annual review and goal setting.

15.2 ConocoPhillips HSE Management System

ConocoPhillips' environmental policies have the underlying principle of conducting business with respect and care for the environment in which the company operates. ConocoPhillips implements such policies through the EMS (ConocoPhillips, 2015g).

The ConocoPhillips (U.K.) HSE Policy provides a framework for the integrated management of environmental issues related to the company's U.K. business activities. It commits the company to comply with environmental legislation and strive for continuous improvement in environmental performance.

ConocoPhillips

U.K. HSE Policy

Policy Statement Commitment

ConocoPhillips (U.K.) Limited is committed to protecting the health and safety of everybody who plays a part in our operations or lives in the communities in which we operate. Wherever we operate, we will conduct our business with respect and care for both the local and global environment and will systematically manage risks to drive sustainable business growth.

We will not be satisfied until we succeed in eliminating all injuries, occupational illnesses, unsafe practices and incidents of environmental harm from our activities.

Organisation and Responsibilities

The ConocoPhillips U.K. President has overall accountability for the Health, Safety and Environmental (HSE) performance of our U.K. operations.

Health, Safety and Environmental staff with reporting lines to senior management are appointed at various locations throughout the Company. These personnel are responsible for providing advice and guidance on matters relating to the health, safety and welfare of employees and on environmental matters.

All managers and supervisors at ConocoPhillips are responsible and accountable for the health and safety of their staff by:

- Ensuring that all applicable Health, Safety and Environment legislation and codes are adhered to and that appropriate actions are taken to ensure a safe working environment.
- The active participation of all employees in the achievement of Health, Safety and Environmental objectives.
- Conducting all activities in accordance with the requirements of the Operating Management System (OMS).

Employees are responsible for ensuring they comply with relevant legislation and the OMS, to ensure prevention of harm to themselves, their colleagues and the environment.

Arrangements

To meet our Policy Statement, ConocoPhillips (U.K.) Limited will:

- Demonstrate active Health, Safety and Environmental leadership and communication of this policy.
- Comply with relevant laws and regulations.
- Maintain "stop work policies" that establish the responsibility and authority for all employees and contractors to stop work they believe to be unsafe.
- Provide medical services to give advice, guidance, support and monitoring on health-related matters.
- Include environmental considerations in our business decisions and minimise the impacts of our activities on the environment.
- Implement procedures to ensure that integrity and reliability issues, which have the potential to cause an HSE impact, are properly considered at all stages in the asset life cycle.
- Ensure that all employees and contractors understand that working safely is a condition of employment, and that everyone is responsible for their own safety and for minimising environmental impacts of our operations.
- Manage all projects and processes through their life cycles in a way that protects health and safety, prevents pollution and manages wastes.
- Develop safe systems of work for all potentially hazardous situations; identify and assess major accident hazards.
- Provide employees, contractors and suppliers with the training, knowledge and resources necessary to achieve our Health, Safety and Environmental commitments.
- Provide effective emergency response systems allowing onshore and offshore personnel to deal effectively with emergency situations.
- Measure, audit and publicly report Health, Safety and Environmental performance and maintain open dialogue with stakeholder groups.
- Promote and adhere to the ConocoPhillips Life Saving Rules.
- Work with the regulator and other stakeholders to continuously improve Health, Safety and Environmental performance.

Terri King .... **Terri King**, President, ConocoPhillips U.K.

"Nothing is so urgent or important, that we cannot take time to do it safely and in an environmentally prudent manner"

UK-00655 February 2018

Figure 15.1: ConocoPhillips (U.K.) HSE Policy Statement

ConocoPhillips (U.K.) has implemented a dedicated environmental management process that is fully integrated within its Deming Cycle-based Operating Management System (OMS) (Figure 15.2).

The OMS provides the governance by which the company's HSE Policy is implemented throughout our operations.

The environmental management process has been designed to meet the requirements of the corporate and global HSE Management System Standard, utilising the requirements and principles contained in the internationally recognised environmental management systems standard ISO 14001:2004.

ConocoPhillips gained company-wide certification to ISO 14001 in 2002 and ConocoPhillips UK Limited gained re-certification in October 2015. Transition to ISO 14001:2015 is scheduled for September 2018.

Figure 15.2: Deming Cycle-based Operating Management System (OMS)

15.3 Environmental Aspects

The Environmental Aspects Register is a comprehensive listing of environmental aspects and their associated impacts arising or likely to arise, from company activities, products and services (existing and planned), including:

- Emissions to atmosphere (controlled and uncontrolled);
- Discharges to sea and surface water and sewers (controlled and uncontrolled);
- Seabed disturbance (impacts in protected habitats);

- Offshore underwater noise (seismic survey and piling noise and the potential impacts on marine mammals and fish species);
- Impacts to land (waste disposal and other waste with potential for contamination);
- Resource consumption (use of land, water, fuel/ energy, raw materials);
- Social and socioeconomic;
- Community issues (onshore) (noise, vibration, dust, odour, and visual impact); and
- Non-routine events (spills and emissions).

The Register and significance scores can be viewed by ConocoPhillips U.K. personnel at all U.K. locations via the company intranet. Areas requiring improvement are subject to annual environmental goals, which are cascaded down through the organisation from company level, through the Business Unit down to specific asset, workgroup and individual employee level. Provision is made within the system to allow goals and programmes to be generated at the operating asset level also. Improvement programmes allow the company to assign resources to meet any environmental targets set and to operate in an environmentally responsible way.

Environmental aspects related to VDP2 and VDP3 will be integrated into the existing ConocoPhillips Environmental Aspects Register.

15.4 Register of Commitments

ConocoPhillips is committed to minimising the environmental impact of its activities. Continuous improvement in environmental performance is sought through effective project planning and implementation, emission reduction, waste minimisation, waste management and energy conservation.

A register of commitments has been developed to address the overall activities of VDP2 and VDP3 (Table 15.1) and are in addition to the mitigation measures identified during the EIA process. This register along with the proposed mitigation measures will form part of the decommissioning project planning process, and will be integrated into the relevant phases.

Table 15.1: Register of commitments

Issue	Commitment
Delivery of commitments	The commitments made within this ES will be incorporated into operational work programmes, plans and procedures. Programmes will be tracked to ensure that commitments and mitigation measures are implemented throughout the project.
Management responsibilities	Key environmental responsibilities, duties, communication, reporting and interface management arrangements of ConocoPhillips and the main contractors involved in the decommissioning activities will be agreed, documented and communicated at the appropriate stages of the project.
Commitment to the environment	ConocoPhillips will work to minimise short and long-term impacts from their decommissioning operations.
Post-decommissioning	ConocoPhillips will undertake post-decommissioning surveys (scope and frequency to be discussed and agreed with BEIS).
Legacy issues	In consultation with BEIS, ConocoPhillips will endeavour to address any material environmental issues identified as requiring positive action regarding man-made infrastructure decommissioned in situ.

The mitigation measures and commitments will also be embedded into the following documents to ensure appropriate execution and management:

- Detailed engineering specifications;
- Contracts; and
- Execution plans.

15.5 Roles and Responsibilities

The roles and responsibilities of ConocoPhillips, contractors and subcontractors will be clearly identified and the interrelationship between these entities defined. As contracts are awarded the organisational chart will be updated and evolve to incorporate amendments to the project phases, then managed accordingly.

15.6 Contractor Interface

Contractor management is an integral part of ConocoPhillips (U.K.) HSE Policy and contractors are expected to demonstrate a high level of HSE commitment and have systems in place for managing Health, Safety and Environmental issues.

The ConocoPhillips (U.K.) HSE Policy requires contractors to attend periodic Health, Safety and Environmental meetings and ensure an understanding that working safely is a condition of employment, and that everyone is responsible for their own safety and for minimising environmental impacts. The necessary training, knowledge and resources are supplied to contractors by ConocoPhillips in order to meet company HSE commitments.

At the project level, all offshore contractors involved in the decommissioning of facilities must produce procedures for all aspects of the decommissioning activities; these procedures are subject to Hazard Identifications (HAZIDs) and procedural Hazard and Operability (HAZOP) assessment. Appropriate measures are introduced where necessary to ensure acceptable levels of safety and environmental protection. All Contractors are responsible for all aspects of national and international regulatory compliance with regard to their activities and equipment, including international pollution prevention measures.

Contractor interface documents will be developed to manage environmental commitments during decommissioning. The interface document will detail the management organisation, the communication and reporting lines and the division of responsibilities during operational and emergency situations.

15.7 Staff Training and Awareness

Environmental training is undertaken by all ConocoPhillips staff involved in activities that have the capacity to create a significant environmental impact. The training ensures competency to perform work in compliance with ConocoPhillips Environmental Policy and individual responsibilities. Records of environmental training are kept as part of asset level EMS documentation.

Training and competency are managed through individual contracts and ConocoPhillips stipulating minimum standards of training and competency that are required for personnel to undertake work on ConocoPhillips' behalf. These comprise industry standard training/ awareness and technical standards. Compliance with this is demonstrated at regular performance reviews. Contractors are also independently audited regularly with training and competency forming a key part of these audits.

15.8 Environmental Monitoring

Decommissioning operations will be conducted under the relevant licences and permits applied for by ConocoPhillips. Monitoring and reporting to the regulator and internally will be conducted in accordance with relevant legislation and these licences. For example, discharges to sea from chemicals and residual hydrocarbons will be permitted appropriately and any accidental discharges to sea will be reported and investigated through ConocoPhillips's incident investigation process.

ConocoPhillips have arrangements in place for monitoring environmental performance and compliance with legislation, company policy, standards and procedures. Two approaches to monitoring are applied: active (providing feedback on performance) and reactive (providing information on incidents, accidents and near misses). Appropriate performance measures will be established for monitoring progress towards the achievement of defined goals and targets, and appropriate arrangements will be in place to ensure the effective collation and reporting of this performance data.

Through the execution of the HSE Management System Standard, a variety of deliverables are generated by ConocoPhillips. These include investigation reports of "high and significant risk" incidents, audit findings and HSE Compliance Verification Reports. A monthly report highlighting HSE performance is communicated electronically via the company intranet, which is accessible to all employees. Both the ConocoPhillips Management Committee and Public Policy Committee of the company's Board of Directors receive updates of HSE issues, events and performance from the HSE Vice President.

15.9 Performance Monitoring (Inspection, Audit and Corrective Actions)

Monitoring will be performed by internal and external parties. The scope and frequency of internal monitoring depends on an assessment of risks performed by line managers, process owners and corporate staff functions. Internal monitoring consists of three main categories: follow-up, verification and internal audit.

ConocoPhillips maintains a multi-tiered risk-based HSE audit programme encompassing regulatory and management system compliance audits at both the corporate and business unit levels. The programme also includes external insurance risk assessments. Independent, limited assurance audits of ConocoPhillips' corporate level processes for collating and reporting aggregated HSE data presented in ConocoPhillips' Sustainable Development report are also commissioned. Auditing associated with decommissioning will be identified and scheduled in the ConocoPhillips Audit Programme prior to and during ongoing decommissioning operations.

16.0 CONCLUSIONS

An EIA forms an integral part of the ConocoPhillips Environmental Management process, ensuring that adequate environmental considerations are incorporated into both VDP2 and VDP3. This ES presents the findings of the EIA for the recommended options for the decommissioning of the VDP2 and VDP3 infrastructure, providing sufficient information to enable a robust evaluation of the potential environmental consequences of the proposed decommissioning activities.

The VDP2 and VDP3 infrastructure is located in a marine environment that is typical of this part of the southern North Sea. ConocoPhillips has considered that there are potentially certain times of the year when populations of seabirds, life stages of fish, marine mammal presence and commercial fishing interests may be more susceptible to potential impact. However, the area is not considered particularly sensitive to the proposed decommissioning activities (Sections 4 and 5).

Infrastructure covered under VDP2 and VDP3 is located within two SACs and one cSAC:

- North Norfolk Sandbanks and Saturn Reef SAC; and
- Inner Dowsing, Race Bank and North Ridge SAC.
- Southern North Sea cSAC.

Both of the SACs are designated for the Annex I habitats; sandbanks that are slightly covered by seawater all the time, and biogenic reefs formed by the polychaete worm *Sabellaria spinulosa*. The cSAC is designated for the conservation of populations of the Annex II species, harbour porpoise, associated with the area.

The Annex II species recorded within and around the VDP2 and VDP3 infrastructure include harbour porpoise, bottlenose dolphin, harbour seal and grey seal. Harbour porpoises have been sighted in very high numbers in August, high numbers in March, May, June, July and September (UKDMAP, 1998; Reid *et al.,* 2003). Low numbers of bottlenose dolphins were sighted in August and November (Reid *et al.*, 2003; UKDMAP, 1998). Harbour and grey seals in varying densities have been observed throughout the decommissioning area (Jones *et al.,* 2013).

Following the identification of the interactions between the proposed decommissioning activities and the local environment, the assessment of potentially significant environmental impacts, stakeholder consideration, the key environmental concerns identified as requiring consideration for impact assessment were:

- Effects of energy use and atmospheric emissions (Section 8).
- Effects of underwater noise generated during the decommissioning activities (Section 9).
- Effects of seabed disturbance during decommissioning activities – vessel anchoring, rock-placement, mattress removal, dredging, overtrawl survey, etc. (Section 10).
- Habitat change within the SAC as a result of rock-placement (Section 10).
- Sediment contamination originating from the degradation of pipelines decommissioned in situ (Section 10).
- Potential release of residual contaminants during routine decommissioning activities (Section 11).

- Physical presence of vessels causing interference/ displacement of other users of the sea (Section 12).
- Impacts to fisheries from pipelines, mattresses and rock decommissioned in situ (Section 12).
- Non-routine events, such as the spillage of hydrocarbons or other fluids during the decommissioning activities or through accidental events such as vessel collisions (Section 13).

Mitigation to avoid and/or reduce the environmental concerns highlighted above is in line with industry best practice. ConocoPhillips has an established EMS process, which will ensure that proposed mitigation measures are implemented and monitored to achieve the outcome presented in this ES.

ConocoPhillips are aware that a number of oil and gas fields/ installations in the southern North Sea are currently being decommissioned or are reaching the end of their operational life. As a consequence the potential for additive or cumulative impacts within the southern North Sea will be increased in the short-term. Decommissioning activities may contribute to overall gaseous emissions in the southern North Sea but the impact of this is estimated to be very minor in context with total UKCS emissions associated with the oil and gas industry (Section 8). Underwater noise will also be increased during decommissioning mainly due to the presence of vessels, but will be transient and is not expected to have a cumulative impact (Section 9).

Activities resulting from the decommissioning of the VDP2 and VDP3 infrastructure are expected to create a maximum long-term seabed impact of 2.244 km^2, representing 0.05% of the total area of the North Norfolk Sandbanks and Saturn Reef SAC and the Inner Dowsing, Race Bank and North Ridge SAC (Section 10). Long-term degradation of the pipelines and mattresses will introduce chemical contaminants to the sediment and water column over an extended period. These chemicals are not expected to rise above background levels in the water column or result in long-term toxicity to marine organisms at the seabed (Section 10).

Most fluids from pipeline cleaning will be re-injected downhole via well BD03, with any discharges to sea meeting regulatory requirements and minimized. There is the possibility that minor releases of materials may occur during cutting of pipeline ends. It is expected that these discharges will result in negligible localised effects and are not anticipated to have any discernible impact on the wider marine environment cumulatively or in combination with other activities.

Decommissioning activities are likely to result in an overall impact on the SACs in the short-term. Decommissioning the majority of the subsea VDP2 and VDP3 infrastructure in situ, the long-term and cumulative impact of these activities will be limited.

Other than a minor contribution to overall emissions, decommissioning activities are not anticipated to cause any transboundary impacts.

Overall, the ES has evaluated the environmental risk reduction measures and although the intent is to decommission some of the infrastructure in situ, this document concludes that ConocoPhillips have, or intend to, put in place sufficient safeguards to mitigate the potential environmental and societal risk and to monitor the implementation of these measures.

The transient loss of access for vessels during the decommissioning operations is unlikely to have a significant impact on other sea users (i.e. commercial shipping and fishing). In addition, the ES has highlighted the positive impact that the decommissioning of the VDP2 and VDP3 infrastructure will have on commercial fisheries with the opening of areas of the sea which have previously been excluded for safety reasons.

Therefore, it is the conclusion of this ES that the recommended options presented for the decommissioning of the VDP2 and VDP3 infrastructure can be completed without causing significant adverse impact to the environment.

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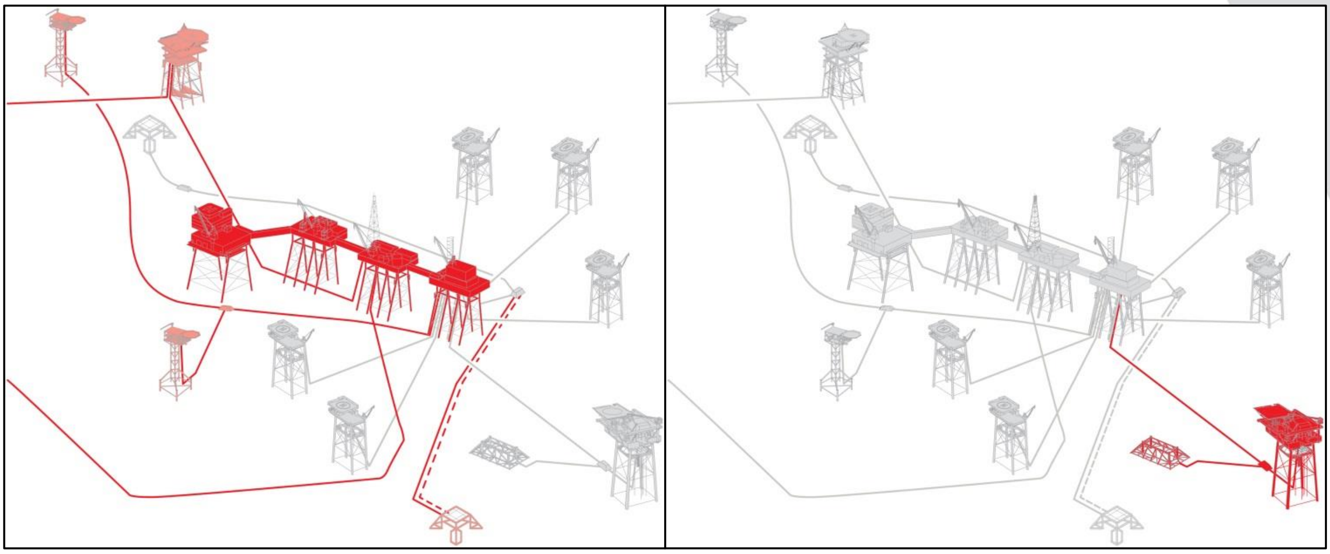
SOUTHERN NORTH SEA (SNS) DECOMMISSIONING PROJECT

APPENDICES FOR SNS DECOMMISSIONING PROGRAMMES ES:

VIKING VDP2 AND VDP3



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APPENDIX A

SUMMARY OF ENVIRONMENTAL LEGISLATION

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LIST OF TABLES

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This appendix presents a summary of key regulatory drivers applicable to the VDP2 and VDP3 decommissioning project. It summarises the policy, legal, and regulatory framework within which this EIA has been undertaken.

Table A.1: Decommissioning

Regulator	Legislation	Summary of requirements
BEIS	Petroleum Act 1998	The Petroleum Act 1998 sets out requirements for undertaking decommissioning of offshore installations and pipelines including preparation and submission of a Decommissioning Programme.
	Energy Act 2008	Part III of the Energy Act 2008 amends Part 4 of the Petroleum Act 1998 and contains provisions to enable the Secretary of State to make all relevant parties liable for the decommissioning of an installation or pipeline; provide powers to require decommissioning security at any time during the life of the installation and powers to protect the funds put aside for decommissioning in case of insolvency of the relevant party.
	Marine and Coastal Access Act 2009	The MCAA will replace and merge the requirements of the Food and Environment Protection Act (FEPA) Part II (deposits to the sea) and the Coast Protection Act (navigation). Many offshore sector activities are exempt from the acts; however certain activities including deposits of substances or articles on the seabed during abandonment and decommissioning operations are covered. Application to BEIS for approval to disturb, recover or place items on the seabed can be made under the provisions of the MCAA using a Marine License.
BEIS, MMO, Scottish Government	The Energy Act 2016	The introduction of the Energy Act 2016 formally establishes the Oil and Gas Authority (OGA) as an independent regulator, detailing its functions. The regulations transfer functions from the Secretary of State for Business, Energy and Industrial Strategy (formerly DECC) to the Oil and Gas Authority (OGA). Functions relate to licensing, production and exploration.
BEIS/ HSE	Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999 Pipeline Safety Regulations 1996 The Petroleum Act 1998	When decommissioning a field, operators should contact BEIS at least a year in advance of proposed pipeline works to discuss PWA Variation requirements and timings for submission of applications.
EA	The Environmental Permitting (England and Wales) Regulations 2010	Some facilities could harm the environment or human health unless they are controlled. The environmental permitting regime ('the regime') requires operators to obtain permits for some facilities, to register others as exempt and provides for ongoing supervision by regulators.
	The Environmental Protection Act 1990	In addition to the above, persons concerned with controlled waste are under a duty of care, under the EPA1990, to ensure that the waste is managed properly, recovered or disposed of safely, does not cause harm to human health or pollution of the environment and is only transferred to someone who is authorized to receive it. This duty applies to any person, who produces, imports, carries, keeps, treats or disposes of controlled waste or as a broker has

Regulator	Legislation	Summary of requirements
		control of such waste. Breach of the duty of care is an offence, with a penalty of up to £5000 on summary conviction or an unlimited fine on conviction on indictment.
BEIS	Offshore Installations and Wells (Design and Construction etc.) Regulations 1996 (DCR)	Well Operators are required to ensure that wells are designed with a view to suspension and abandonment and outlines measures for plug and abandonment operations to comply with Regulations. Sections 13, 15 and 16 of the Regulations are relevant to well suspension and abandonment and cover well integrity, design for abandonment and materials. It also outlines requirements for the decommissioning and dismantlement of offshore installations.

Regulator	Legislation	Summary of requirements
OGA/ HSE	The Offshore Installations (Offshore Safety Directive) Regulations 2015	This regulation implements the requirements of Directive 2013/30/EU of the European Parliament and of the Council on safety of offshore oil and gas operations and amending Directive 2004/35/EC (the "Offshore Safety Directive"), which intends to reduce as far as possible the occurrence of major accidents related to offshore oil and gas operations (such as the 2010 Deepwater Horizon incident in the Gulf of Mexico) and to limit their consequences. The Offshore Installations (Offshore Safety Directive) (Safety Case etc.) Regulations 2015 supersedes the Offshore Installations (Safety Case) Regulations 2005. Operators must prepare a Safety Case for offshore installations and the notification of specified activities to the competent authority (the Health and Safety Executive and the Secretary of State acting jointly). This incorporates operations through production and including decommissioning.
EA	Hazardous Waste (England & Wales) Regulations 2005	Depending on its nature and composition, waste may be defined as hazardous waste (in England and Wales) within the UK. Hazardous wastes are those that are potentially the most difficult and dangerous and are listed on the European Commission's List of Wastes. The Regulations contain strict rules for the storage, transport and disposal of hazardous wastes. For example, the regulations require all movement of hazardous waste to be tracked by way of a consignment note system.
	Transfrontier Shipment of Waste Regulations 2007	The international movement of waste is controlled by means of Council Regulation No 1013/2006/EC on shipments of waste (the "WSR"). The Transfrontier Shipment of Waste Regulations 2007 gives effect to certain aspects of the WSR into UK law, nominate the competent authorities for the UK and provide them with their respective enforcement powers. The UK Plan for Shipments of Waste sets out Government policy on shipments for disposal. The Regulations are enforced by the Environment Agency ((EA) England and Wales), Scottish Environment Protection Agency ((SEPA) Scotland) and Northern Ireland Environment Agency ((NIEA) Northern Ireland). The regulations apply to decommissioned offshore installations. The Secretary of State is the competent authority for the offshore area. Operators should consult the appropriate Agency when considering decommissioning activities that involve transboundary movements of waste.
	Radioactive Substances Act 1993, Amendment (Scotland) Regulations 2011 and the Environmental Permitting (England and Wales) Regulations 2010 as amended (2015)	The Radioactive Substances Act 1993 has been superseded by the Environmental Permitting (England and Wales) Regulations 2010 (as amended in 2015) in England and Wales. Anyone who receives radioactive sources or radioactive waste for disposal is subject to the requirements of the Radioactive Substances Act 1993 (RSA 93) as superseded by the Environmental Permitting (England and Wales) Regulations 2010 (as amended). Under these regulations they must have an authorisation from the appropriate regulatory body (EA in England & Wales) for the accumulation, storage or disposal of radioactive waste or be able to demonstrate compliance with the conditions contained in specific exemption orders. The Regulations apply to offshore installations and the preparation of a decommissioning programme and should identify whether the selected disposal route requires such an authorisation and that the selected facility has one. It is likely that new disposal routes will require an application for authorisations.

Regulator	Legislation	Summary of requirements
EA	Transfrontier Shipment of Radioactive Waste and Spent Fuel Regulations 2008	The Transfrontier Shipment of Radioactive Waste and Spent Fuel Regulations 2008 (TFSRWR 2008) transpose Council Directive 2006/117/Euratom on the supervision and control of shipments of radioactive waste and spent fuel. TFSRWR 2008 makes it an offence to ship radioactive waste or spent fuel into or out of the UK unless authorised by the appropriate authority. The new Regulations came into force on 25 December 2008 and are administered by the EA in England and Wales, SEPA in Scotland and the Chief Inspector in Northern Ireland. They replace and revoke the previous UK regulatory regime (The Transfrontier Shipment of Radioactive Waste Regulations 1993) and some transfers of radioactive waste across international boundaries which were previously regulated are now exempted.
HSE	Dangerous Substances in Harbour Areas Regulations 1987	The carriage, loading, unloading and storage of all classes of dangerous substances in port areas are controlled under the dangerous Substances in Harbour Areas Regulations 1987 (and amendments) and the Waste Management Licensing Regulations 1994.
OSPAR/ BEIS	OSPAR Decision 98/3 on the Disposal of Disused Offshore Installations	Lays down the general principle of forbidding the dumping and the leaving wholly or partly in place of disused offshore installations in the maritime area covered by the OSPAR Convention. The Decision recognises potential difficulties in removing large steel jackets weighing more than 10,000 tonnes and concrete gravity base structures and provides a facility for derogation from the main rule of complete removal such that leaving the jacket footings or concrete structure in place may be considered.
OSPAR/ BEIS	OSPAR Recommendation 2006/5 on a management scheme for offshore cuttings piles	This recommendation outlines the approach for the management of cuttings piles offshore. The first stage of the Recommendation is to be carried out within two years of the Recommendation coming into effect with the second stage completed in a predetermined timeframe laid out in stage 1. This Recommendation entered into force from 30 June 2006.
IMO	International Maritime Organisation (IMO) Guidelines and Standards for the Removal of Offshore Installations and Structures on the Continental Shelf and in the Exclusive Economic Zone 1989	These Guidelines and Standards represent the "generally accepted international standards" as mentioned in the United Nations Convention on the Law of the Sea (UNCLOS), Article 60, which prescribes that any installations or structures which are abandoned or disused shall be removed to ensure safety of navigation and to prevent any potential effect on the marine environment.

Table A.2: Environmental impact assessment

Regulator	Legislation	Summary of requirements
BEIS	Council Directive on the Assessment of the Effects of Certain Public and Private Activities on the Environment - 85/337/EEC (the EIA Directive) as amended by Directives 97/11/EC, 2003/35/EC and 2009/31/EC. EC Directive 2014/52/EU, amending EC Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment	The EIA Directive (85/337/EEC) has been in force since 1985 and applies to a wide range of defined public and private projects, which are defined in Annexes I and II: Annex 1: all projects listed in Annex I are considered as having significant effects on the environment and require a mandatory EIA. Typical projects include, for example: Extraction of petroleum and natural gas for commercial purposes where the amount extracted exceeds 500 tonnes/ day in the case of petroleum and 500,000 cubic metres/ day in the case of gas. Pipelines with a diameter of more than 800 mm and a length of more than 40 km: • For the transport of gas, oil, chemicals; and • For the transport of CO_2 streams for the purposes of geological storage, including associated booster stations. Installations for storage of petroleum, petrochemical, or chemical products with a capacity of 200,000 tonnes or more. The EC Directive 2011/92/EU (as amended by Directive 2014/52/EU) revokes the 85/337/EEC and 97/11/EC Directives and amends the 2003/35/EC directive. The 2012/92/EU lists two classes of project to which the Directive applies: Annex 1 Projects for which environmental assessment is mandatory; and Annex 2 projects for which EA is discretionary. Under 2012/92/EU, oil and gas developments are listed as Annex 1 projects. Directive 2014/52/EU makes provision for improvements to the EIA procedure. Significant changes are also made to Annex 3 and 4, with new Annex 2a detailing information that needs to be provided when determining whether projects listed in Annex II require an EIA. Member States are required to implement the provision of this Directive no later than 16th May 2017.
	The Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999 as amended (2007)	These Regulations implement the EIA Directive with regard to the offshore oil and gas industry. The Regulations require an EIA and the associated public consultation document (ES) to be submitted for certain projects. Although there is currently no statutory requirement to undertake an EIA at the decommissioning stage, a decommissioning programme will nevertheless need to be supported by an EIA. The ES submitted for the development under the EIA regulations requires the applicant to consider the long term impacts of the development and these include the impacts arising from decommissioning.
	The Offshore Petroleum Production and Pipe-lines (Environmental Impact Assessment and other Miscellaneous Provisions) (Amendment) Regulations 2017	These Regulations offer further amendments to The Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999 (as amended) (see above). The amendments are under the interpretation of certain regulations, which addresses the requirements of the contents of licence, agreement of projects, provisions to directions over Environmental Statements, projects which have transboundary impacts, and generally the contents, exemptions, and criteria of environmental statements.

Regulator	Legislation	Summary of requirements
		In regards the amendments to the pipe-line regulations, the amendments are again under the provision, content and determinations of environmental statements; their publicity, provision of information, information and evidence, projects which affect other states and the concert to pipe-line works.
	OSPAR Recommendation 2010/5 on assessments of environmental impact in relation to threatened and/or declining species and habitats	The purpose of this Recommendation is to support the protection and conservation of species and habitats on the OSPAR List of threatened and/or declining species and habitats, through assessments of environmental impacts of human activities. When assessments of environmental impacts of human activities that may affect the marine environment of the OSPAR maritime area are prepared, Contracting Parties should ensure they take account of relevant species/ habitats on the OSPAR List of threatened and/or declining species/ habitats (OSPAR Agreement 2008/6).

Table A.3: Territorial waters

Regulator	Legislation	Summary of requirements
-	Territorial Sea Act 1987 Territorial Waters Order	Defines the extent of the territorial sea adjacent to the British Islands.

Table A.4: Atmospheric emissions

Regulator	Legislation	Summary of requirements
MCA	MARPOL 73/78 Annex VI the Prevention of Air Pollution from Ships	Annex VI is concerned with the control of emissions of ozone depleting substances, NOx, SOx, and VOCs and require ships (including platforms and drilling rigs) to be issued with an International Air Pollution Certificate following survey. This annex set limits on sulphur oxide and nitrogen oxide emissions from ship exhausts as well as particulate matter and prohibit deliberate emissions of ozone depleting substances. Emissions arising directly from the exploration, exploitation and associated offshore processing of seabed mineral resources are exempt from Annex VI, including the following: • emissions from flaring, burning of cuttings, muds, well clean-up emissions and well testing; • release of gases entrained in drilling fluids and cuttings; • emissions from treatment, handling and storage of reservoir hydrocarbons; and • emissions from diesel engines solely dedicated to the exploitation of mineral resources.
BEIS	The National Emission Ceilings Regulations 2002	There regulations transpose EC Directive on national emission ceilings for certain atmospheric pollutants 2001/81/EC into UK law and set national ceilings and a requirement for the development of a reduction programme for SOx, NOx and VOCs and set out the UK government commitment for achieving a reduction of atmospheric emissions by 2010 and thereafter not to exceed the amounts specified in the Schedule of that pollutant.

Regulator	Legislation	Summary of requirements
	The Merchant Shipping (Prevention of Air Pollution from Ships) Regulations 2008 as amended (2010) Directive 2012/33/EU (amending Directive 1999/32/EC)	These regulations implement Annex VI of MARPOL (the International Convention for the Prevention of Pollution from Ships 73/78) in the UK. The 2010 Amendments primarily implement provisions concerning the sulphur content of marine fuels contained in Council Directive 1999/32/EC. The Directive sets maximum sulphur content for fuel including heavy fuel oil and gas oil including marine fuel.
BEIS	Climate Change Act 2008	The Act sets up a framework for the UK to achieve its long-term goals of reducing greenhouse gas emissions and to ensure actions are taken towards adapting to the impact of climate change. The Act enables a number of elements, including amongst others; setting medium and long-term emissions reduction targets in statute, introduction of a system of carbon budgeting which constrains the total amount of emissions in a given time period, a new reporting framework for annual reporting of the UK's greenhouse gas emissions, creation of an independent advisory body (the Committee on Climate Change). As a result of the Act and the 2009 Order, the current legally-binding targets for the net UK carbon account are: 34% reduction by 2020 and 80% reduction by 2050, against a 1990 baseline.
BEIS	EU Regulation 517/2014 on Fluorinated Greenhouse Gases The Fluorinated Greenhouse Gases Regulations 2015	The Regulations implement the EU Parliament Regulation 517/2014 and cover certification of equipment such as refrigeration, fire protection and that which contains fluorinated gas (f-gas) based solvents. The Regulations create offences and penalties for not complying with recovery of f-gases, labelling and qualifications and certifications required to work with products or equipment containing them. The Regulations ban the manufacture of certain f-gases and provide a time-frame for their phasing-out. Recently there has been the release of an amendment of the EU Parliament Regulation 517/2014, the Regulation (EU) 1375/2017 amending Implementing Regulation (EU) 1191/2014 determining the format and means for submitting the report referred to in Article 19 of Regulation (EU) No 517/2014 of the European Parliament and of the Council on fluorinated greenhouse gases, which concerns the implementation and establishment of beat available techniques (BAT) in the management of industrial emissions.
	Regulation (EC) 1005/2009 on substances that deplete the ozone layer. Environmental Protection (Controls on Ozone-Depleting Substances Regulations 2011. The Ozone –Depleting Substances (Qualifications) Regulations 2009 The Ozone-Depleting Substances Regulations 2015	These regulations replace and consolidate the Ozone-Depleting Substances (Qualifications) Regulations 2009 (S.I. 2009/2016) and the Environmental Protection (Controls on Ozone Depleting Substances) Regulations 2011 (S.I. 2011/1543)). These Regulations make provision in the UK for EC Regulation 1005/2009 which controls the production, impact, export, placing on the market, recovery, recycling, reclamation and destruction of substances that deplete the ozone layer.

Table A.5: Access to environmental information and public participation

Regulator	Legislation	Summary of requirements
BEIS	Directive 2003/4/EC of the European Parliament and of the Council of 28 January 2003 on public access to environmental information and repealing Council Directive 90/313/EEC	This Directive transposes the first pillar of the Aarhus convention on access to information into EU legislation. This Directive requires all public authorities to provide members of the public with access to environmental information, and to actively disseminate the environmental information they hold. The information must be provided to any person at their request, without them having to prove an interest and at the latest within two months of the request being made.
	Public Participation Directive (PPD) 2003/35/EC	Provides for public participation in the preparation of environmental plans, programmes and projects with significant environmental impacts. See section on environmental impact assessment.

Table A.6: Conservation and biodiversity

Regulatory Body	Legislation	Summary of requirements
BEIS	The Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 as amended (2012)	These Regulations make provision for implementing the Birds Directive and Habitats Directive in relation to marine areas where the United Kingdom has jurisdiction beyond its territorial sea. The Regulations make provision for the selection, registration and notification of sites in the offshore marine area (European Offshore Marine Sites) and for the management of these sites. Competent authorities are required to ensure that steps are taken to avoid the disturbance of species and deterioration of habitat in respect of the offshore marine sites and that any significant effects are considered before authorisation of certain plans or projects. Provisions are also in place for issuing of EPS licences for certain activities and for undertaking monitoring and surveillance of offshore marine sites. The Amendment Regulations make various insertions for new enactments (e.g. new Birds Directive). Most recent amendments to the 2007 and 2010 regulations are The Conservation of Habitats and Species (Amendment) Regulations 2012. JNCC is an advisory body for these Regulations.
	The Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 as amended (2007)	Secretary of State set out these Regulations to consider whether a “Habitats Regulatory Assessment” should be undertaken prior to granting a licence under the Petroleum Act 1998. Habitats Regulatory Assessment is the formal assessment by the Competent Authority of the impacts of a plan or project on the integrity of (a) Natura 2000 site(s). Habitats Regulatory Assessment is a process separate from the EIA requirements, but which should run alongside and concurrently with the EIA requirements. The 2007 amendments also extend this requirement to all UK waters. These regulations implement European Directives for the protection of habitats and species in relation to oil and gas activities carried out in whole or in part on the UKCS. In particular these are the Council Directive 92/43 on the conservation of natural habitats, wild fauna and flora and Council Directive 79/409 on the conservation of wild birds. The 2007 amendments extend the requirements to all UK waters. JNCC is an advisory body for these Regulations.
MMO/ EA	Marine and Coastal Access Act 2009	Marine Nature Conservation – Powers in the Marine and Coastal Access Act 2009 enable the designation of Marine Conservation Zones (MCZs) in the territorial waters adjacent to England and Wales and UK offshore waters. The purpose of these new conservation measures is to halt the deterioration of the state of the UK’s marine biodiversity and promote recovery where appropriate, support healthy ecosystem functioning and provide the legal mechanism to deliver our current European and international marine conservation commitments, such as those laid out under the Marine Strategy Framework Directive, OSPAR Convention and Convention on Biological Diversity.

Regulator	Legislation	Summary of requirements
EA	The EC Water Framework Directive, 2000	In December 2000 the 'Directive 2000/60/EC of the European Parliament established a framework for Community action in the field of water policy' (referred to as the Water Framework Directive or WFD). The purpose of the Directive is to establish a framework for the protection of inland and coastal waters. It ensures that all aquatic ecosystems meet 'good status' by 2015. Transposition into national law in the UK occurred through the following regulations: The Water Environment (Water Framework Directive) (England and Wales) Regulations 2003 (Statutory Instrument 2003 No. 3242) for England and Wales.

Table A.7: Emergency response

Regulator	Legislation	Summary of requirements
BEIS	The Offshore Installations (Emergency Pollution Control) Regulations 2002	The Regulations give the Representative of the Secretary of State for Energy and Climate Change (SOSREP) powers to intervene in the event of an incident involving an offshore installation where there is, or may be, a risk of significant pollution, or where an operator is failing or has failed to implement effective control and preventative operations.
	The Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005 as amended (2011)	Under these Regulations, it is an offence to make an unlawful release of oil, i.e. a release of oil other than in accordance with the permit granted under these Regulations for oily discharges (e.g. produced water etc.). However, it will be a defence to prove that the contravention arose because of something that could not have been reasonably prevented, or that it was due to something done as a matter of urgency for the purposes of securing the safety of any person. PON 1 reporting.
	Merchant Shipping Act 1995	The Merchant Shipping Act 1995 implements in the UK the Oil Pollution Preparedness, Response and Co-operation (OPRC) Convention. The aim of the OPRC Convention is to increase the level of effective response to oil pollution incidents and to promote international co-operation to this end. The Convention applies to ships and offshore installations and requires operators to have in place OPEP, which are approved by the body that is the National Competent Authority for the Convention.
	The Merchant Shipping (Oil Pollution Preparedness, Response and Co-operation Convention) (Amendment) Regulations 2015	The Merchant Shipping (Oil Pollution Preparedness, Response and Co-operation Convention) (Amendment) Regulations 2015 amend the existing requirements in the Merchant Shipping (Oil Pollution Preparedness, Response and Co-operation Convention) Regulations 1998 to have an oil pollution emergency plan. The 1998 Regulations make provision for certain facilities in the United Kingdom’s internal waters, territorial sea and continental shelf to have an oil pollution emergency plan. The amendments extend the requirement to have an oil pollution emergency plan to non-production installations in the territorial sea and the continental shelf and apply further requirements to installations and their connected infrastructure which are carrying out offshore oil and gas operations, including decommissioning operations.

Table A.8: Environmental liability

Regulatory Body	Legislation	Summary of requirements
EA	Directive 2004/35/EC of the European Parliament and the Council of 21 April 2004 on environmental liability with regard to the prevention and remedying of environmental damage.	The Environmental Liability Directive 2004/35/EC(ELD) enforces strict liability for prevention and remediation of environmental damage to 'biodiversity', water and land from specified activities and remediation of environmental damage for all other activities through fault or negligence. The Directive defines "environmental damage" as damage to protected species and natural habitats, damage to water and damage to soil. Operators carrying out dangerous activities listed in Annex III of the Directive fall under strict liability (no need to proof fault). Operators carrying out other occupational activities than those listed in Annex III are liable for fault-based damage to protected species or natural habitats. The establishment of a causal link between the activity and the damage is always required. Affected natural or legal persons and environmental NGOs have the right to request the competent authority to take remedial action if they deem it necessary. The ELD was amended three times through Directive 2006/21/EC on the management of waste from extractive industries, through Directive 2009/31/EC on the geological storage of carbon dioxide and amending several directives, and through Directive 2013/30/EU on safety of offshore oil and gas operations and amending Directive 2004/35/EC. The amendments broadened the scope of strict liability by adding the "management of extractive waste" and the "operation of storage sites pursuant to Directive 2009/31/EC" to the list of dangerous occupational activities in Annex III of the ELD. The Offshore Safety Directive, containing an amendment to the ELD (extension of the scope of damage to marine waters), was adopted in June 2013.

Table A.9: Chemicals, drainage and oily discharge

Regulator	Legislation	Summary of requirements
BEIS	The Offshore Chemical Regulations 2002 as amended (2011)	The Offshore Chemicals Regulations 2002 implement the OSPAR Decision (2000/2) and OSPAR Recommendations (2000/4 and 2000/5) introducing a Harmonised Mandatory Control System for the use and reduction of the discharge of offshore chemicals. The Regulations introduced a permit system for the use and discharge of chemicals offshore and include a requirement for site specific risk assessment. Chemicals used offshore must be notified through the Offshore Chemical Notification Scheme (OCNS) and chemicals are ranked by hazard quotient, using the Chemical Hazard Assessment and Risk management (CHARM) model. Applications for permits are made *via* the submission of the relevant PET system permit application (i.e. chemicals for drilling: DRA; pipelines: PLA; production: PRA; decommissioning: DCA; and workovers and well interventions: WIA). Amendments in 2011 to the Offshore Chemicals Regulations and the Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2010. The principal aim is to make unlawful unintentional releases of chemicals and oil that arise through accidents / non-operational discharges by broadening accordingly the definitions of "offshore chemical" and "discharges" and incorporating a new concept of "release".
BEIS/ OSPAR	Convention for the Protection of the Marine Environment of the North East Atlantic 1992 (OSPAR Convention) OSPAR Decision 2000/3 on the Use of Organic-Phase Drilling Fluids (OPF) and the Discharge of OPF-Contaminated Cuttings OSPAR Recommendation 2006/5 on a Management Regime for Offshore Cuttings Piles.	The OSPAR Convention (in particular Annex III) is the main driver for reductions in oily discharges to the North Sea. The UK as a contracting party to the Convention is therefore obliged to implement any Decisions and Recommendations made by the Commissions. Certain decisions made under the earlier Paris Convention also still stand. OSPAR Decision 2000/3 that came into effect on 16 January 2001 effectively eliminates the discharge of organic phase fluids (OPF) (oil based (OBF) or synthetic based (SBF) drilling fluids) or cuttings contaminated with these fluids. Use of OPF is still allowed provided total containment is operated. The use of diesel-oil-based drilling fluids is prohibited. The discharge of whole OPF to the sea is prohibited. The mixing of OPF with cuttings for the purpose of disposal is not acceptable. The discharge of cuttings contaminated with OBF (including SBF) greater than 1% by weight on dry cuttings is prohibited. The use of OPF in the upper part of the well is prohibited. Exemptions may be granted by the national competent authority for geological or safety reasons. The discharge into the sea of cuttings contaminated with synthetic fluids will only be authorised in exceptional circumstances. Authorisations to be based on the application of BAT/Best Environmental Practice (BEP). Best Available Techniques described within the Decision include recycling, recovery and reuse of muds. The OSPAR 2006/5 Recommendation sets out measures to reduce pollution from oil or other chemicals from cuttings piles.

Regulator	Legislation	Summary of requirements
MCA/ BEIS	The Merchant Shipping (Prevention of Oil Pollution) (Amendment) Regulations 2000	These Regulations give effect to Annex I of MARPOL 73/78 (prevention of oil pollution) in UK waters and have been amended by the Merchant Shipping (Implementation of Ship-Source Pollution Directive) Regulations 2009 described above. They address oily drainage from machinery spaces on vessels and installations. The North Sea is designated a "Special Area", within which the limit for oil in discharged water from these sources is 15ppm. Vessels and installations are required to hold a valid UK Oil Pollution Prevention (UKOPP) or International Oil Pollution Prevention (IOPP) certificate. Vessels and drilling rigs are also required to hold a current, approved SOPEP which is in accordance with guidelines issued by the Marine Environment Protection Committee of the IMO.
	Merchant Shipping Act 1995 International Convention for the Prevention of Pollution from Ships (MARPOL) 73/78	Arrangements for Survey and Certification Part VI of the Merchant Shipping Act, 1995 makes provision for the prevention of pollution from ships. It implements in the UK the requirements of MARPOL 73/78. MARPOL defines ships to include offshore installations and relevant provisions of MARPOL are applied to offshore installations. Annex 1 of MARPOL relates to prevention of oil pollution and has provisions for machinery space drainage that are applied to offshore platforms. Vessels of 400 GT or above (which includes a Floating Storage Unit (FSU)) are permitted to discharge processed water (i.e. Oily Drainage Water) from Machinery Space Drainage as long as the oil content without dilution, does not exceed 15 ppm of the oil in water.
BEIS	PARCOM Recommendation 86/1 of a 40 mg/l Emission Standard for Platforms	The PARCOM Recommendation 86/1 provision of a 40 mg/l performance standard for platforms is applicable, and remains in force for discharges of displacement water, drainage water and ballast water, which are not covered under MARPOL. The maximum concentration of dispersed oil must not exceed 100 mg/l at any time.
HSE	The REACH Enforcement Regulations 2008	These enforce Regulation (EC) No 1907/2006 of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) which require chemical users to demonstrate the safe manufacture of chemicals and their safe use throughout the supply chain. Under REACH, the users of chemicals as well as their manufacturers and importers have a responsibility to ensure that the risks to both human health and the environment are adequately assessed.

Regulator	Legislation	Summary of requirements
BEIS	The Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005 as amended (2011)	These Regulations replaced the Prevention of Oil Pollution Act 1971 ("POPA") and are a mechanism to continue implementation on the UKCS of OSPAR Recommendation 2001/1. Discharges of reservoir oil associated with drilling from an FSU must be covered by an Oil Pollution Prevention and Control (OPPC) Term Permit, whereas discharges from a production installation are covered by an OPPC Life Permit. Operators are required to regularly report actual oil discharge in order that adequate monitoring can be achieved. These regulations do not apply to those discharges regulated under the Offshore Chemicals Regulations 2002, the Merchant Shipping (Prevention of Oil Pollution) Regulations 1996 (as amended) or the Merchant Shipping (Prevention of Pollution by Sewage and Garbage from Ships) Regulations 2008. Amendments in 2011, *via* the Offshore Chemicals Regulations and the Offshore Petroleum Activities (OPPC) Regulations 2010 introducing new concept of "release " and " offshore installation" which encompasses all pipelines . The concentration of dispersed oil in produced water discharges as averaged over a monthly period must not exceed 30 mg/l, whereas the maximum permitted concentration must not exceed 100 mg/l at any time. The quantity of dispersed oil in produced water discharged must not exceed 1 tonne in any 12 hour period.
	Offshore Pollution Liability Agreement as amended (1st April 2015)	Any UKCS oil and gas operator should have membership to OPOL. Each Party and applicant to become a Party shall provide to the Association evidence of its financial responsibility to fulfil its obligations under Clause IV of OPOL in accordance with the criteria and in the form set out in Form B of these Rules (subject to such changes as the Association may prescribe in cases where the Association has agreed that OPOL does not apply to all Offshore Facilities of which that Party and applicant is or becomes the Operator).

Table A.10: Waste handling and disposal

Regulator	Legislation	Summary of requirements
EA	International Convention for the Prevention of Pollution from Ships (MARPOL) 1973 Annex V	Annex V: Prevention of pollution by garbage from ships (entered into force December 1998). Deals with the different types of garbage and specifies the distances from land and the manner in which they may be disposed of. The Annex also designates Special Areas (including the North Sea) where the disposal of any garbage is prohibited except food wastes. The dumping of plastics at sea is also prohibited by this Annex.
	Environmental Protection Act 1990	This Act, and associated regulations, introduces a “Duty of Care” for all controlled wastes. Waste producers are required to ensure that wastes are identified, described and labelled accurately, kept securely and safely during storage, transferred only to authorised persons and that records of transfers (waste transfer notes) are maintained for a minimum of two years. Carriers and waste handling sites require licensing. This Act and associated Regulations brought into effect a system of regulation for “controlled waste”. Although the Act does not apply to offshore installations, it requires operators to ensure that offshore waste is handled and disposed of onshore in accordance with the “Duty of Care” introduced by the Act.
	Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives.	The European Parliament introduced a new Directive, 2008/98/EC, on waste and repealing certain Directives. The Directive lays down measures to protect the environment and human health by preventing or reducing the adverse impacts of the generation and management of waste and by reducing overall impacts of resource use and improving efficiency of such use.
	The Environment Protection (Duty of Care) Regulations 1991	Under these Regulations any person who imports, produces, carries, keeps, treats or disposes of Controlled Waste has a duty to take all reasonable steps to ensure that their waste is handled lawfully and safely. Special/Hazardous Waste is a sub-category of Controlled Waste (see also Special Waste Regulations and Hazardous Waste Regulations).
	The Controlled Waste (England and Wales) Regulations 2012	This legislation does not strictly apply offshore. However, because the offshore disposal of garbage is prohibited then all wastes must be transferred on shore for disposal. Once onshore, the wastes must meet the requirements of onshore legislation when being disposed of. These regulations must therefore be considered offshore to allow onshore requirements to be met, for example the identification and appropriate documentation of these wastes. These regulations define household, industrial and commercial waste for waste management licensing purposes.
	The Merchant Shipping (Implementation of Ship-Source Pollution Directive) Regulations 2009	These Regulations implement Directive 2005/35/EC of the European Parliament and of the Council of 7th September 2005 on ship-source pollution and on the introduction of penalties for infringements. The Directive aims to achieve better enforcement of the requirements of the International Convention for the Prevention of Pollution from Ships, 1973 (MARPOL 73), as modified by the Protocol of 1978 (MARPOL 73/78).

Regulator	Legislation	Summary of requirements
EA	The Merchant Shipping (Prevention of Pollution by Sewage and Garbage from Ships) Regulations 2008 as amended (2010)	These Regulations implement the requirements of MARPOL 73/78 Annex IV in the UK and apply to vessels including fixed or floating platforms which operate in the marine environment and came into force on 01 February 2009. They lay out the requirements for sewage system surveys and certification and the requirements of sewage systems with an exception for fixed installations at a distance of more than 12 nautical miles from the nearest land. They also identify the requirements for a garbage management plan, garbage record books and prohibit the disposal of various types of garbage into the marine environment and define enforcement action. The 2010 Amendments correct drafting errors.
	Hazardous Waste (England & Wales) Regulations as amended (2015)	Depending on its nature and composition waste may be defined as hazardous waste (in England and Wales) within the UK. Hazardous wastes are those that are potentially the most difficult and dangerous and are listed on the European Commission's List of Wastes. The Regulations contain strict rules for the storage, transport and disposal of hazardous wastes. For example, the regulations require all movement of hazardous waste to be tracked by way of a consignment note system.

Table A.11: Naturally Occurring Radioactive Material (NORM) contaminated waste (sand, sludge and scale) and radioactive waste

Regulator	Legislation	Summary of requirements
EA	Radioactive Substances Act 1993 The Environmental Permitting 2010 (England and Wales) Regulations as amended (2015)	Onshore and offshore storage and disposal of naturally occurring radioactive materials (NORM) is regulated under the Radioactive Substances Act. Operators are required to hold, for each relevant installation, an Authorisation to store and dispose of radioactive waste such as NORM scale which may be deposited in vessels and pipework. The authorisation specifies the route and methods of disposal. Records of disposal are required. The offshore use, storage and disposal of radioactive sources are regulated under the same legislation. A Registration Certificate is required to keep; transport and use sources and records must be kept. Additionally, different radionuclides have different activity thresholds over which the containing sources qualify as a High Activity Sealed Source (HASS). As of January 2008, and if applicable, HASS records must be reported to the EA and maintenance of an inventory is required. The Radioactive Substances Act 1993 has been superseded by the Environmental Permitting (England and Wales) Regulations 2010 (as amended in 2015) in England and Wales.

Table A.12: Environmental management systems

Regulator	Legislation	Summary of requirements
BEIS/ OSPAR	OSPAR Recommendation 2003/5 to Promote the Use and Implementation of Environmental Management Systems by the Offshore Industry	All Operators controlling the operation of offshore installations on the UKCS are required to have in place an independently verified Environmental Management System (EMS) designed to achieve: the environmental goals of the prevention and elimination of pollution from offshore sources and of the protection and conservation of the maritime area against other adverse effects of offshore activities and to demonstrate continual improvement in environmental performance. OSPAR recognises the ISO 14001: 2004 & EMS international standards as containing the necessary elements to fulfil these requirements. All operators are also required to provide a public statement of their environmental performance on an annual basis.

Table A.13: Licensing

Regulator	Legislation	Summary of requirements
BEIS	Petroleum Act 1998 as amended The Petroleum Licensing (Exploration and Production) (Seaward and Landward Areas) Regulations 2004 as amended (2006) The Petroleum Licensing (Production) (Seaward Areas) Regulations 2008	These Regulations consolidate with amendments the provisions of the Petroleum (Production) Regulations 1982 (as amended) in relation to (a) applications to the Secretary of State for petroleum production licences in respect of seaward areas and (b) applications to the Secretary of State for petroleum exploration licences in respect of seaward areas and landward areas below low water line. This Act vests all rights to the nation's petroleum resources to the Crown and provides the basis for granting licences to explore for and produce oil and gas. Production licences grant exclusive rights to the holders to “search and bore for and get petroleum” in specific blocks. Licences generally contain a number of environmental restrictions and conditions. Under the terms of a Licence, licence holders require the authorisation of the Secretary of State prior to conducting activities such as installing equipment or drilling of wells in the licence area. Consent to flare or vent hydrocarbons is also required from BEIS under the terms of the Model Clauses incorporated into Production Licences. Licence conditions will include environmental issues e.g. time constraints in sensitive areas. The model clauses of the licence require the licensee to appoint a fisheries liaison officer.
	Marine & Coastal Access Act 2009	The Marine & Coastal Access Act provides the legal mechanism to help ensure clean, healthy, safe, productive and biologically diverse oceans and seas by putting in place a new system for improved management and protection of the marine and coastal environment.

Table A.14: Ballast water

Regulator	Legislation	Summary of requirements
MCA	International Convention for the Control and Management of Ships' Ballast Water and Sediments (Ballast Water Management - BWM) – adopted 2004	Objective to prevent, minimise and ultimately eliminate the transfer of harmful aquatic organisms and pathogens though control and management of ships' ballast water and sediments. Helsinki and OSPAR Commissions General Guidance on the Voluntary Interim has set out an application of the D1 Ballast Water Exchange Standard. Under this regulation, all tankers > 150 GRT and all ships > 400 GRT in the UK are required to have in place UKOPP or IOPP Certificate and Ballast Water Exchange Management plan. It is required all vessels entering the North East Atlantic to exchange the ballast water at least 200 miles from the nearest land and at least 200 metres deep.

Table A.15: Transboundary impacts

Regulator	Legislation	Summary of requirements
BEIS	Convention on Environmental Impact Assessment in a Transboundary Context (Espoo, 1991)	The 1991 UNECE Convention on Environmental Impact Assessment in a Transboundary Context (the Espoo Convention) requires any country that has ratified the convention to consider the transboundary environmental effects of industrial projects and activities, including offshore hydrocarbon exploration and productions activities. The Convention requires that if the activity is found to cause a significant adverse transboundary impact then the party undertaking the activity shall, for the purpose of ensuring adequate and effective consultations, notify any potentially affected country as early as possible.

Table A.16: Location of structures

Regulator	Legislation	Summary of requirements
BEIS	Energy Act 2008 Part 4A	The provisions of the Coast Protection Act were transferred to the Energy Act 2008 Part 4A by the MCAA 2009 and Marine Scotland Act 2010 (MSA) to cover navigation considerations relating to exempted exploration or production/storage operations. Consent to locate provisions of the Energy Act Part4A came into force in April 2011. On 11th October 2012 DECC (now BEIS) launched its consultation on the Part 4A consenting provisions. Section 77 of the MCAA excludes the vast majority of offshore oil and gas operations and carbon dioxide storage operations controlled under The Petroleum Act 1998 (PA) or The Energy Act 2008 (EA). To maintain the Consent to Locate provisions for these excluded operations, Section 314 of the MCAA created a new Part 4A of the EA, transferring the provisions of Section 34 of the CPA to the EA and transferring regulatory competence from DfT to DECC (now BEIS). On 5th June 2013 DECC (now BEIS) published its response to consultation on the Part 4A consenting provisions. Full implementation of the Consent to Locate (CtL) regime under Part 4A of the EA commenced on Friday 7th June 2013.

Regulator	Legislation	Summary of requirements
BEIS	Continental Shelf Act 1964	This act extends the UK government's right to grant licences to explore and exploit the UKCS.
	The Continental Shelf (Designation of Areas) (Consolidation) Order 2000	This Order consolidates the various Orders made under the Continental Shelf Act 1964 which have designated the areas of the continental shelf within which the rights of the United Kingdom with respect to the sea bed and subsoil and their natural resources are exercisable
	Marine and Coastal Access Act 2009	The MCAA replaced and merged the requirements of FEPA Part II (deposits to the sea) and the Coast Protection Act 1949 (navigation). The licensing provisions of this Act entered into force in April 2011.

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APPENDIX B

MARINE GROWTH TECHNICAL NOTE

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A part of BMT in Energy and Environment

Technical Note - Marine Growth and Weight Assessments for SNS VDP2 and VDP3 Decommissioning Programmes

Reference: A.CON.106 – CTR 4
Client Reference: BMT-SNS-V-XX-X-HS-11-00002
Client: ConocoPhillips (U.K.) Limited
Date: July 2015
Confidential

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Contents

ABBREVIATIONS

Abbreviation	Meaning
ACT	Average Compressed Thickness
BMT Cordah	British Maritime Technology Cordah
ConocoPhillips	ConocoPhillips (U.K.) Limited
CP	Cathodic Protection
CTF	Compressed Thickness Factor
DP	Decommissioning Programme
ES	Environmental Statement
LAT	Lowest Astronomical Tide
LOGGS	Lincolnshire Offshore Gas Gathering System
MTD	Marine Technology Directorate Limited
ROV	Remotely Operated Vehicle
SNS	Southern North Sea
VDP1	Viking Decommissioning Programme 1
VDP2	Viking Decommissioning Programme 2
VDP3	Viking Decommissioning Programme 3
LDP1	LOGGS Decommissioning Programme 1
R2	The value R^2 is a fraction between 0.0 and 1.0, and has no units. An r2 value of 0.0 means that knowing X does not help you predict Y. There is no linear relationship between X and Y, and the best-fit line is a horizontal line going through the mean of all Y values. When R^2 equals 1.0, all points lie exactly on a straight line with no scatter. Knowing X lets you predict Y.

SUMMARY

This Technical Note provides quantitative estimates of the depth/ thickness profiles of marine growth on the:

a) Viking BD platform jacket which forms part of the four bridge-linked Viking Bravo Hub Complex (Viking BA, BC, BD and BP); and

b) Victor JD platform jacket, one of the three satellite platforms (Viking KD, Viking LD and Victor JD) which tie back to the Viking Bravo Hub Complex.

All of the structures are included within the southern North Sea (SNS) Viking Decommissioning Programmes 2 and 3 (VDP2 and VDP3).

The Technical Note estimates the wet weights in air of the attached marine growth within three depth zones for these two platforms, each delineated by the predominance of characteristic species, and provides a total estimated wet weight for each jacket.

The remaining VDP2 and VDP3 jackets have had a qualitative assessment of the marine growth and an estimate of the weight has been provided by depth zone. This has been done on a comparative basis between these jackets and the observations undertaken as part of the quantitative assessments for Viking BD and Victor JD and the previous marine growth assessments undertaken as part of the Viking Decommissioning Programme 1 (VDP1) and LOGGS Decommissioning Programme 1 (LDP1).

Table i summarises the results and **Figure i** shows the locations of the jackets.

Table i: Summary of the overall average compressed thickness and estimated weight of marine growth for the Viking Bravo Hub Complex and satellite platform jackets

Jacket	Surface Area (m^2)	Depth Zone (m)	Estimated weight of marine growth (tonnes)
Viking Bravo Hub Complex (included in VDP2)			
Viking BA	2297	-1 to -5	5.1
		-5 to -14	17.4
		-14 to -24	22.1
		Estimated total weight of marine growth	44.6
Viking BC	1924	-1 to -3	2.2
		-3 to -13	12.6
		-13 to -24	22.5
		Estimated total weight of marine growth	37.3
Viking BD	2059	-1 to -3	6.0
		-3 to -11	7.4
		-11 to -24	19.3
		Estimated total weight of marine growth	32.7
Viking BP	1986	-1 to -4	3.2
		-4 to -14	14.6
		-14 to -24	20.7
		Estimated total weight of marine growth	38.5
Victor Satellite Platform (included in VDP2)			
Victor JD	2438	-1 to -3	2.0
		-3 to -13	7.4
		-13 to -38	36.5
		Estimated total weight of marine growth	45.9
Viking Satellite Platforms (included in VDP3)			
Viking KD	666	-1 to -3	0.6
		-3 to -17	5.8
		-17 to -24	6.5
		Estimated total weight of marine growth	12.9
Viking LD	692	-1 to -2	0.3
		-2 to -12	4.2
		-12 to -20	9.0
		Estimated total weight of marine growth	13.5

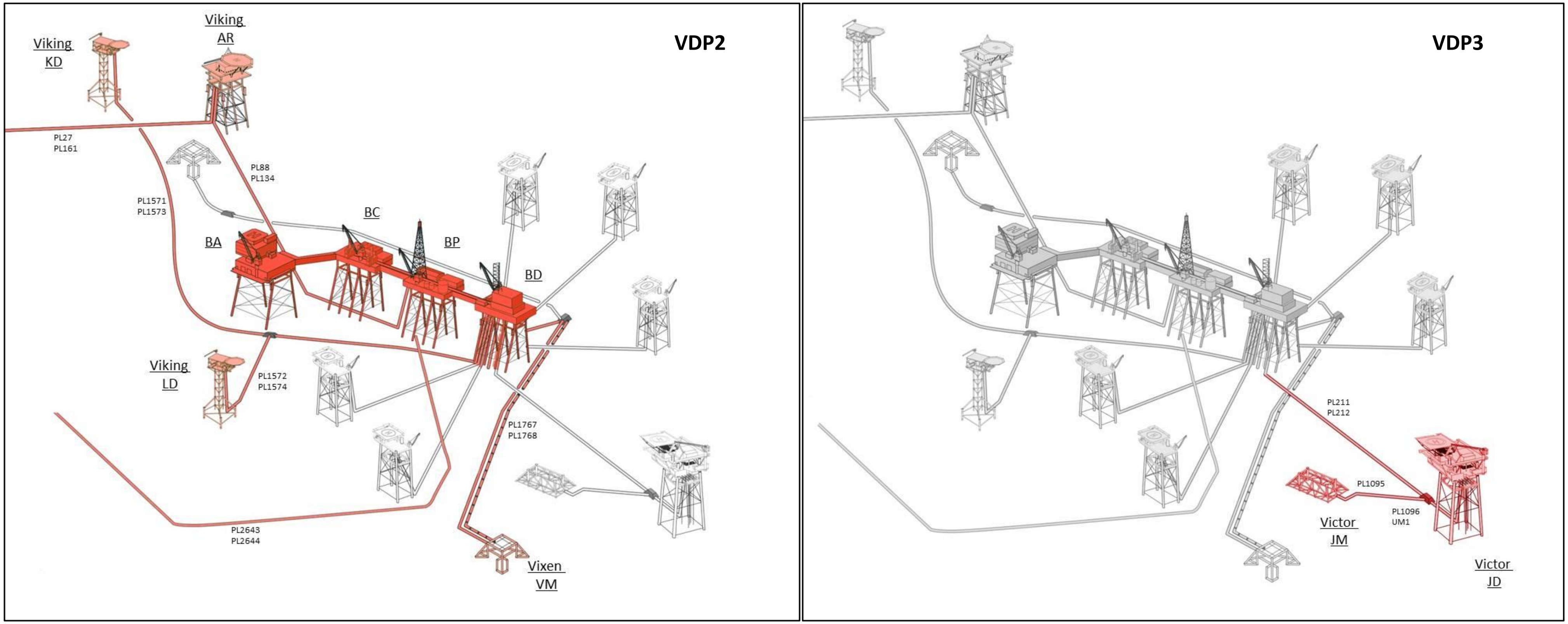

Figure i: VDP2 and VDP3 infrastructure to be decommissioned (highlighted in red).

1.0 INTRODUCTION

ConocoPhillips (U.K.) Limited (hereafter referred to as ConocoPhillips) commissioned BMT Cordah Limited (BMT Cordah) to carry out marine growth and weight assessments of seven jackets that are included within ConocoPhillips's SNS VDP2 and VDP3 work programmes. These jackets fall into three groups:

1. Viking BA, BC, BD and BP jackets which support the Viking Bravo Hub Complex, covered under VDP2;
2. Jackets of the two separate satellite platforms which tie back to the Viking Bravo Hub Complex: (Viking KD and Viking LD) also covered under VDP2; and
3. The jacket of the Victor JD satellite platform which also ties back to the Viking Bravo Hub Complex, covered under VDP3.

This Technical Note presents the methods, assumptions, limitations and results of the assessments.

2.0 BACKGROUND

In 2014, BMT Cordah conducted detailed marine growth and weight assessments on the jackets of nine installations from the LOGGS and Viking areas that lay within the scope of ConocoPhillips's SNS VDP1 and LDP1 (ConocoPhillips, 2014). Individual assessments were carried out on: Viking AR, CD, DD, ED, GD and HD; Vampire/ Valkyrie OD; Viscount VO; and Vulcan UR.

Results of these assessments can be summarised as:

- In general, the composition, depth zonation and cover of the fouling marine growth observed on the nine jackets were found to be similar. The Viking and LOGGS platforms were installed in the early 1970s to late 1990s, and exhibit characteristically well-established fouling communities.
- Hard growth consisted mainly of mussels which predominated in the upper- and mid-jacket depth zones (upper and mid zonal boundary typically occurring to a depth of around -15 m above Lowest Astronomical Tide (LAT).
- Soft growth consisted mainly of anemones, which predominated in the mid- and lower-jacket depth zones.
- The main contributors to the weight of marine growth were:
    - Mussels for the upper-jacket sections;
    - Mussels and anemones for the mid-jacket sections; and
    - Anemones for the lower-jacket sections.

Both the proximity of the jackets in the VDP2 and VDP3 to the nine VDP1 and LDP1 jackets previously assessed in detail in 2014, and the level of consistency in the fouling pattern within the 2014 VDP1 and LDP1 study provided a basis for the development of a more streamlined approach for the marine growth and weight assessments of the seven VDP2 and VDP3 jackets in the proposed programmes.

This modified approach, for which further detail is provided in **Section 5**, involved:

- Carrying out detailed assessments of marine growth on two of the seven jackets;
- Validation checks to ensure consistency in the composition and zonation of marine growth between the eleven jackets assessed in detail in the current and previous studies (two jackets from the current VDP2 and VDP3 study and nine from the 2014 VDP1 and LDP1 study) and the five jackets from the present study which were not selected for detailed investigation; and
- Using the results of current and previous detailed assessments to derive conservative estimates of the weights of marine growth on the five jackets which were not selected for detailed assessment.

3.0 SCOPE OF WORK

The scope of work was as follows:

1. Prepare detailed quantitative assessments of the:
    I. Percentage cover and thickness of the main fouling organisms, calculate the average thickness of hard and compressed soft growth, construct depth/ thickness profiles;
    II. Calculate the total surface area of submerged members for each of the determined depth zones;
    III. Provide weight per unit surface area of structural member; and
    IV. Total weight estimates for the attached marine growth.

Following discussions with ConocoPhillips, one of the four Viking Bravo Hub Complex jackets (Viking BD) and one of the three satellite jackets (Victor JD) were selected for detailed assessment.

2. Prepare a qualitative assessment of the remaining five VDP2 and VDP3 structures, validating and comparing the type and cover of marine growth with previous assessments undertaken in the Viking area, and applying a calculation which uses previously assessed values of the maximum weights of marine growth of per unit area of structural member to provide conservative estimates of the overall weight of marine growth on the jackets.
3. Following the quantitative and qualitative assessments, prepare a Technical Note for inclusion in the relevant Environmental Statement (ES) section and associated appendix.

4.0 METHODOLOGY

The marine growth and weight assessments for the seven VDP2 and VDP3 structures were conducted in three stages:

1. Quantitative assessments of fouling marine growth on two jackets.
2. Qualitative assessment of weight per unit area for the remaining five jackets.
3. Overall weight estimates for the remaining five jackets.

Each stage is described in further detail in the following sub-sections.

4.1 Detailed Quantitative Assessments of Marine Growth for Viking BD and Victor JD

In the current study, detailed quantitative marine growth assessments were made on one jacket selected to represent the Viking Bravo Hub Complex (BD) and one jacket selected to represent a satellite (Victor JD).

The method for quantitatively assessing the marine growth on these two platforms was derived from the methodology used to assess the nine VDP1 and LDP1 jackets (ConocoPhillips, 2014). The methodology applied the following process:

- A visual assessment of average thickness of hard and compressed soft growth;
- Calculation of the surface area of structural members within the specified depth zones; and
- An estimate of the volume and weight (in air) the marine growth within the specified depth zones and on the entire jacket.

Appendices 1 to 3 provide full details on the method, dimensions and calculations used in the process described above.

The percentage cover and thickness of the main types of space-occupying fouling organisms on VDP2 and VDP3 structural members were determined using digital video clips taken during structural inspections offshore. ConocoPhillips provided all of the survey material and ‘as built’ scale drawings. Both sources were used in the assessments undertaken in this Technical Note.

The space-occupying organisms considered in the quantitative assessment were: seaweeds, anemones, hydroids, soft corals, encrusting sponges and mussels. Other types of marine growth were not included as their lower abundance or smaller volume would not significantly add to the marine growth weight on the structure.

Anomalies, such as areas of bare member, were also noted but not factored into the comparisons made between jackets. It was assumed that representative types of marine growth could potentially recolonize and build up on bare areas prior to decommissioning.

4.2 Qualitative Assessment of Weights Per Unit Area for Viking BA, BC, BP, KD and LD

Within the methodology there was a requirement to provide a rational for deriving estimates of the marine growth weights per unit area to the five jackets not selected for detailed quantitative assessment (Viking BA, BC, BP, KD and LD).

Visual spot checks were undertaken on the digital video clips from surveys of the remaining five jackets. This provided confirmation on whether the composition, depth zonation and cover by the conspicuous space-occupying types of marine growth were comparable to the detailed quantitative assessments for the Viking BD and Victor JD jackets (**Section 4.1**) and the nine VDP1 and LDP1 jackets assessed for marine growth (ConocoPhillips, 2014).

4.3 Overall Weight Estimates for Viking BA, BC, BP, KD and LD

A predictive model was made using data collected from the quantitative assessment results obtained from Viking BD, Victor JD and the platforms from VDP1 and LDP1 (**Table 6.3**). Values for each of the depth zones for each platform were analysed to determine the regression equation to input into a model that could be applied to the Viking BA, BC, BP, KD and LD platforms. This calculates an estimate of the predicted weight of marine growth per platform. Three distinct model options were tested to establish the equation which would produce the most credible results (**Section 6.3**).

The selected option encompasses all three depth zones for each platform into one equation. The model was applied to each of the five platforms (Viking BA, BC, BP, KD and LD) to estimate the weight of marine growth (in air). Each estimate was calculated by multiplying the platforms surface area for each depth zone by 0.0194. The overall weight of marine growth on each jacket was calculated from the sum of the model outputs for all three depth zones (**Section 6.3** and **Table 6.5**).

5.0 ASSUMPTIONS AND LIMITATIONS

The assumptions and limitations for the marine growth and weight assessments of the jackets of the VDP2 and VDP3 platforms include:

1. The assessment of marine growth on the Viking BD and Victor JD jackets followed the standard method specified by the Marine Technology Directorate Limited (MTD), 1992. This methodology rationalises the data of marine fouling organisms gathered on the complex assemblages at pre-determined survey points in order to provide average thickness values for hard and compressed soft growth. This method is routinely used for marine growth assessments on offshore structures. Inherent limitations do exist and predominately relate to the quality of the video clips taken and the representativeness (i.e. structural cover) of the surveys conducted offshore.
2. In order to overcome such limitations, BMT Cordah carried out checks to ensure that the data gathered was representative of wider areas of the jacket within the depth zone. Footage that was considered to be of inadequate quality was screened out.
3. The video clips provided by ConocoPhillips were primarily for Cathodic Protection (CP) inspection purposes and covered the full depth range for the jackets. BMT Cordah carried out the marine growth assessment on the basis of a selection of video clips considered to be representative. These included footage from surveys undertaken in 2012, 2013 and 2014.
4. The absence of a marine growth measurement probe and infrequent contact points made during inspection surveys could potentially reduce accuracy in the assessment of average thickness of marine growth organisms.
5. No assessment of the marine growth was made on any of the jackets above -1 m LAT. This was due to remotely operated vehicle (ROV) access restrictions, reduced visibility and high wave action.
6. Calculations of the marine growth weight on the Viking BD and Victor JD jackets were carried out using a method routinely applied to offshore structures for marine growth assessments. The calculations are intended to provide estimates of the weights of marine growth in air when the jackets are initially lifted. It should be noted that this calculation has limitations because of inherent difficulties in determining the exact volumes and weights of marine growth which would allow for the retention or loss of body fluids and seawater or sediments present in spaces between organisms, and allowing for organism losses during the initial lift. These points should be considered when using the estimates of weight in air.
7. The weight estimates made for all of the VDP2 and VDP3 jackets, as presented in this Technical Note, were based on member dimensions from engineering drawings provided by ConocoPhillips (**Appendix 3**).
8. Marine growth on internal structures within the jackets, such as risers and j-tubes, has not been assessed.
9. The qualitative weight estimates made for Viking BA, BC, BP, KD and LD were based on assumed conservative values for the weight of marine growth per unit area of each submerged member. BMT Cordah consider that these values represent the majority of fouling scenarios.

10. The values provided in this document are intended to represent the wet weight in air of marine growth attached to the jacket when it is initially lifted from the sea. There are, however, notable differences between weight estimates made on jackets *in situ* and actual weights recorded in waste returns by the decommissioning yards. By the time the marine growth is removed at the decommissioning yards, the recorded marine growth weight as waste can typically be less than 10% of the original estimate (Oil and Gas UK, 2013). These differences result from desiccation (water loss as organisms dry out) and material loss of (marine growth falling off) during lifting operations, transit to the decommissioning yard and onshore handling prior to weighing.
11. Subsea infrastructure was not included in this assessment. It is likely that these structures would not add significant weight to the overall marine growth value. Since the marine growth at these depths would primarily be dominated by soft bodied organisms, as is typical of the lower regions of the jacket structures assessed.

6.0 RESULTS

The following sections provide the results of the marine growth assessment for VDP2 and VDP3:

- Detailed quantitative assessments for Viking BD and Victor JD (**Section 6.1**);
- Comparison between Viking BD, Victor JD and the VDP1/ LDP1 assessments (**Section 6.2**)
- Methodology for the qualitative assessment of weights per unit area for Viking BA, BC, BP, KD and LD (**Section 6.3**)
    - Validation checks for Viking BA, BC, BP, KD and LD (**Section 6.3.1**)
    - Qualitative assessment of weight estimates for the Viking BA, BC, BP, KD and LD jackets (**Section 6.3.2**)

6.1 Detailed Quantitative Assessments for Viking BD and Victor JD

The main findings of the marine growth assessments conducted on the Viking BD and Victor JD jackets are presented in **Table 6.1**. This table outlines the characteristics of the predominant types of marine growth in addition to the organisms mentioned in **Section 2**, which lie broadly within three depths zones:

- A shallow-water, upper zone where mussels, seaweeds and hydroids were prevalent;
- A mid-water, transitional zone comprising of a mosaic of hydroids, anemones and mussels; and
- A deeper-water, lower zone where anemones formed a blanket cover over the majority of members. Marine growth became much sparser (comprising mainly hydroids) within a few metres of the seabed.

The numerical output from the calculations carried out on the raw data obtained during the assessments of the two jackets is provided in **Table 6.2**. These results were principally used to:

- Graph the depth/ thickness profiles for marine growth on each jacket (**Figure 6.1**);
- Illustrate the distributions (percentage covers) of the dominant types of marine growth within the three depth zones (**Figure 6.1**);
- Provide estimates of the weight per unit area of marine growth in each of the three depth zones; and
- Provide estimates of the total weight (in air) of marine growth on each jacket. These are 32.7 tonnes for Viking BD and 45.9 tonnes for Victor JD.

Table 6.1: Predominant types of marine growth on the Viking BD and Victor JD jackets.

Jacket	Depth zone	Types of Marine Growth (in order of dominance)	Observations
Viking BD (Hub Complex)	-1 to -4	**Mussels**: Patchy distribution, one to two animals thick. Cover*: 71% average; 100% maximum. **Hydroids**: Thin blanket cover growing directly on members and on top of other organisms. Cover: 60% average; 90% maximum. **Seaweeds**: Sparse distribution, mainly leaf-like and filamentous types. Cover*: 11% average; 40% maximum.	Many patches of bare member, varying from small and isolated to large areas, where marine growth was most likely to have been dislodged.
	-4 to -12	**Hydroids**: Thin blanket cover growing directly on members and on top of other organisms. Cover*: 47% average; 90% maximum. **Anemones**: Discontinuous distribution comprising discrete areas of blanket cover. Cover*: 41% average; 100% maximum. **Mussels**: Sparsely distributed patches of mussels, one layer thick. Cover*: 16% average; 50% maximum.	Patches of bare member observed, but not as extensive as previous depth zone
	-12 to -24	**Anemones**: Blanket cover over the majority of surfaces. Cover*: 85% average; 100% maximum. **Hydroids**: Thin blanket cover interspersed between anemones. Cover*: 14% average; 80% maximum.	Blanket cover of marine growth prevalent until the last two or three metres above the seabed. Growth here is likely to be limited by suspended sediments resulting from seabed mobility.
Victor JD (Satellite)	-1 to -3	**Hydroids**: Thin blanket cover growing directly on members and on top of other organisms. Cover*: 38% average; 60% maximum. **Mussels**: Patchy distribution, one to two animals thick. Cover*: 36% average; 90% maximum. **Seaweeds**: Sparse distribution, mainly leaf-like and filamentous types. Cover: 8% average; 20% maximum.	Many patches of bare member where marine growth was most likely to have been dislodged.
	-3 to -13	**Hydroids**: Thin blanket cover growing directly on members and on top of other organisms. Cover*: 58% average; 90% maximum. **Anemones**: Discontinuous distribution comprising discrete areas of blanket cover. Cover*: 37% average; 100% maximum. **Mussels**: Sparsely distributed patches of mussels, one layer thick. Cover*: 16% average; 70% maximum.	Patches of bare member observed, but not as many as previous depth zone
	-13 to -38	**Anemones**: Blanket cover over the majority of surfaces. Cover*: 82% average; 100% maximum. **Hydroids**: Thin blanket cover interspersed between anemones. Cover*: 19% average; 90% maximum.	Blanket cover of marine growth prevalent until the last two or three metres above the seabed. Growth here is likely to be limited by suspended sediments resulting from seabed mobility.

*Average = Percentage cover averaged over all of the locations from which data was gathered from structural members within the stated depth range. Maximum = maximum percentage cover from any single location.

Table 6.2: Results of the detailed quantitative assessments of marine growth on the Viking BD and the Victor JD jackets. Note that the figures shown represent overall averages for all sites assessed within the stated depth zones.

Jacket	Depth zone	Soft growth cover & thickness								Hard growth cover & thickness				Average thickness		Weight of marine growth		
		Seaweeds		Anemones		Hydroids		Soft corals		Encrusting Sponges		Mussels		Hard growth	Compressed soft growth	Weight per unit area	Surface area	Total weight
	(m)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(mm)	(mm)	(tonne/m²)	(m²)	(tonne)
Viking BD (Hub Complex)	-1 to -3	11	385	1	6	60	22	0	0	0	0	71	47	33	6	0.055	108	6
	-3 to -11	0	0	41	30	47	23	0	0	2	2	16	25	6	7	0.012	634	7
	-11 to -24	0	0	85	52	14	4	0	1	3	2	2	6	1	15	0.015	1294	19
	Overall Total																*2036*	***32***
Victor JD (Satellite)	-1 to -3	8	215	0	3	38	8	0	0	0	0	36	52	22	3	0.030	66	2
	-3 to -13	0	0	39	44	58	23	0	0	2	1	15	33	8	10	0.011	698	7
	-13 to -38	0	0	84	78	17	7	0	0	1	0	3	9	1	23	0.022	1675	36
	Overall Total																*2439*	***45***

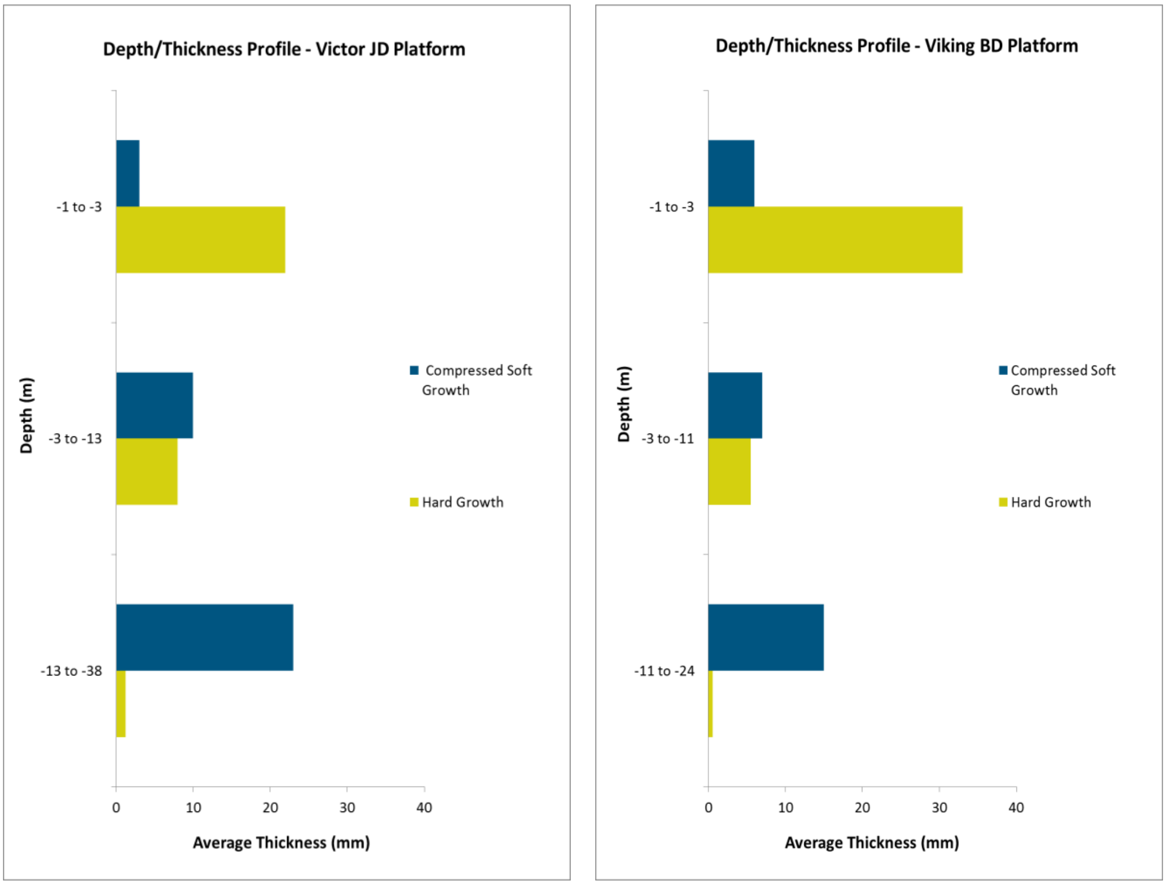

Figure 6.1: Diagram representation of marine growth depth/ thickness for the Victor JD and Viking BD platforms studied.

The distribution of hard and compressed soft marine growth on the Viking BD and Victor JD platforms show a similar pattern (**Figure 6.1**). However, the actual values for both thickness and percentage cover differ between the structures (**Table 6.2**), due to factors such as age, location and shape of jacket.

6.2 Comparison between the Viking BD, Victor JD and the VDP1/ LDP1 Assessments

Key results from the detailed marine growth assessments of the Viking BD jacket, Victor JD jacket and the VDP1and LDP1 jackets assessed in 2014 were collated in order to determine if there is a reasonable degree of parity between the two sets of data. An examination of **Table 6.3** confirms that both the depth zonation 'boundaries' for the predominant organisms, and the percentage cover and thicknesses values of marine growth on the Viking BD and Victor JD jackets lie within the range of parameters recorded during the VDP1 and LDP1 assessments. This composition and zonation pattern is typical of that seen on steel jackets of oil and gas platforms at similar depths and location in the North Sea (Oil and Gas UK, 2013).

The similarity of the estimated weights of marine growth per unit area for the three depth zones on the Viking BD and Victor JD jackets with those values obtained during the VDP1 and LDP1 assessments is also apparent from **Table 6.3**.

Table 6.3: Results collated from the detailed marine growth assessments of the Viking BD jacket, Victor JD jacket (both shown in italics) and the nine jackets covered under VDP1 and LDP1

Depth zone	Jacket	Depth range (m)	Overall average percentage cover within depth zone						Weight of marine growth in air (tonne)	Surface area (m^2)	Weight in air per unit area ($tonne/m^2$)
			Seaweeds	Anemones	Hydroids	Soft corals	Encrusting sponges	Mussels			
Upper-Water	Viking AR	-1 to -6	13%	5%	71%	0%	0%	70%	10.1	227	0.045
	Viking CD	-1 to -4	5%	0%	66%	0%	0%	33%	3.7	334	0.011
	Viking DD	-1 to -3	40%	1%	63%	0%	0%	11%	0.6	96	0.006
	Viking ED	-1 to -2	27%	1%	75%	0%	0%	52%	2.3	66	0.035
	Viking GD	-1 to -3	18%	3%	82%	0%	0%	55%	3.5	97	0.036
	Viking HD	-1 to -2	6%	0%	75%	0%	0%	64%	3.8	77	0.050
	Vampire/ Valkyrie OD	-1 to -4	32%	8%	33%	0%	0%	36%	1.2	64	0.019
	Viscount VO	-1 to -3	7%	4%	28%	0%	0%	80%	2.3	38	0.061
	Vulcan UR	-1 to -5	19%	9%	24%	1%	6%	32%	4.6	222	0.021
	Victor JD	*-1 to -3*	*8%*	*0%*	*38%*	*0%*	*0%*	*36%*	*2.0*	*66*	*0.030*
	Viking Hub Complex BD	*-1 to -3*	*11%*	*1%*	*60%*	*0%*	*0%*	*71%*	*6.0*	*108*	*0.055*
Mid-Water	Viking AR	-6 to -20	0%	38%	53%	0%	0%	60%	28.4	690	0.041
	Viking CD	-4 to -12	0%	26%	59%	0%	0%	4%	6.5	1266	0.005
	Viking DD	-4 to -19	0%	40%	54%	0%	0%	13%	6.7	589	0.011
	Viking ED	-3 to -17	0%	41%	46%	0%	1%	21%	8.5	527	0.016
	Viking GD	-4 to -18	0%	55%	50%	0%	1%	21%	11.8	676	0.018
	Viking HD	-3 to -18	0%	38%	56%	0%	0%	34%	12.1	618	0.020
	Vampire/ Valkyrie OD	-5 to -16	0%	24%	32%	1%	0%	30%	6.7	374	0.018
	Viscount VO	-4 to -19	0%	18%	61%	0%	0%	29%	5.7	369	0.015
	Vulcan UR	-6 to -13	0%	60%	26%	0%	8%	27%	25.0	986	0.025
	Victor JD	*-3 to -13*	*0%*	*37%*	*58%*	*0%*	*3%*	*16%*	*7.4*	*698*	*0.011*
	Viking Hub Complex BD	*-3 to -11*	*0%*	*41%*	*47%*	*0%*	*2%*	*16%*	*7.4*	*634*	*0.012*
Lower-Water	Viking AR	-20 to -26	0%	75%	26%	0%	0%	0%	8.4	549	0.015
	Viking CD	-12 to -25	0%	86%	4%	0%	0%	0%	40.3	2029	0.020
	Viking DD	-20 to -29	0%	90%	21%	0%	0%	0%	18.8	888	0.021
	Viking ED	-18 to -30	0%	78%	25%	0%	4%	0%	15.3	956	0.016
	Viking GD	-19 to -25	0%	74%	40%	0%	0%	0%	5.3	419	0.013
	Viking HD	-19 to -34	0%	85%	27%	0%	3%	0%	15.9	1133	0.014
	Vampire/ Valkyrie OD	-17 to -27	0%	78%	5%	0%	0%	16%	23.6	1330	0.018
	Viscount VO	-20 to -31	0%	88%	16%	0%	0%	1%	50.4	2148	0.023
	Vulcan UR	-14 to -34	0%	85%	8%	0%	1%	0%	42.3	1878	0.023
	Victor JD	*-13 to -38*	*0%*	*82%*	*19%*	*0%*	*1%*	*3%*	*36.5*	*1675*	*0.022*
	Viking Hub Complex BD	*-11 to -24*	*0%*	*85%*	*14%*	*0%*	*3%*	*2%*	*19.3*	*1294*	*0.015*

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6.3 Methodology for the Qualitative Assessment of Weights Per Unit Area for Viking BA, BC, BP, KD and LD

This section provides the rationale and method selected for deriving the qualitative estimates of the weights of marine growth per unit area that could be applied to the five jackets which were not selected for the quantitative assessment.

Data obtained from the quantitative assessments of the eleven jackets (**Table 6.3**) were used as the basis for creating a predictive model to estimate the marine growth weight for Viking BA, BC, BP, KD and LD. Several approaches were assessed for their suitability in predicting the marine growth on these platforms. The methods considered were the mean, highest values, and the mean plus standard deviations of the weights per unit area within the three submerged depth zones, based on the data from observations of the previous SNS assessments. These were tested against the previously assessed platforms and the predicted values of marine growth were found to be considerably higher than the observed estimations, as a result these methods were disregarded and a regression model approach was developed.

Three regression analyses were tested in order to generate the ‘best fit’ predictive model which was then used on the platforms selected for qualitative assessment. These were as follows:

- Separate model for each depth zone;
- One model that encompassed all depth zones, treating each depth zone as a different sample; and
- One model combining all depth zones and treating each platform as a different sample

The R^2 values were used to determine how closely aligned the data were to a fitted regression line. R^2 is the percentage of the variation that is explained by the model; in this case the percentage of variability in marine growth weight that can be attributed to the surface area. A higher R^2 value indicates the model has a ‘better fit’ to the data from the quantitative assessments. This model can then be used to predict the weight of marine growth for additional platforms if the surface area is known.

The strongest correlation found was between surface area and weight for the Lower Water depth zone (R^2=0.93). This is likely because marine growth in the Lower Water zone is typically more consistent in comparison to the Mid and Upper Water zones where there can be a greater degree of variability with species composition and damage from wave and tidal action. Since separating out the depth zones to calculate different equations would not provide reliable results for the Mid and Upper zones, this method was not applied.

When all depth zones were incorporated into one analysis, a linear model results in an R^2 of 0.8227, meaning 82.3% of the variation can be attributed to surface area (**Figure 6.2**). This was selected as the best option as it can be applied to all depth zones while still returning credible results. The model used for the weight calculations is therefore as follows: **Weight (tonnes) = 0.0194 x Surface Area.**

This equation estimates that for every 100 m^2 increase in surface area, there will be an estimated increase of approximately 2 tonnes of marine growth on the structure.

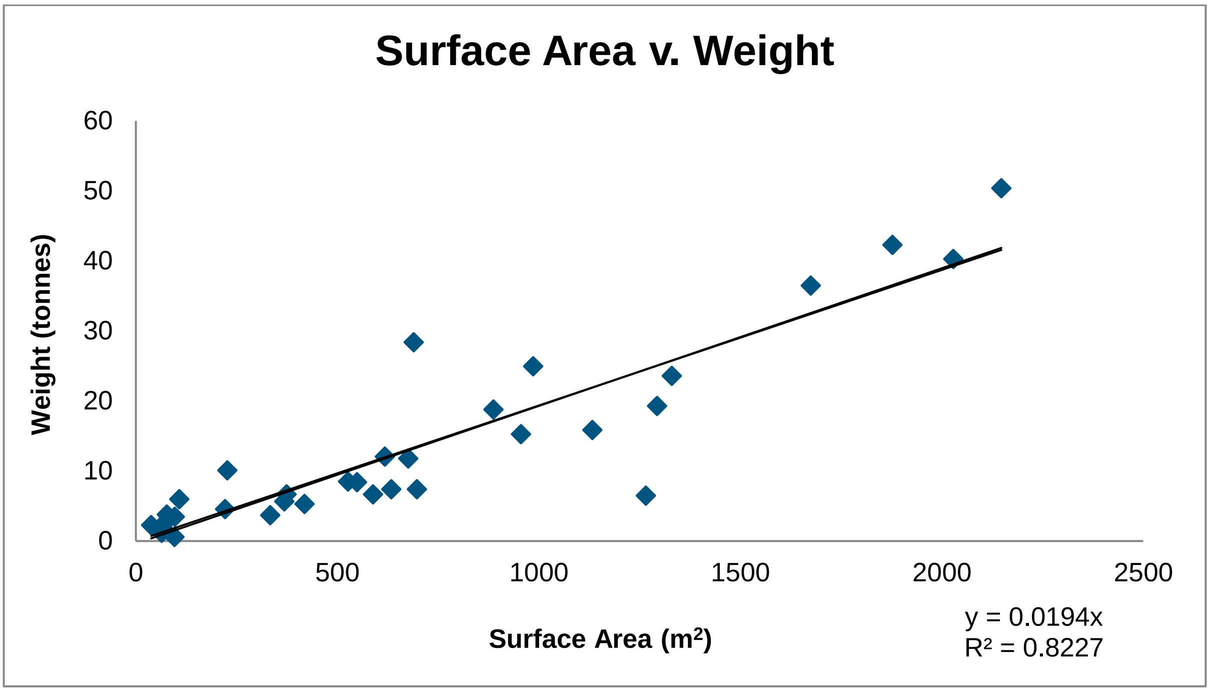

Figure 6.2: Graphical representation of data used to calculate linear model for estimate of the weight of marine growth on VDP2 platforms.

The model was applied to surface area data for the VDP2 infrastructure to create estimates of the marine growth weight for each platform. These results can be found in **Table 6.5**.

The regression equation was used to estimate the marine growth for the previously assessed jackets to validate the model. These comparisons indicated that the model was returning credible estimates of marine growth.

6.3.1 Validation Checks for Viking BA, BC, BP, KD and LD

Validation checks were carried out on a selection of video clips from the Viking BA, BC, BP, KD and LD jackets to establish if the depth zonation and composition (percentage cover) of the marine growth was similar to that assessed on the Viking BD, Victor JD and the VDP1and LDP1 jackets.

The results of the validation checks are provided in **Table 6.4**, confirming that the patterns of marine growth observed on the Viking BA, BC, BP, KD and LD jackets are similar to those recorded on the eleven previously-surveyed jackets (**Section 6.2**; **Table 6.3**).

Table 6.4: Results of validation checks to establish the depth zonation and percentage cover of marine growth on the Viking BA, BC, BP, KD and LD jackets

Jacket	Depth zone (m)	Soft growth percentage cover						Hard growth percentage cover			
		Seaweeds		Anemones		Hydroids		Encrusting sponges		Mussels	
		Average	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average	Maximum
Viking BA	-1 to -5	14%	30%	0%	0%	48%	70%	0%	0%	64%	100%
	-5 to -14	0%	0%	15%	30%	70%	100%	11%	40%	31%	70%
	-14 to -24	0%	0%	71%	100%	20%	60%	10%	30%	2%	10%
Viking BC	-1 to -3	8%	15%	2%	5%	65%	70%	0%	0%	80%	100%
	-3 to -13	0%	0%	40%	80%	64%	90%	6%	20%	18%	70%
	-13 to -24	0%	0%	93%	100%	6%	15%	5%	15%	0%	0%
Viking BP	-1 to -4	26%	50%	6%	15%	53%	70%	0%	0%	87%	100%
	-4 to -14	0%	0%	68%	90%	24%	70%	4%	20%	8%	15%
	-14 to -24	0%	0%	85%	100%	16%	50%	8%	15%	0%	0%
Viking KD	-1 to -3	8%	15%	1%	2%	66%	70%	0%	0%	90%	100%
	-3 to -17	0%	0%	14%	70%	44%	70%	13%	70%	45%	80%
	-17 to -24	0%	0%	81%	90%	11%	20%	14%	30%	3%	15%
Viking LD	-1 to -2	5%	10%	5%	10%	70%	70%	0%	0%	90%	100%
	-2 to -12	0%	0%	22%	70%	25%	50%	13%	60%	8%	40%
	-12 to -20	0%	0%	94%	100%	6%	40%	3%	10%	3%	15%

6.3.2 Weight Estimates for the Viking BA, BC, BP, KD and LD Jackets

As stated in **Section 6.3**, the estimates of the weights (in air) of marine growth on the jackets which were not subject to a quantitative assessment were obtained by multiplying the surface area of the platforms by a regression model equation per depth zone and summing the total outputs for each depth zone for the jacket.. The estimated values are provided in **Table 6.5**.

Table 6.5: Estimated marine growth weights for the Viking BA, BC, BP, KD and LD jackets

Jacket	Depth zone (m)	Surface area (m^2)	Estimated weight of marine growth (tonnes)
Viking BA	-1 to -5	263	5.1
	-5 to -14	895	17.4
	-14 to -24	1139	22.1
	Total	**2297**	44.6
Viking BC	-1 to -3	113	2.2
	-3 to -13	650	12.6
	-13 to -24	1161	22.5
	Total	**1924**	37.3
Viking BP	-1 to -4	163	3.2
	-4 to -14	755	14.6
	-14 to -24	1068	20.7
	Total	**1986**	38.5
Viking KD	-1 to -3	32	0.6
	-3 to -17	299	5.8
	-17 to -24	335	6.5
	Total	**666**	12.9
Viking LD	-1 to -2	15	0.3
	-2 to -12	215	4.2
	-12 to -20	462	9.0
	Total	**692**	13.5

7.0 REFERENCES

BMT Cordah. 2003. Assessment of the weight of marine growth on the NW Hutton platform. A report for the NW Hutton Decommissioning project, BP.

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MARINE GROWTH TECHNICAL NOTE:
APPENDIX 1
2014 STUDY METHODOLOGY

APPENDIX 1: 2014 STUDY METHODOLOGY

The methodology used in the previous 2014 Study (ConocoPhillips, 2014) has been re-applied during the detailed quantitative marine growth and weight assessments for the Viking BD and Victor JD jackets. These jackets were surveyed during CP inspections by ConocoPhillips's subsea inspection contractor at varying years in 2012 and 2013 respectively.

1.1 ROV Survey

Each CP survey used a Remotely Operated Vehicle (ROV) fitted with a digital video camera and a CP measurement instrument ('CP probe'). Archived digital video clips from these CP surveys were re-examined to obtain the raw data which was used for the current assessment of marine growth on the two jackets of interest.

Appendix 2 lists the locations of members surveyed, and provides the raw marine growth data from the assessment. The assessments for each jacket were based on the video clips from the single survey year that provided the most comprehensive coverage of structural members throughout the depth range.

The survey material was selected after preliminary examination of all the video clips from the CP surveys. In most cases, video clips from a single survey covered the structural members on the jacket. CP surveys undertaken in the other years focused on the conductors, which would typically be removed separately from their guide frames during decommissioning as part of the well plug and abandonment programme, and as such are not considered part of the jacket structure.

1.2 Raw Data

The method used to obtain the data on marine growth for the video clips taken during the CP surveys follows that given in the MTD (1992) (MTD, 1992). Data was extracted from the video clips after the ROV had steadied its position in view of the member.

1.2.1 Percentage Cover Estimates

Visual estimates of percentage cover were made for each of the main hard-bodied ('hard growth') and soft-bodied ('soft growth') types of marine organisms observed at the specific locations on structural members at different surveyed depths.

1.2.2 Size Estimates:

Estimates of the sizes (i.e. thicknesses or heights perpendicular to the member's surface, in mm) of representative (average sized) organisms were made for each of the observed types of attached hard growth and soft growth. Size estimates were made at:

- Designated survey locations where the ROV's CP probe made direct contact with or was in proximity to the member's surface during CP readings. Size estimates were made against a banded scale (50 mm tape increments) on the CP probe, where possible. Efforts were made to estimate thickness when the CP probe was perpendicular to the member.
- At other locations where the ROV did not take CP readings directly from the member's surface or when in close proximity to it, but where the marine growth was clearly visible, size estimates were based on an experienced biologist's knowledge of the morphology of different types of observed marine growth. Comparison was also made with data gathered from CP probe contacts. As contacts between the CP probe

and structural member were infrequent, the majority of marine growth size estimates were based on the marine biologist's judgement.

1.2.3 Checks on Representativeness

Where available, stand-off ROV footage was used to provide a wider perspective on the general composition, distribution and depth zonation of the marine growth. This stand-off footage was used to ensure that the data gathered at varying depths was representative and to enable anomalies to be discounted from the data set.

If data from the close-up footage was not considered representative, then the percentage cover estimate was adjusted to reflect the distribution in the stand-off footage.

Anomalies (unusual features) were mainly considered to be the results of localised structural cleaning for inspection purposes. However, sparsely fouled members were observed on video clips, mainly from within the mussel-dominated zone. In particular, areas of exposed member, where there was little or no marine growth, were observed on all nine jackets, particularly on the upper-jacket sections towards the 'splash zone'. These locations were discounted from the data set because it is likely that mussels, which previously fouled these members, could recolonize these bare areas prior to decommissioning, during the cycle of decline, recruitment and growth that typically occurs in mussel beds.

1.2.4. Data Recording

Raw data from the assessments of video clips from surveys of the individual jackets were recorded by structure, depth, and member on an MS Excel matrix which was then used in the calculations that follow.

1.3 Calculations

The following calculations were based on the methodology given in the MTD (1992) (MTD, 1992)

1.3.1 Average Thickness of Marine Growth Layer

The calculation of the average thickness of the marine growth layer provides an averaging process which distributes various components of the hard and soft growth evenly over 100% of the member's surface. Both fouled and bare areas of member are taken into account in the calculation:

$$\textbf{Average Thickness} = \sum \frac{\textbf{(\% cover x average thickness) for all groups}}{\textbf{100}}$$

Note: Average thickness values for soft and hard growth are calculated separately then totalled to give an overall average. Average thickness is expressed in mm.

1.3.2 Compressed Thickness of Soft Growth Layer

The calculation of average thickness shown in **Section 5.3.1** makes no allowance for the fact that most soft fouling organisms will flex, bend or change shape to varying degrees in response to hydrodynamic currents. The upright, extended length or size of a soft organism may therefore bear little relation to the actual thickness of soft growth lying over the steel or concrete surface of a structure when the growth is flattened by currents or wave action.

A determination of the average thickness of the fouling layer when flexible growth is bent or flattened has been undertaken by incorporating an additional parameter, the Compressed Thickness Factor (CTF) shown in **Table 1.1**, into the calculation for processing raw marine growth data (MTD, 1992).

Thus, the Average Compressed Thickness (ACT) can be calculated as follows:

$$\textbf{ACT} = \frac{\sum \textbf{(\% cover x average size x CTF) for all groups}}{\textbf{100}}$$

Where CTF is the Compressed Thickness Factor and ACT (Average Compressed Thickness) is expressed in mm.

Table 1.1: Compressed thickness factors for soft growth MTD (1992)

Organism	CTF
Kelps and Seaweeds	0.08
Soft corals	0.67
Anemones	0.33
Hydroids	0.15
All Types of Hard Growth	1.00

The CTFs shown in **Table 1.1** are intended to represent the responses of different types of soft growth to relatively strong waves and currents. By definition, hard growth is rigid and does not bend or compress, and therefore has a CTF of 1.0. Mussels and tubeworms, for example, are hard fouling organisms.

Although other CTF values can be used, those used in **Table 1.1** represent compression under more moderate waves and currents, opting to use the CTFs shown in the **Table 1.1** will enable more representative estimates to be made in the calculations that follow of the volume and weight in air of the tissue and skeletal constituents of the attached marine growth.

1.3.3 Calculation of Surface Area

For volume and weight to be accurately calculated the surface area of the submerged jacket structure must also be calculated. To do this, the as-built engineering drawings for each of the nine jackets were reviewed and the relevant data on the member dimensions extracted.

For the purposes of this project only the structural members of the jacket from -1 m elevation to the seabed were reviewed. Conductors were omitted as they will not factor in the jacket lift.

The conductor guide frames on the jackets comprise a lattice of many small diameter members for which the dimensional data were not available. To account for the surface area of the conductor guide frames, an assumption was made that each frame could be treated as a single solid sheet of steel of known external dimensions. The decision to adopt this simplification was taken following consultation with ConocoPhillips's engineers.

Each structural member on the as-built drawing for the jacket was recorded. Information on the start point elevation and the end point elevation for each structural member was recorded. The diameter of the structural member was recorded along with its length.

The surface area for each member was calculated as follows:

Surface Area $= \emptyset \times \boldsymbol{L} \times \boldsymbol{\pi}$

Where $\emptyset$ = diameter (m); $\boldsymbol{L}$ = Length (m); $\boldsymbol{\pi}$ = 3.416

The structural members were then grouped into the marine growth depth zones based on observations for that jacket and summed to give a total surface area for that depth zone.

The raw surface area data recording sheets grouped by depth zone for each jacket can be found in **Appendix 2**.

1.3.4 Calculation of Volume and Weight of Marine Growth

To provide an estimate of weight for each organism, a density relevant to that particular organism must be applied to the estimated volume.

The majority of soft fouling organisms do not have a rigid external skeleton and are comprise mostly of water. Therefore these organisms have a density at or close to 1.0 tonne/m^3. Hard fouling organisms, however, have a skeleton made of silica or calcium and therefore have a density >1.0 tonne/m^3. The actual density is determined by the proportion of hard material in their body. The weight of marine growth for each depth zone was calculated using the organism-specific density shown in **Table 1.2** (BMT Cordah, 2003).

The values of the density are best estimates from lab measurements on preserved specimens and from a consideration of the structure and morphology of the species or types of marine growth. With the exception of mussels (MTD, 1992), none of the values have been validated by actual physical measurements of the species collected from offshore structures (BMT Cordah, 2003).

Table 1.2 Density of marine fouling organisms

Organism Type	Density tonne/m^3
Seaweeds (all species)	1.0
Hydroids (all species)	1.0
Soft corals (*Alcyonium digitatum*)	1.0
Anemones (all species)	1.0
Sponges (all species)	1.0
Mussels (*Mytilus edulis*)	1.5

A row from the estimated weight table used for the calculation of wet weight in air of anemones in one depth zone on the Viking BD jacket is provided in **Table 1.2**. The weight of each organism for the depth zone was calculated and summed. Each depth zone total was in turn summed to give an estimated weight total for the jacket.

The weight and volume for a single organism is calculated as follows:

- Step 1 – Average cover of organism
- Step 2 – Area Covered = Average Cover x Surface area for depth zone
- Step 3 – Volume = Area Covered x Average Thickness x CTF
- Step 4 – Weight = Volume x Density

A worked example for Anemones on the Viking BD jacket in the depth zone -11 m to -24 m can be seen in **Table 1.3** below.

Table 1.3 Anemone weight calculation for the depth zone -11 m to -24 m on the BD jacket of the Viking Bravo Hub Complex.

Marine Growth Type	Average Cover (%)	Surface Area for Depth Zone (m^2)	Area Covered (m^2)	Average Thickness (mm)	Average Thickness (m)	CTF'	Volume (m3)	Density (Tonnes/m^3)	Weight (Tonnes/m^3)
Anemone	85.19	1293.80	1102.18	52.08	0.05	0.33	18.9	1.00	18.9

The calculation is as follows:

Step 1: Anemones Average Cover = 85.19 %

Step 2: Area Covered = Average Cover x Surface area for depth zone
Area Covered = 85.19 % x 1293.80 m^2
Area Covered = 1102.18 m^2

Step 3: Volume = Area Covered x Average Thickness x CTF
Volume = 1102.18 x 0.052 x 0.33
Volume = 18.9 m^3

Step 4: Weight = Volume x Density
Weight = 18.9 x 1.00
Weight = 18.9 tonnes

MARINE GROWTH TECHNICAL NOTE:
APPENDIX 2
RAW MARINE GROWTH DATA

Table 2.1 Viking BD

Member reference	Depth	Soft growth cover & thickness								Hard growth cover & thickness				Average thickness	
		Seaweeds		Anemones		Hydroids		Soft Corals		Encrusting sponge		Mussels		Hard growth	Compressed soft growth
	(m)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(mm)	(mm)
ROW 2 - V18/27	-1	10	500	0	0	50	10	0	0	0	0	80	40	32	5
ROW 2 - V18/27	-1	10	450	0	0	40	10	0	0	0	0	100	40	40	4
ROW 3 - V19/30	-1	15	450	0	0	70	20	0	0	0	0	90	50	45	8
ROW 4 - V8/16	-1	40	450	5	20	90	15	0	0	0	0	70	60	42	17
ROW 1 - V5/13	-2	15	450	0	0	70	20	0	0	0	0	80	40	32	8
ROW 2 - V18/27	-2	5	350	2	15	60	20	0	0	0	0	70	50	35	3
ROW 2 - V18/27	-2	15	400	0	0	70	20	0	0	0	0	80	60	48	7
ROW 3 - V19/30	-2	5	300	0	0	30	40	0	0	0	0	20	50	10	3
ROW 4 - V8/16	-2	10	400	0	0	70	15	0	0	0	0	90	50	45	5
ROW 1 - V5/13	-3	5	350	5	20	60	30	0	0	0	0	40	50	20	4
ROW A - LSE 1/5	-3	1	300	5	20	60	40	0	0	0	0	40	40	16	4
ROW A - LSE 1/5	-3	15	350	0	0	60	40	0	0	0	0	80	50	40	8
ROW B - LSE 16/20	-3	1	250	0	0	50	10	0	0	0	0	80	30	24	1
Maximum	-1 to -3	40	500	5	20	90	40	0	0	0	0	100	60	48	17
Average	-1 to -3	11	385	1	6	60	22	0	0	0	0	71	47	33	6
Minimum	-1 to -3	1	250	0	0	30	10	0	0	0	0	20	30	10	1
ROW 1 - V5/13	-4	0	0	10	20	20	40	0	0	0	0	15	30	5	2
ROW 2 - V18/27	-4	0	0	10	20	60	40	0	0	0	0	50	40	20	4
ROW 3 - V19/30	-4	0	0	5	20	20	30	0	0	0	0	20	40	8	1
ROW 4 - V8/16	-4	0	0	0	0	30	20	0	0	0	0	15	30	5	1
ROW 4 - V8/16	-4	0	0	2	20	60	40	0	0	0	0	40	40	16	4
ROW A - LSE 1/5	-4	0	0	20	30	70	30	0	0	0	0	30	40	12	5
ROW A - LSE 1/5	-4	0	0	60	30	60	20	0	0	10	5	15	30	5	8

Member reference	Depth	Soft growth cover & thickness								Hard growth cover & thickness				Average thickness	
		Seaweeds		Anemones		Hydroids		Soft Corals		Encrusting sponge		Mussels		Hard growth	Compressed soft growth
	(m)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(mm)	(mm)
ROW 1 - V5/13	-5	0	0	15	30	40	30	0	0	0	0	30	40	12	3
ROW 2 - V18/27	-5	0	0	1	20	15	20	0	0	0	0	10	20	2	1
ROW A - LSE 1/5	-5	0	0	70	30	50	30	0	0	2	5	15	30	5	9
ROW 1 - V5/13	-6	0	0	40	30	60	40	0	0	0	0	50	30	15	8
ROW 3 - V19/30	-6	0	0	20	30	50	30	0	0	0	0	30	30	9	4
ROW 4 - V8/16	-6	0	0	5	10	90	20	0	0	0	0	0	0	0	3
ROW B - LSE 16/20	-6	0	0	15	30	60	20	0	0	0	0	30	40	12	3
ROW 1 - V5/13	-7	0	0	40	30	70	50	0	0	0	0	40	30	12	9
ROW 3 - V19/30	-7	0	0	40	30	80	40	0	0	0	0	10	30	3	9
ROW A - LSE 1/5	-7	0	0	90	30	30	15	0	0	0	0	15	30	5	10
ROW 1 - V17/26	-8	0	0	100	40	5	5	0	0	0	0	0	0	0	13
ROW 2 - V18/27	-8	0	0	15	20	80	20	0	0	5	5	0	0	0	3
ROW 3 - V19/30	-8	0	0	70	30	60	40	0	0	0	0	0	0	0	11
ROW 4 - V8/16	-8	0	0	10	20	80	15	0	0	20	5	0	0	1	2
ROW A - LSE 1/5	-8	0	0	50	20	70	30	0	0	1	5	5	30	2	6
ROW A - LSE 5/9	-8	0	0	70	30	40	15	0	0	1	5	10	20	2	8
ROW 1 - V17/26	-9	0	0	90	50	20	10	0	0	0	0	0	0	0	15
ROW 1 - V17/26	-9	0	0	90	40	15	5	0	0	5	5	0	0	0	12
ROW 3 - V7/31	-9	0	0	70	30	70	20	0	0	0	0	10	30	3	9
ROW 4 - V8/16	-9	0	0	15	20	80	10	0	0	10	5	0	0	1	2
ROW B - LSE 20/24	-9	0	0	15	30	60	15	0	0	2	5	20	30	6	3
ROW B - H 17/18	-9	0	0	2	20	70	40	0	0	0	0	50	40	20	4
ROW B - H 17/18	-9	0	0	0	0	5	40	0	0	0	0	1	30	0	0
ROW B - H 17/18	-9	0	0	20	20	60	30	0	0	0	0	15	20	3	4

Member reference	Depth	Soft growth cover & thickness								Hard growth cover & thickness				Average thickness	
		Seaweeds		Anemones		Hydroids		Soft Corals		Encrusting sponge		Mussels		Hard growth	Compressed soft growth
	(m)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(mm)	(mm)
ROW B - H 17/18	-9	0	0	60	40	0	0	0	0	0	0	40	30	12	8
H09 - H 56/190	-9	0	0	50	50	40	40	0	0	0	0	2	30	1	11
ROW 2 - V6/28	-10	0	0	90	40	15	5	0	0	5	5	0	0	0	12
ROW A - LSE 5/9	-10	0	0	60	40	30	10	0	0	2	5	15	20	3	8
ROW B - LSE 20/24	-10	0	0	90	40	0	0	0	0	0	0	15	30	5	12
ROW 1 - V17/26	-11	0	0	20	50	70	20	0	0	10	5	20	40	9	5
ROW 1 - V17/26	-11	0	0	60	50	50	20	0	0	0	0	20	40	8	11
ROW 3 - V7/31	-11	0	0	60	30	70	15	0	0	10	5	5	20	2	8
ROW A - V7/10	-11	0	0	70	50	60	10	0	0	2	5	5	20	1	12
ROW B - LSE 20/24	-11	0	0	70	40	15	10	0	0	0	0	10	50	5	9
Maximum	-3 to -11	0	0	100	50	90	50	0	0	20	5	50	50	20	15
Average	-3 to -11	0	0	41	30	47	23	0	0	2	2	16	25	6	7
Minimum	-3 to -11	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ROW 1 - V17/26	-12	0	0	100	60	0	0	0	0	0	0	0	0	0	20
ROW 2 - V6/28	-12	0	0	100	50	0	0	0	0	0	0	0	0	0	17
ROW A - LSE 5/9	-12	0	0	80	50	30	10	10	30	0	0	5	15	1	16
ROW 1 - V17/26	-13	0	0	90	60	15	10	0	0	0	0	0	0	0	18
ROW 2 - V6/28	-13	0	0	100	60	0	0	0	0	0	0	0	0	0	20
ROW 3 - V7/31	-13	0	0	70	40	30	10	0	0	0	0	10	30	3	10
ROW B - LSE 20/24	-13	0	0	100	50	0	0	0	0	0	0	0	0	0	17
ROW 2 - V6/28	-14	0	0	100	60	0	0	0	0	0	0	0	0	0	20
ROW 3 - V7/31	-14	0	0	60	40	30	10	0	0	5	5	5	30	2	8
ROW 3 - VM31/32	-15	0	0	90	40	5	5	0	0	10	5	15	30	5	12
ROW A - V7/10	-15	0	0	90	60	0	0	0	0	0	0	10	30	3	18

Member reference	Depth	Soft growth cover & thickness								Hard growth cover & thickness				Average thickness	
		Seaweeds		Anemones		Hydroids		Soft Corals		Encrusting sponge		Mussels		Hard growth	Compressed soft growth
	(m)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(mm)	(mm)
ROW 2 - V22/28	-16	0	0	90	60	10	5	0	0	5	5	0	0	0	18
ROW A - LSE 5/9	-16	0	0	90	60	0	0	0	0	2	5	5	20	1	18
ROW A - V7/10	-16	0	0	100	60	5	5	0	0	0	0	0	0	0	20
ROW 1 - V9/26	-17	0	0	100	50	0	0	0	0	0	0	0	0	0	17
ROW 3 - VM31/32	-17	0	0	100	50	0	0	0	0	0	0	0	0	0	17
ROW 4 - V24/34	-17	0	0	100	60	0	0	0	0	0	0	5	30	2	20
ROW B - LSE 20/24	-17	0	0	90	50	0	0	0	0	10	20	0	0	2	15
ROW 2 - V22/28	-18	0	0	100	70	5	5	0	0	0	0	0	0	0	23
ROW 4 - V24/34	-18	0	0	90	50	0	0	0	0	0	0	10	30	3	15
ROW A - LSE 5/9	-18	0	0	90	60	0	0	0	0	5	5	5	20	1	18
ROW B - LSE 20/24	-18	0	0	100	50	0	0	0	0	2	5	0	0	0	17
ROW 3 - VM31/32	-19	0	0	100	40	0	0	0	0	0	0	0	0	0	13
ROW 1 - V9/26	-20	0	0	90	50	5	5	0	0	0	0	0	0	0	15
ROW 2 - V22/28	-20	0	0	100	90	5	5	0	0	0	0	0	0	0	30
ROW 4 - V24/34	-20	0	0	100	80	0	0	0	0	0	0	5	20	1	26
ROW A - LSE 5/9	-20	0	0	90	60	0	0	0	0	10	5	0	0	1	18
ROW A - V7/10	-20	0	0	90	60	15	5	0	0	0	0	0	0	0	18
ROW B - LSE 20/24	-20	0	0	90	50	5	5	0	0	5	5	0	0	0	15
ROW 2 - V22/28	-21	0	0	100	100	5	5	0	0	0	0	0	0	0	33
ROW 3 - VM31/32	-21	0	0	100	40	0	0	0	0	0	0	0	0	0	13
ROW B - LSE 20/24	-21	0	0	100	50	0	0	0	0	0	0	0	0	0	17
ROW 1 - V9/26	-22	0	0	90	40	10	5	0	0	2	5	0	0	0	12
ROW 3 - VM31/32	-22	0	0	100	30	5	5	0	0	0	0	0	0	0	10
ROW 4 - V24/34	-22	0	0	100	90	0	0	0	0	0	0	0	0	0	30

Member reference	Depth	Soft growth cover & thickness								Hard growth cover & thickness				Average thickness	
		Seaweeds		Anemones		Hydroids		Soft Corals		Encrusting sponge		Mussels		Hard growth	Compressed soft growth
	(m)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(mm)	(mm)
ROW A - LSE 5/9	-22	0	0	70	50	50	5	0	0	0	0	0	0	0	12
ROW A - V7/10	-22	0	0	90	50	20	5	0	0	0	0	0	0	0	15
ROW 2 - V22/28	-23	0	0	100	80	5	5	0	0	5	5	0	0	0	26
ROW 3 - VM31/32	-23	0	0	90	30	0	0	0	0	0	0	5	20	1	9
ROW 4 - V24/34	-23	0	0	100	50	0	0	0	0	0	0	0	0	0	17
ROW A - V7/10	-23	0	0	80	40	30	5	0	0	5	5	0	0	0	11
ROW B - LSE 20/24	-23	0	0	80	40	15	5	0	0	10	5	2	30	1	11
ROW B - LSE 20/24	-24	0	0	60	30	70	10	0	0	0	0	0	0	0	7
ROW A - H 10/11	-24	0	0	80	60	20	5	0	0	2	5	0	0	0	16
ROW A - H 10/11	-24	0	0	80	60	15	5	0	0	5	5	0	0	0	16
ROW A - H 10/11	-24	0	0	30	0	80	5	0	0	0	0	0	0	0	1
ROW A - H 10/11	-24	0	0	5	20	80	5	0	0	5	5	0	0	0	1
ROW A - H 10/11	-24	0	0	40	30	50	5	0	0	5	5	0	0	0	4
H24 - H 32/47	-24	0	0	70	50	40	5	0	0	0	0	0	0	0	12
H24 - H 32/47	-24	0	0	90	60	10	5	0	0	0	0	0	0	0	18
H24 - H 32/47	-24	0	0	70	40	20	5	0	0	5	5	0	0	0	9
H24 - H 32/47	-24	0	0	60	50	50	10	0	0	5	5	2	20	1	11
H24 - H 32/47	-24	0	0	40	50	20	10	0	0	40	5	0	0	2	7
Maximum	-11 to -24	0	0	100	100	80	10	10	30	40	20	15	30	5	33
Average	-11 to -24	0	0	85	52	14	4	0	1	3	2	2	6	1	33
Minimum	-11 to -24	0	0	5	0	0	0	0	0	0	0	0	0	0	1

Table 2.2 Victor JD

Member reference	Depth	Soft growth cover & thickness								Hard growth cover & thickness				Average thickness	
		Seaweeds		Anemones		Hydroids		Soft corals		Encrusting sponge		Mussels		Hard growth	Compressed soft growth
	(m)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(mm)	(mm)
ROW 1 - LSE 23/39	-1	10	350	0	0	10	5	0	0	0	0	90	80	72	3
ROW A - V 23/38	-1	15	350	1	15	60	15	0	0	0	0	60	60	36	6
ROW 1 - LSE 23/39	-2	20	350	0	0	60	5	0	0	0	0	70	60	42	6
ROW 1 - LSE 23/39	-2	15	400	0	0	60	5	0	0	0	0	60	60	36	5
ROW A - V 23/38	-2	0	0	0	0	15	5	0	0	0	0	10	40	4	0
ROW B - V 25/36	-2	5	90	0	0	0	0	0	0	0	0	15	50	8	0
ROW B - V 36/41	-2	10	400	0	0	60	5	0	0	0	0	40	60	24	4
ROW 2 - V 27/37	-2	10	300	0	0	60	15	0	0	0	0	40	60	24	4
ROW 2 - V 29/37	-2	0	0	0	0	30	5	0	0	0	0	20	70	14	0
ROW 2 - V 29/37	-3	0	0	2	20	50	20	0	0	0	0	1	30	0	2
ROW 1 - LSE 23/39	-3	10	250	0	0	50	5	0	0	0	0	30	40	12	2
ROW A - V 23/38	-3	5	300	1	10	30	10	0	0	0	0	30	40	12	2
ROW B - V 25/36	-3	0	0	0	0	10	5	0	0	0	0	5	30	2	0
Maximum	-1 to -3	20	400	2	20	60	20	0	0	0	0	90	80	72	6
Average	-1 to -3	8	215	0	3	38	8	0	0	0	0	36	52	22	3
Minimum	-1 to -3	0	0	0	0	0	0	0	0	0	0	1	30	0	0
ROW A - V 23/38	-5	0	0	10	20	60	30	0	0	0	0	15	40	6	3
ROW 2 - V 29/37	-5	0	0	10	30	20	10	0	0	0	0	20	50	10	1
ROW 1 - LSE 23/39	-6	0	0	10	30	70	20	0	0	30	10	10	30	6	3
ROW 1 - LSE 23/39	-6	0	0	10	30	40	50	0	0	0	0	5	40	2	4
ROW A - V 23/38	-6	0	0	15	10	70	15	0	0	0	0	20	50	10	2
ROW 2 - V 27/37	-6	0	0	15	40	90	15	0	0	0	0	10	30	3	4
ROW A - V 23/38	-8	0	0	10	10	90	15	0	0	0	0	20	40	8	2

Member reference	Depth	Soft growth cover & thickness								Hard growth cover & thickness				Average thickness	
		Seaweeds		Anemones		Hydroids		Soft corals		Encrusting sponge		Mussels		Hard growth	Compressed soft growth
	(m)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(mm)	(mm)
ROW 2 - V 29/37	-8	0	0	10	40	70	20	0	0	0	0	60	70	42	3
ROW 1 - LSE 23/39	-9	0	0	30	40	80	40	0	0	20	5	15	30	6	9
ROW A - V 23/38	-9	0	0	50	50	60	20	0	0	0	0	10	40	4	10
ROW 2 - V 27/37	-9	0	0	20	40	70	10	0	0	0	0	30	40	12	4
ROW B - V 25/36	-10	0	0	40	40	60	10	0	0	10	5	30	50	16	6
ROW 2 - V 27/37	-10	0	0	70	40	15	10	0	0	0	0	0	0	0	9
ROW 1 - LSE 23/39	-11	0	0	40	40	60	20	0	0	0	0	10	30	3	7
ROW A - V 20/30	-12	0	0	80	60	30	15	0	0	0	0	0	0	0	17
ROW 2 - V 27/37	-12	0	0	70	50	50	30	0	0	0	0	0	0	0	14
ROW 1 - V 23/35	-13	0	0	60	60	70	30	0	0	0	0	5	40	2	15
ROW 2 - LSE 20/29	-13	0	0	90	90	15	5	0	0	0	0	0	0	0	27
ROW 2 - LSE 20/29	-13	0	0	15	60	90	15	0	0	0	0	0	0	0	5
H12 - 24/26	-13	0	0	15	30	80	40	0	0	0	0	15	50	8	6
H12 - 24/26	-13	0	0	15	20	90	40	0	0	0	0	40	60	24	6
H12 - 24/26	-13	0	0	30	20	80	30	0	0	0	0	70	80	56	6
H12 - 24/26	-13	0	0	10	20	90	40	0	0	0	0	5	60	3	6
H12 - 24/26	-13	0	0	15	30	70	40	0	0	0	0	15	50	8	6
H12 - 24/26	-13	0	0	50	40	60	30	0	0	10	10	15	40	7	9
H12 - 24/26	-13	0	0	70	60	50	30	0	0	0	0	10	30	3	16
ROW A - H23/29	-13	0	0	80	80	60	30	0	0	0	0	0	0	0	24
ROW A - H23/29	-13	0	0	100	90	0	0	0	0	0	0	0	0	0	30
ROW A - H23/29	-13	0	0	90	100	0	0	0	0	0	0	0	0	0	30
Maximum	-3 to -13	0	0	100	100	90	50	0	0	30	10	70	80	56	30
Average	-3 to -13	0	0	39	44	58	23	0	0	2	1	15	33	8	10

Member reference	Depth	Soft growth cover & thickness								Hard growth cover & thickness				Average thickness	
		Seaweeds		Anemones		Hydroids		Soft corals		Encrusting sponge		Mussels		Hard growth	Compressed soft growth
	(m)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(mm)	(mm)
Minimum	-3 to -13	0	0	10	10	0	0	0	0	0	0	0	0	0	1
ROW 1 - LSE 23/39	-14	0	0	80	50	20	15	0	0	0	0	5	20	1	14
ROW 1 - V 16/24	-14	0	0	15	50	70	10	0	0	0	0	10	40	4	4
ROW B - V 16/26	-14	0	0	1	30	80	20	0	0	0	0	0	0	0	2
ROW B - V 18/26	-14	0	0	40	60	60	20	0	0	0	0	0	0	0	10
ROW 2 - LSE 20/29	-14	0	0	40	60	70	20	0	0	0	0	0	0	0	10
ROW 1 - LSE 16/25	-16	0	0	80	50	20	10	0	0	0	0	0	0	0	14
ROW A - V 20/30	-16	0	0	30	70	60	15	0	0	0	0	40	40	16	8
ROW 1 - LSE 14/23	-17	0	0	80	90	30	20	0	0	0	0	0	0	0	25
ROW 1 - V 16/24	-17	0	0	40	80	70	10	0	0	0	0	0	0	0	12
ROW B - V 16/26	-17	0	0	10	20	80	30	0	0	0	0	0	0	0	4
ROW B - V 18/26	-17	0	0	90	90	15	10	0	0	0	0	0	0	0	27
ROW A - V 20/30	-18	0	0	80	90	40	15	0	0	0	0	15	50	8	25
ROW 2 - LSE 20/29	-18	0	0	90	60	5	5	0	0	0	0	10	30	3	18
ROW 1 - LSE 14/23	-19	0	0	70	70	15	10	0	0	0	0	10	40	4	16
ROW 1 - LSE 16/25	-19	0	0	80	60	20	15	0	0	0	0	0	0	0	16
ROW 1 - V 16/24	-19	0	0	100	120	0	0	0	0	0	0	0	0	0	40
ROW 2 - LSE 20/29	-19	0	0	100	80	0	0	0	0	0	0	0	0	0	26
ROW A - V 20/30	-20	0	0	80	100	30	10	0	0	0	0	15	60	9	27
ROW 1 - LSE 14/23	-21	0	0	70	60	40	10	0	0	0	0	0	0	0	14
ROW 2 - LSE 20/29	-21	0	0	70	70	50	15	0	0	5	5	0	0	0	17
ROW 1 - V 16/24	-22	0	0	90	100	15	5	0	0	0	0	0	0	0	30
ROW A - V 20/30	-22	0	0	100	120	10	5	0	0	0	0	0	0	0	40
ROW 2 - LSE 20/29	-23	0	0	80	50	5	5	0	0	0	0	20	40	8	13

Member reference	Depth	Soft growth cover & thickness								Hard growth cover & thickness				Average thickness	
		Seaweeds		Anemones		Hydroids		Soft corals		Encrusting sponge		Mussels		Hard growth	Compressed soft growth
	(m)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(mm)	(mm)
ROW 1 - LSE 16/25	-24	0	0	90	80	10	5	0	0	0	0	0	0	0	24
ROW 2 - LSE 5/18	-24	0	0	90	80	5	5	0	0	10	5	0	0	1	24
ROW 2 - H 18/19	-24	0	0	100	70	0	0	0	0	0	0	0	0	0	23
ROW 2 - H 18/19	-24	0	0	100	80	0	0	0	0	0	0	0	0	0	26
ROW 2 - H 18/19	-24	0	0	80	70	10	5	0	0	15	5	0	0	1	19
ROW 2 - H 19/20	-24	0	0	100	90	5	5	0	0	0	0	0	0	0	30
ROW 2 - H 19/20	-24	0	0	100	100	0	0	0	0	0	0	0	0	0	33
ROW 2 - H 19/20	-24	0	0	80	80	20	5	0	0	0	0	0	0	0	21
ROW 2 - H 19/20	-24	0	0	100	90	0	0	0	0	0	0	0	0	0	30
H24 - 13/21	-24	0	0	100	100	0	0	0	0	0	0	0	0	0	33
H24 - 15/17	-24	0	0	100	70	5	5	0	0	0	0	2	40	1	23
H24 - 15/17	-24	0	0	70	50	40	10	0	0	0	0	0	0	0	12
H24 - 15/17	-24	0	0	90	70	5	5	0	0	0	0	5	50	3	21
ROW 1 - LSE 14/23	-25	0	0	100	100	5	10	0	0	0	0	0	0	0	33
ROW B - VM 4/17	-25	0	0	80	70	10	5	0	0	0	0	20	40	8	19
ROW 2 - LSE 5/18	-25	0	0	100	110	5	5	0	0	0	0	0	0	0	36
ROW 2 - LSE 20/29	-25	0	0	90	60	5	5	0	0	0	0	10	40	4	18
ROW 1 - LSE 3/16	-26	0	0	90	60	15	5	0	0	0	0	0	0	0	18
ROW 2 - LSE 5/18	-27	0	0	100	100	5	5	0	0	0	0	0	0	0	33
ROW B - VM 4/17	-28	0	0	100	70	5	5	0	0	0	0	10	40	4	23
ROW 1 - LSE 1/4	-29	0	0	100	120	0	0	0	0	0	0	0	0	0	40
ROW B - VM 4/17	-29	0	0	90	80	5	5	0	0	0	0	10	40	4	24
ROW 1 - LSE 3/16	-30	0	0	100	60	5	5	0	0	0	0	0	0	0	20
ROW 2 - LSE 5/18	-30	0	0	100	70	5	5	0	0	0	0	0	0	0	23

Member reference	Depth	Soft growth cover & thickness								Hard growth cover & thickness				Average thickness	
		Seaweeds		Anemones		Hydroids		Soft corals		Encrusting sponge		Mussels		Hard growth	Compressed soft growth
	(m)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(mm)	(mm)
ROW A - V 1/21	-30	0	0	90	90	15	5	0	0	0	0	0	0	0	27
ROW 2 - LSE 5/18	-31	0	0	100	90	5	5	0	0	0	0	0	0	0	30
ROW 1 - V 1/2	-34	0	0	100	110	0	0	0	0	0	0	0	0	0	36
ROW B - V 4/5	-34	0	0	100	70	5	5	0	0	0	0	0	0	0	23
ROW 2 - LSE 5/18	-34	0	0	90	70	10	5	0	0	0	0	0	0	0	21
ROW B - V 4/5	-35	0	0	90	60	15	5	0	0	0	0	0	0	0	18
ROW 1 - LSE 3/16	-36	0	0	90	80	20	5	0	0	0	0	0	0	0	24
H 36 - 2/8	-36	0	0	100	110	0	0	0	0	0	0	0	0	0	36
H 36 - 2/8	-36	0	0	100	90	0	0	0	0	0	0	0	0	0	30
H36 - 4/6	-36	0	0	100	80	0	0	0	0	0	0	0	0	0	26
H36 - 4/6	-36	0	0	90	70	10	5	0	0	0	0	0	0	0	21
H36 - 4/6	-36	0	0	100	60	5	5	0	0	0	0	0	0	0	20
ROW 1 - V 1/2	-37	0	0	90	100	10	5	0	0	0	0	0	0	0	30
ROW A - V 1/21	-37	0	0	100	110	10	5	0	0	0	0	0	0	0	36
ROW 1 - LSE 1/4	-38	0	0	90	90	0	0	0	0	5	5	0	0	0	27
Maximum	-13 to -38	0	0	100	120	80	30	0	0	15	5	40	60	16	40
Average	-13 to -38	0	0	84	78	17	7	0	0	1	0	3	9	1	23
Minimum	-13 to -38	0	0	1	20	0	0	0	0	0	0	0	0	0	2

MARINE GROWTH TECHNICAL NOTE:
APPENDIX 3
STRUCTURAL MEMBER DIMENSIONS

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Table 3.1 Viking BD

Elevation	Diameter (mm)	Diameter (m)	Length (mm)	Length (m)	Pi	Surface Area (m^2)	% of member within the depth zone	Surface area of subsea members (m^2)
Depth Zone 1 (-1m to -3m)								
0 to -24	1016	1.0	23796	23.8	3.14	76	8	6.3
0 to -24	1016	1.0	23796	23.8	3.14	76	8	6.3
0 to -24	1016	1.0	23796	23.8	3.14	76	8	6.3
0 to -24	1016	1.0	23796	23.8	3.14	76	8	6.3
0 to -24	1016	1.0	23796	23.8	3.14	76	8	6.3
0 to -24	1016	1.0	23796	23.8	3.14	76	8	6.3
0 to -24	1016	1.0	23796	23.8	3.14	76	8	6.3
0 to -24	1016	1.0	23796	23.8	3.14	76	8	6.3
0 to -9	622	0.6	12134	12.1	3.14	24	22	5.3
0 to -9	622	0.6	12134	12.1	3.14	24	22	5.3
0 to -9	622	0.6	12134	12.1	3.14	24	22	5.3
0 to -9	622	0.6	12134	12.1	3.14	24	22	5.3
0 to -9	622	0.6	12134	12.1	3.14	24	22	5.3
0 to -9	622	0.6	12134	12.1	3.14	24	22	5.3
0 to -9	622	0.6	12134	12.1	3.14	24	22	5.3
0 to -9	622	0.6	12134	12.1	3.14	24	22	5.3
0 to -9	610	0.6	10187	10.2	3.14	20	22	2.5
0 to -9	610	0.6	10187	10.2	3.14	20	22	2.5
0 to -9	610	0.6	10187	10.2	3.14	20	22	2.5
0 to -9	610	0.6	10187	10.2	3.14	20	22	2.5
0 to -9	610	0.6	10187	10.2	3.14	20	22	2.5
0 to -9	610	0.6	10187	10.2	3.14	20	22	2.5
							Total	**107.6**

Elevation	Diameter (mm)	Diameter (m)	Length (mm)	Length (m)	Pi	Surface Area (m^2)	% of member within the depth zone	Surface area of subsea members (m^2)
Depth Zone 2 (-3m to -11m)								
-9 to -9	457	0.5	17780	17.8	3.14	26	100	25.5
-9 to -9	457	0.5	17780	17.8	3.14	26	100	25.5
-9 to -9	336	0.3	10668	10.7	3.14	11	100	11.2
-9 to -9	336	0.3	10668	10.7	3.14	11	100	11.2
-9 to -9	356	0.4	7476	7.5	3.14	8	100	8.4
-9 to -9	356	0.4	7476	7.5	3.14	8	100	8.4
-9 to -9	356	0.4	7476	7.5	3.14	8	100	8.4
-9 to -9	356	0.4	7476	7.5	3.14	8	100	8.4
Conductor Guide Frame at -9m	356	0.4				68	100	67.8
0 to -24	1016	1.0	23796	23.8	3.14	76	33	25.3
0 to -24	1016	1.0	23796	23.8	3.14	76	33	25.3
0 to -24	1016	1.0	23796	23.8	3.14	76	33	25.3
0 to -24	1016	1.0	23796	23.8	3.14	76	33	25.3
0 to -24	1016	1.0	23796	23.8	3.14	76	33	25.3
0 to -24	1016	1.0	23796	23.8	3.14	76	33	25.3
0 to -24	1016	1.0	23796	23.8	3.14	76	33	25.3
0 to -24	1016	1.0	23796	23.8	3.14	76	33	25.3
-9 to -15	635	0.6	10918	10.9	3.14	22	33	7.3
-9 to -15	635	0.6	10918	10.9	3.14	22	33	7.3
-9 to -15	635	0.6	10918	10.9	3.14	22	33	7.3
-9 to -15	635	0.6	10918	10.9	3.14	22	33	7.3
-9 to -15	635	0.6	10918	10.9	3.14	22	33	7.3
-9 to -15	635	0.6	10918	10.9	3.14	22	33	7.3
-9 to -15	635	0.6	10918	10.9	3.14	22	33	7.3

Elevation	Diameter (mm)	Diameter (m)	Length (mm)	Length (m)	Pi	Surface Area (m^2)	% of member within the depth zone	Surface area of subsea members (m^2)
-9 to -15	635	0.6	10918	10.9	3.14	22	33	7.3
-9 to -24	610	0.6	17330	17.3	3.14	33	13	4.4
-9 to -24	610	0.6	17330	17.3	3.14	33	13	4.4
-9 to -24	610	0.6	17330	17.3	3.14	33	13	4.4
-9 to -24	610	0.6	17330	17.3	3.14	33	13	4.4
-9 to -24	610	0.6	17330	17.3	3.14	33	13	4.4
-9 to -24	610	0.6	17330	17.3	3.14	33	13	4.4
0 to -9	622	0.6	12134	12.1	3.14	24	67	15.8
0 to -9	622	0.6	12134	12.1	3.14	24	67	15.8
0 to -9	622	0.6	12134	12.1	3.14	24	67	15.8
0 to -9	622	0.6	12134	12.1	3.14	24	67	15.8
0 to -9	622	0.6	12134	12.1	3.14	24	67	15.8
0 to -9	622	0.6	12134	12.1	3.14	24	67	15.8
0 to -9	622	0.6	12134	12.1	3.14	24	67	15.8
0 to -9	622	0.6	12134	12.1	3.14	24	67	15.8
0 to -9	610	0.6	10187	10.2	3.14	20	67	7.5
0 to -9	610	0.6	10187	10.2	3.14	20	67	7.5
0 to -9	610	0.6	10187	10.2	3.14	20	67	7.5
0 to -9	610	0.6	10187	10.2	3.14	20	67	7.5
0 to -9	610	0.6	10187	10.2	3.14	20	67	7.5
0 to -9	610	0.6	10187	10.2	3.14	20	67	7.5
							Total	**633.5**
Depth Zone 3 (-11m to -24m)								
-24 to -24	356	0.4	11922	11.9	3.14	13	100	13.3
-24 to -24	356	0.4	11922	11.9	3.14	13	100	13.3
-24 to -24	356	0.4	11922	11.9	3.14	13	100	13.3

Elevation	Diameter (mm)	Diameter (m)	Length (mm)	Length (m)	Pi	Surface Area (m^2)	% of member within the depth zone	Surface area of subsea members (m^2)
-24 to -24	356	0.4	11922	11.9	3.14	13	100	13.3
-24 to -24	356	0.4	11922	11.9	3.14	13	100	13.3
-24 to -24	356	0.4	11922	11.9	3.14	13	100	13.3
-24 to -24	356	0.4	11922	11.9	3.14	13	100	13.3
-24 to -24	356	0.4	11922	11.9	3.14	13	100	13.3
-24 to -24	457	0.5	21782	21.8	3.14	31	100	31.3
-24 to -24	457	0.5	21782	21.8	3.14	31	100	31.3
-24 to -24	457	0.5	21782	21.8	3.14	31	100	31.3
-24 to -24	457	0.5	9700	9.7	3.14	14	100	13.9
-24 to -24	457	0.5	9700	9.7	3.14	14	100	13.9
-24 to -24	457	0.5	9700	9.7	3.14	14	100	13.9
-24 to -24	457	0.5	9700	9.7	3.14	14	100	13.9
-24 to -24	457	0.5	9700	9.7	3.14	14	100	13.9
-24 to -24	457	0.5	9700	9.7	3.14	14	100	13.9
-24 to -24	356	0.4	9092	9.1	3.14	10	100	10.2
-24 to -24	356	0.4	9092	9.1	3.14	10	100	10.2
-24 to -24	356	0.4	9092	9.1	3.14	10	100	10.2
-24 to -24	356	0.4	9092	9.1	3.14	10	100	10.2
-24 to -24	457	0.5	7690	7.7	3.14	11	100	11.0
-24 to -24	457	0.5	11958	12.0	3.14	17	100	17.2
Conductor Guide Frame at -9m	356	0.4				68	100	67.8
0 to -24	1016	1.0	23796	23.8	3.14	76	54	41.2
0 to -24	1016	1.0	23796	23.8	3.14	76	54	41.2
0 to -24	1016	1.0	23796	23.8	3.14	76	54	41.2
0 to -24	1016	1.0	23796	23.8	3.14	76	54	41.2

Elevation	Diameter (mm)	Diameter (m)	Length (mm)	Length (m)	Pi	Surface Area (m^2)	% of member within the depth zone	Surface area of subsea members (m^2)
0 to -24	1016	1.0	23796	23.8	3.14	76	54	41.2
0 to -24	1016	1.0	23796	23.8	3.14	76	54	41.2
0 to -24	1016	1.0	23796	23.8	3.14	76	54	41.2
0 to -24	1016	1.0	23796	23.8	3.14	76	54	41.2
-9 to -15	635	0.6	10918	10.9	3.14	22	54	11.8
-9 to -15	635	0.6	10918	10.9	3.14	22	54	11.8
-9 to -15	635	0.6	10918	10.9	3.14	22	54	11.8
-9 to -15	635	0.6	10918	10.9	3.14	22	54	11.8
-9 to -15	635	0.6	10918	10.9	3.14	22	54	11.8
-9 to -15	635	0.6	10918	10.9	3.14	22	54	11.8
-9 to -15	635	0.6	10918	10.9	3.14	22	54	11.8
-9 to -15	635	0.6	10918	10.9	3.14	22	54	11.8
-15 to -24	635	0.6	13808	13.8	3.14	28	100	27.5
-15 to -24	635	0.6	13808	13.8	3.14	28	100	27.5
-17 to -24	356	0.4	6302	6.3	3.14	7	100	7.0
-17 to -24	356	0.4	6302	6.3	3.14	7	100	7.0
-17 to -24	356	0.4	6302	6.3	3.14	7	100	7.0
-17 to -24	356	0.4	6302	6.3	3.14	7	100	7.0
-15 to -24	635	0.6	13808	13.8	3.14	28	100	27.5
-15 to -24	635	0.6	13808	13.8	3.14	28	100	27.5
-15 to -24	356	0.4	8403	8.4	3.14	9	100	9.4
-15 to -24	635	0.6	13808	13.8	3.14	28	100	27.5
-15 to -24	635	0.6	13808	13.8	3.14	28	100	27.5
-15 to -24	356	0.4	8403	8.4	3.14	9	100	9.4
-15 to -24	635	0.6	13808	13.8	3.14	28	100	27.5
-15 to -24	635	0.6	13808	13.8	3.14	28	100	27.5

Elevation	Diameter (mm)	Diameter (m)	Length (mm)	Length (m)	Pi	Surface Area (m^2)	% of member within the depth zone	Surface area of subsea members (m^2)
-15 to -24	356	0.4	8403	8.4	3.14	9	100	9.4
-9 to -24	610	0.6	17330	17.3	3.14	33	87	28.8
-9 to -24	610	0.6	17330	17.3	3.14	33	87	28.8
-9 to -24	610	0.6	17330	17.3	3.14	33	87	28.8
-9 to -24	610	0.6	17330	17.3	3.14	33	87	28.8
-9 to -24	610	0.6	17330	17.3	3.14	33	87	28.8
-9 to -24	610	0.6	17330	17.3	3.14	33	87	28.8
							Total	**1293.8**

Table 3.2 Victor JD

Elevation	Diameter (mm)	Diameter (m)	Length (mm)	Length (m)	Pi	Surface Area (m^2)	% of member within the depth zone	Surface area of subsea members (m^2)
Depth Zone 1 (-1m to -3m)								
0 to -38	1600	1.6	38921	38.9	3.14	196	5	9.8
0 to -38	1600	1.6	38921	38.9	3.14	196	5	9.8
0 to -38	1600	1.6	38921	38.9	3.14	196	5	9.8
0 to -38	1600	1.6	38921	38.9	3.14	196	5	9.8
+7 to -13	650	0.7	25649	25.6	3.14	52	10	3.4
+7 to -13	650	0.7	25649	25.6	3.14	52	10	3.4
+7 to -13	650	0.7	25649	25.6	3.14	52	10	3.4
+7 to -13	650	0.7	25649	25.6	3.14	52	10	3.4
+7 to -13	650	0.7	25649	25.6	3.14	52	10	3.4
+7 to -13	650	0.7	25649	25.6	3.14	52	10	3.4
+7 to -13	650	0.7	25649	25.6	3.14	52	10	3.4
+7 to -13	650	0.7	25649	25.6	3.14	52	10	3.4
							Total	**66.0**
Depth Zone 2 (-3m to -13m)								
-13 to -13	610	0.6	19842	19.8	3.14	38	100	38.0
-13 to -13	610	0.6	19842	19.8	3.14	38	100	38.0
-13 to -13	610	0.6	19064	19.1	3.14	37	100	36.5
-13 to -13	610	0.6	19064	19.1	3.14	37	100	36.5
-13 to -13	610	0.6	19064	19.1	3.14	37	100	36.5
-13 to -13	457	0.5	13271	13.3	3.14	19	100	19.1
-13 to -13	457	0.5	13271	13.3	3.14	19	100	19.1
-13 to -13	406	0.4	3210	3.2	3.14	4	100	4.1
-13 to -13	406	0.4	3210	3.2	3.14	4	100	4.1
-13 to -13	457	0.5	13276	13.3	3.14	19	100	19.1

Elevation	Diameter (mm)	Diameter (m)	Length (mm)	Length (m)	Pi	Surface Area (m^2)	% of member within the depth zone	Surface area of subsea members (m^2)
-13 to -13	457	0.5	13276	13.3	3.14	19	100	19.1
Conductor Guide Frame at -13m	457	0.5				128	100	89.7
0 to -38	1600	1.6	38921	38.9	3.14	196	26	50.9
0 to -38	1600	1.6	38921	38.9	3.14	196	26	50.9
0 to -38	1600	1.6	38921	38.9	3.14	196	26	50.9
0 to -38	1600	1.6	38921	38.9	3.14	196	26	50.9
+7 to -13	650	0.7	25649	25.6	3.14	52	50	16.8
+7 to -13	650	0.7	25649	25.6	3.14	52	50	16.8
+7 to -13	650	0.7	25649	25.6	3.14	52	50	16.8
+7 to -13	650	0.7	25649	25.6	3.14	52	50	16.8
+7 to -13	650	0.7	25649	25.6	3.14	52	50	16.8
+7 to -13	650	0.7	25649	25.6	3.14	52	50	16.8
+7 to -13	650	0.7	25649	25.6	3.14	52	50	16.8
+7 to -13	650	0.7	25649	25.6	3.14	52	50	16.8
							Total	**697.5**
Depth Zone 3 (-13m to -38m)								
-24 to -24	610	0.6	22276	22.3	3.14	43	100	42.7
-24 to -24	610	0.6	22276	22.3	3.14	43	100	42.7
-24 to -24	610	0.6	21906	21.9	3.14	42	100	42.0
-24 to -24	610	0.6	21906	21.9	3.14	42	100	42.0
-24 to -24	610	0.6	21906	21.9	3.14	42	100	42.0
-24 to -24	457	0.5	15139	15.1	3.14	22	100	21.7
-24 to -24	457	0.5	15139	15.1	3.14	22	100	21.7
-24 to -24	457	0.5	8874	8.9	3.14	13	100	12.7
-24 to -24	457	0.5	8874	8.9	3.14	13	100	12.7

Elevation	Diameter (mm)	Diameter (m)	Length (mm)	Length (m)	Pi	Surface Area (m^2)	% of member within the depth zone	Surface area of subsea members (m^2)
-24 to -24	457	0.5	4950	4.9	3.14	7	100	7.1
-24 to -24	457	0.5	4950	4.9	3.14	7	100	7.1
-24 to -24	457	0.5	6000	6.0	3.14	9	100	8.6
-24 to -24	457	0.5	11201	11.2	3.14	16	100	16.1
-24 to -24	457	0.5	11201	11.2	3.14	16	100	16.1
-24 to -24	457	0.5	8439	8.4	3.14	12	100	12.1
-24 to -24	457	0.5	8439	8.4	3.14	12	100	12.1
-34 to -36	457	0.5	12126	12.1	3.14	17	100	17.4
-34 to -36	457	0.5	12126	12.1	3.14	17	100	17.4
-34 to -36	457	0.5	12658	12.7	3.14	18	100	18.2
-34 to -36	457	0.5	12658	12.7	3.14	18	100	18.2
-34 to -36	457	0.5	12658	12.7	3.14	18	100	18.2
-34 to -36	457	0.5	12658	12.7	3.14	18	100	18.2
-34 to -36	457	0.5	12684	12.7	3.14	18	100	18.2
-34 to -36	457	0.5	12684	12.7	3.14	18	100	18.2
-34 to -34	457	0.5	17162	17.2	3.14	25	100	24.6
-34 to -34	457	0.5	17162	17.2	3.14	25	100	24.6
-34 to -34	457	0.5	17162	17.2	3.14	25	100	24.6
-34 to -34	457	0.5	17162	17.2	3.14	25	100	24.6
-13 to -24	559	0.6	15881	15.9	3.14	28	100	27.9
-13 to -24	559	0.6	15881	15.9	3.14	28	100	27.9
-24 to -26	650	0.7	17060	17.1	3.14	35	100	34.8
-24 to -26	650	0.7	17060	17.1	3.14	35	100	34.8
-24 to -34	457	0.5	9500	9.5	3.14	14	100	13.6
-13 to -24	559	0.6	15881	15.9	3.14	28	100	27.9
-13 to -24	559	0.6	15881	15.9	3.14	28	100	27.9

Elevation	Diameter (mm)	Diameter (m)	Length (mm)	Length (m)	Pi	Surface Area (m^2)	% of member within the depth zone	Surface area of subsea members (m^2)
-24 to -26	650	0.7	17060	17.1	3.14	35	100	34.8
-24 to -26	650	0.7	17060	17.1	3.14	35	100	34.8
-24 to -34	457	0.5	9500	9.5	3.14	14	100	13.6
-13 to -24	559	0.6	15881	15.9	3.14	28	100	27.9
-13 to -24	559	0.6	15881	15.9	3.14	28	100	27.9
-24 to -26	650	0.7	17060	17.1	3.14	35	100	34.8
-24 to -26	650	0.7	17060	17.1	3.14	35	100	34.8
-24 to -34	457	0.5	9500	9.5	3.14	14	100	13.6
-13 to -24	559	0.6	15881	15.9	3.14	28	100	27.9
-13 to -24	559	0.6	15881	15.9	3.14	28	100	27.9
-24 to -26	650	0.7	17060	17.1	3.14	35	100	34.8
-24 to -26	650	0.7	17060	17.1	3.14	35	100	34.8
-24 to -34	457	0.5	9500	9.5	3.14	14	100	13.6
0 to -38	1600	1.6	38921	38.9	3.14	196	66	129.1
0 to -38	1600	1.6	38921	38.9	3.14	196	66	129.1
0 to -38	1600	1.6	38921	38.9	3.14	196	66	129.1
0 to -38	1600	1.6	38921	38.9	3.14	196	66	129.1
							Total	**1674.8**

APPENDIX C

NON-SIGNIFICANT IMPACTS

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LIST OF TABLES

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Appendix C provides the justification for environmental and societal risks that were assessed as “low” during the Environmental Risk Assessment (Section 7) and were excluded from further investigation within the main Environmental Statement.

Table C.1: Non-significant (low risk) impacts: general decommissioning activities

Aspect	Receptors or concerns	Proposed control or mitigation	Justification
Planned operations			
Physical presence of vessels	• Commercial fishing • Shipping • Government, MOD • Other commercial users • Recreation and amenity users • Onshore communities (resources)	• Project planning • Design and operational procedures • Notice to mariners and consultation with NFFO • 500 m safety zones where appropriate • Navigation aids • Communications • Good seamanship • Consent to locate for vessels	• Shipping/ fishing traffic can readily navigate round the vessel spread at any given stage during the work programme
Operational discharges of treated oily bilge	• Water quality • Water column (plankton) • Finfish and shellfish • Sea mammals • Seabirds	• Separation systems for oil recovery from bilge • Discharges of oil bilge to marine environment will be within permitted levels of 15 ppm	• Any discharge from the vessels will be within permitted limits
Waste produced from onsite vessels	• Air quality (local) • Terrestrial flora & fauna • Onshore communities (resources)	• Materials will be reused or recycled where possible thereby minimising landfill requirements • Compliance with UK waste legislation and duty of care • Use of designated licensed sites only. • Permits and traceable chain of custody for waste management, shipment, treatment and onshore disposal	• Storage and removal arrangements on the vessels will ensure minimal impact to environment • Small-scale use of landfill capacity for non-reusable and non-recyclable wastes
Sewage and grey water discharges	• Water quality • Water column (plankton) • Finfish and shellfish	• Sewage and grey water will be screened as minimum requirement prior to disposal at sea, or contained and shipped to shore • Vessels will be audited to ensure compliance	• Sewage (organic material only) will be broken down and readily dispersed in the offshore environment • This will result in a localised transient impact with the discharge dissipating to background concentrations within relatively short distance
Macerated food waste discharge	• Water quality • Water column (plankton) • Finfish and shellfish	• Food waste will be macerated prior to discharge; this will aid its dispersal and decomposition in the water column	• Macerated food waste (organic material only) will be broken down and readily dispersed in the offshore environment • The particles of food waste will be <25 mm in diameter, and will be rapidly and widely dispersed in the water column
Ballast water uptake and discharge from the vessels on site	• Sediment biology (benthos) • Water column (plankton) • Finfish and shellfish	• Adherence to the International Convention for the Control and Management of Ships’ Ballast Water and Sediments	• Contractors adherence to the International Convention for the Control and Management of Ships’ Ballast Water is expected to mitigate any potential transboundary, cumulative or global impact resulting from the transfer of organisms
Unplanned events			
Dropped objects	• Sediment structure/ chemistry • Seabed integrity/ physical change • Commercial fishing • Other commercial users	• Adhere to lifting and handling procedures and use of certified equipment for lifting • Retrieve items of debris from the seabed after operations, in compliance with relevant legislation. • Undertake a debris/ sweep survey after completion	• Major items will be recovered from the seabed, therefore no long term impact would be anticipated • Loss of individual hand-tools or minor items of equipment will not constitute a threat to species, habitats or fishing

Table C.2: Non-significant (low risk) impacts: full removal (single or multiple lifts) of topsides

Aspect	Receptors or concerns	Proposed control or mitigation	Justification
Planned operations			
Topside preparation for removal using hot cut, welding, etc.	• Water quality • Air quality (local) • Water column (plankton) • Finfish and shellfish	• Workpacks and procedures for topsides preparatory operations • Containment procedures	• Activities within established 500 m exclusion zone • All impacts will be temporary not permanent
Engineering down and cleaning	• Water quality • Water column (plankton) • Finfish and shellfish	• All new chemicals will be risk-assessed and covered by the relevant discharge permit under the Offshore Chemical Regulations 2002. Chemicals within the topsides system will be covered within the relevant discharge permit at the time of decommissioning	• Any discharge will be within permitted limits
Power generation for topside separation and cutting (plasma, flame or cold cutting)	• Air quality (local)	• Planned efficient cutting regime to achieve as few cuts as possible • Emissions will be minimised through the use of well-maintained equipment • Workpacks and procedures for cutting preparatory operations, under which any hazardous materials will be identified and contained • Containment procedures	• The emissions will be a small-scale contributor of GHGs and other global gases • Localised transient impact in the vicinity of the exhausts • The atmospheric emissions will disperse in the exposed offshore environment
Topside separation and cutting (plasma, flame or cold cutting).	• Water quality • Air quality (local) • Water column (plankton) • Finfish and shellfish	• Planned efficient cutting regime to achieve as few cuts as possible • Emissions will be minimised through the use of well-maintained equipment	• The emissions will be a small-scale contributor of GHGs and other global gases • The atmospheric emissions will disperse in the exposed offshore environment
Power generation for dismantling structures onshore	• Air quality (local)	• Emissions will be minimised through the planning of material movements and decommissioning contractors will be audited to ensure adequate maintenance of equipment.	• The emissions will be a small-scale contributor of GHGs and other global gases
Dismantling structures/ recovery of materials onshore	• Air quality (local) • Land • Freshwater • Onshore communities (resources)	• ConocoPhillips will have in place the following industry standard controls: Materials will be reused or recycled where possible thereby minimising landfill requirements Compliance with UK waste legislation and duty of care and compliance with receiving countries waste legislation if located out with the UK Use of designated licensed sites only. Permits and traceable chain of custody for waste management, shipment, treatment and onshore disposal	• Any cleaning required will be undertaken by a specialist contractor • Potential for NORM/ additional chemicals to be removed affecting other commercial users • Minimal amount of landfill
Unplanned events			
Topside loss during lifting and transportation	• Sediment structure/ chemistry • Seabed integrity/ physical change • Water quality • Sediment biology (benthos) • Finfish and shellfish • Conservation sites	• Detail procedures for heavy lift operations • Module recovery • Post-removal survey	• The area of seabed that will be impacted will be small and localised • All impacts will be temporary not permanent • Oil and gas debris (including any dropped objects) will be recovered
Loss of minor/ small items e.g. scaffold within 500 m of the platform	• Seabed integrity/ physical change • Water column (plankton) • Sea mammals • Conservation sites	• Post-decommissioning debris clearance operations	• The area of seabed that will be impacted will be small and localised • All impacts will be temporary not permanent • Oil and gas debris (including any dropped objects) will be recovered

Table C.3: Non-significant (low risk) impacts: full removal (single lift) of jackets

Aspect	Receptors or concerns	Proposed control or mitigation	Justification
Planned operations			
Power generation for underwater cutting of jackets legs	• Air quality (local)	• Planned efficient cutting regime to achieve as few cuts as possible • Emissions will be minimised through the use of well-maintained equipment • Workpacks and procedures for cutting preparatory operations, under which any hazardous materials will be identified and contained • Containment procedures	• The emissions will be a small-scale contributor of GHGs and other global gases • Localised transient impact in the vicinity of the exhausts • The atmospheric emissions will disperse in the exposed offshore environment
Power generation for dismantling structures onshore	• Air quality (local)	• Emissions will be minimised through the planning of material movements and decommissioning contractors will be audited to ensure adequate maintenance of equipment.	• The emissions will be a small-scale contributor of GHGs and other global gases
Dismantling structures/ recovery of materials onshore	• Air quality (local) • Land • Freshwater • Onshore communities (resources)	• ConocoPhillips will have in place the following industry standard controls: Materials will be reused or recycled where possible thereby minimising landfill requirements Compliance with UK waste legislation and duty of care and compliance with receiving countries waste legislation if located out with the UK Use of designated licensed sites only. Permits and traceable chain of custody for waste management, shipment, treatment and onshore disposal	• Any cleaning required will be undertaken by a specialist contractor • Potential for NORM/ additional chemicals to be removed affecting other commercial users • Minimal amount of landfill
Unplanned events			
Jacket loss during lifting and transportation	• Sediment structure/ chemistry • Seabed integrity/ physical change • Water quality • Sediment biology (benthos) • Finfish and shellfish • Conservation sites	• Detail procedures for heavy lift operations • Module recovery • Post-removal survey	• The area of seabed that will be impacted will be small and localised • All impacts will be temporary not permanent • Oil and gas debris (including any dropped objects) will be recovered
Loss of minor/ small items e.g. scaffold within 500 m of the platform	• Seabed integrity/ physical change • Water column (plankton) • Sea mammals • Conservation sites	• Post-decommissioning debris clearance operations	• The area of seabed that will be impacted will be small and localised • All impacts will be temporary not permanent • Oil and gas debris (including any dropped objects) will be recovered

Table C.4: Non-significant (low risk) impacts: full removal of tee-pieces, manifolds and pigging skid

Aspect	Receptors or concerns	Proposed control or mitigation	Justification
Planned operations			
Removing grout bags	• Sediment structure/ chemistry • Seabed integrity/ physical change • Sediment biology (benthos) • Ecosystem integrity • Conservation sites	• Post-decommissioning surveys will be conducted and will build on pre-decommissioning data acquired during the operational phase to determine the status of the tee-piece, protective structures and seabed before and after the proposed operations	• All impacts will be temporary not permanent • The area of seabed that will be impacted will be small and localised
Removing protective structure	• Sediment structure/ chemistry • Seabed integrity/ physical change • Sediment biology (benthos) • Ecosystem integrity • Conservation sites	• Post-decommissioning surveys will be conducted and will build on pre-decommissioning data acquired during the operational phase to determine the status of the tee-piece, protective structures and seabed before and after the proposed operations.	• All impacts will be temporary not permanent • The area of seabed that will be impacted will be small and localised
Seabed disturbance during full removal of mattresses to access tee-piece/ manifold/ pigging skid	• Sediment structure/ chemistry • Seabed integrity/ physical change • Sediment biology (benthos) • Water column (plankton) • Finfish and shellfish • Ecosystem integrity • Conservation sites	• Post-decommissioning surveys will be conducted and will build on pre-decommissioning data acquired during the operational phase to determine the status of the pipeline and seabed before and after the proposed operations • ConocoPhillips will ensure the seabed is safe and overtrawlable for other users of the sea after completion of the mattress removal operations. This may involve filling the hole with rock or another material to prevent the hole from being left open should natural infill fail.	• All impacts will be temporary not permanent • The area of seabed that will be impacted will be small and localised
Lift the tee-piece/ manifold/ pigging skid using DSV	• Sediment structure/ chemistry • Seabed integrity/ physical change • Water quality • Sediment biology (benthos) • Water column (plankton) • Finfish and shellfish • Ecosystem integrity • Conservation sites	• As the tee-piece will be loaded onto/ transferred to the onsite vessels, it will be placed in a bunded area • Any spillage will be dealt with accordingly • Capped and sealed and any waste will be dealt with for treatment and disposal onshore	• All impacts will be temporary not permanent • The area of seabed that will be impacted will be small and localised • Any possible deterioration of water quality will be rapidly dispersed and diluted
Unplanned events			
Accidentally dropped sections of tee-piece/ manifold/ pigging skid during removal operations	• Seabed integrity/ physical change • Sediment biology (benthos) • Water column (plankton) • Finfish and shellfish • Conservation sites	• Detail procedures for heavy lift operations • Module recovery • Post-removal survey • Oil and gas debris (including any dropped objects) will be recovered	• The area of seabed that will be impacted will be small and localised • All impacts will be temporary not permanent

Table C.5: Non-significant (low risk) impacts: decommissioning pipelines and mattresses in situ

Aspect	Receptors or concerns	Proposed control or mitigation	Justification
Planned operations			
Dredging operations to water jet out pipeline at each end (diver operated)	• Sediment structure/ chemistry • Seabed integrity/ physical change • Water quality • Sediment biology (benthos) • Water column (plankton) • Finfish and shellfish • Ecosystem integrity • Conservation sites	• Post-decommissioning surveys will be conducted and will build on pre-decommissioning data acquired during the operational phase to determine the status of the pipeline and seabed before and after the proposed operations • ConocoPhillips will ensure the seabed is safe and overtrawlable for other users of the sea after completion of the jetting or trenching operations. This may involve filling the hole with rock or another material to prevent the hole from being left open should natural infill fail.	• All impacts will be temporary not permanent • The area of seabed that will be impacted will be small and localised • Any possible deterioration of water quality will be rapidly dispersed and diluted
Cutting the pipelines with diamond wires	• Sediment structure/ chemistry • Water quality • Water column (plankton) • Finfish and shellfish • Ecosystem integrity • Conservation sites	• Post-decommissioning surveys will be conducted and will build on pre-decommissioning data acquired during the operational phase to determine the status of the pipeline and seabed before and after the proposed operations	• Discharges to the marine environment from the cutting operations will be single discrete releases • Concrete will be benign and last in environment for many years • The pipeline will be flooded before they are cut, result in the natural dissipation of the pipeline contents. • If any NORM is released from the pipeline contents this will be localised
Seabed disturbance during full removal of mattresses to access pipeline ends	• Sediment structure/ chemistry • Seabed integrity/ physical change • Water quality • Sediment biology (benthos) • Water column (plankton) • Ecosystem integrity • Conservation sites	• Post-decommissioning surveys will be conducted and will build on pre-decommissioning data acquired during the operational phase to determine the status of the pipeline and seabed before and after the proposed operations • ConocoPhillips will ensure the seabed is safe and overtrawlable for other users of the sea after completion of the mattress removal operations. This may involve filling the hole with rock or another material to prevent the hole from being left open should natural infill fail.	• All impacts will be temporary not permanent • The area of seabed that will be impacted will be small and localised

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APPENDIX D

ENERGY AND EMISSIONS TECHNICAL NOTE

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BMT Cordah

A part of BMT in Energy and Environment

Energy and Emissions Technical Note for ConocoPhillips Decommissioning Programmes, VDP2 and VDP3

Reference: BMT-SNS-V-XX-X-HS-11-00001
Client: ConocoPhillips (U.K.) Limited
Date: October 2015
Confidential

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Contents

ACRONYMS, UNITS AND ABBREVIATIONS

Abbreviation	Meaning
AR	Alpha Riser
AWV	Accommodation Work Vessel
BA	Viking BA Hub Platform
BC	Viking BC Hub Platform
BD	Viking BD Hub Platform
BEIS	Department for Business, Energy & Industrial Strategy
BP	Viking BP Hub Platform
CA	Comparative Assessment
CH_4	Methane
CO_2	Carbon Dioxide
CSV	Construction Support Vessel
DECC	Department of Energy & Climate Change
Defra	Department of Food and Rural Affairs
DP	Decommissioning Programme
DSV	Diving Support Vessel
GJ	Gigajoule
GWP	Global Warming Potential
HLV	Heavy Lift Vessel
IoP	Institute of Petroleum
IPCC	Intergovernmental Panel on Climate Change
JD	Victor JD Satellite Platform
KD	Viking KD Satellite Platform
kg	kilograms
km	kilometres
LD	Viking LD Satellite Platform
m	metres
ND	No Data
NORM	Naturally Occurring Radioactive Material
NO_x	Nitrous Oxides
OSPAR	Oslo Paris Convention
P&A	Plug and Abandonment
ROVSV	Remotely Operated Vehicle Support Vessel
SLV	Single Lift Vessel
SNS	southern North Sea
SO_2	Sulphur Dioxide
UK	United Kingdom
UKCS	United Kingdom Continental Shelf
UTM	Universal Transverse Mercator
VDP2	Viking Decommissioning Programme 2
VDP3	Viking Decommissioning Programme 3
WOW	Waiting on Weather

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1.0 INTRODUCTION

This assessment is based on the Institute of Petroleum (IoP) “Guidelines for the Calculation of Estimates of Energy Use and Gaseous Emissions in the Decommissioning of Offshore Structures” (Section 1.1; IoP, 2000). The method considers the fate of decommissioned material from pre-decommissioning preparation to an onshore end-point, such as recycling or disposal in landfill. Industry standard conversion factors are used to estimate the energy used and associated gaseous emissions generated during each decommissioning activity, including the use of vessels offshore, transportation by road, dismantling of recovered materials and recycling. The estimated energy and emissions are then summed to provide a total figure for the various activities. Within the bounds of uncertainty inherent in all energy and emission assessments, these figures may be used as an indicator of environmental performance.

1.1 Energy Consumption and Gaseous Emissions Factors

As previously stated, the method employed for the calculation of energy use and associated gaseous emissions is based on the IoP guidelines (IoP, 2000). These are drawn from a wide variety of sources and have been selected to represent the breadth of current industry practice; therefore, where possible and appropriate, these factors are used in preference to other data sources (IoP, 2000). In this way, a comparison is possible between the different components of the current study and other studies that have been undertaken using this methodology.

An alternative data source should only be used when it is considered by the operator that new or special equipment may be used that is likely to have a significantly different fuel use from that presented in the IoP database. The tables below present the factors used for each element of the energy and emissions calculations: recycling of materials (Table 1.1); manufacture of new materials (Table 1.2); general fuel consumption (Table 1.3); deconstruction of materials (Table 1.4) and vessel fuel use (Table 1.5). Where conversion factors are available, the gaseous emissions considered are:

- carbon dioxide (CO_2);
- nitric oxide and nitrogen dioxide (NO_X);
- sulphur dioxide (SO_2); and
- methane (CH_4).

Table 1.1: Energy consumption and gaseous emissions factors used in the calculations for the recycling of materials

Material	Energy consumption (GJ/tonne)	Gaseous emissions (kg/tonne)				Source
		CO_2	NOx	SO_2	CH_4	
Standard steel	9	960	1.6	3.8	ND	IoP (2000)
Copper	25	300	ND	120	ND	IoP (2000)
Aluminum	15	1,080	1.3	1.7	ND	IoP (2000)

Table 1.2: Energy consumption and gaseous emissions factors used in the calculations for the new manufacture of materials

Material	Energy consumption (GJ/tonne)	Gaseous emissions (kg/tonne)				Source*
		CO_2	NO_x	SO_2	CH_4	
Standard steel	25.0	1,889	3.5	5.5	No data	IoP (2000)
Concrete	1.0	880	5.4	0.1	No data	IoP (2000)
Plastic (mid-range)*	105.0	3,179	No data	No data	No data	Harvey (2010)*
Aggregate	0.1	5	No data	No data	No data	University of Bath (2008)

* Mid-range energy consumption for 'Plastics' from Harvey (2010); CO_2 expressed as CO_2 equivalent emissions from open loop manufacture of plastics from recycled and raw materials from DEFRA/ DECC (2011).

Table 1.3: Energy consumption and gaseous emissions factors used in the calculations for fuel use

Fuel type	Energy consumption (GJ/tonne)	Gaseous emissions (kg/tonne)				Source
		CO_2	NOx	SO_2	CH_4	
Marine diesel	43.1	3,200	59.0	4	0.270	IoP (2000)
Aviation fuel	46.1	3,200	12.5	4	0.087	IoP (2000)
Diesel fuel	44.0	3,180	40	1	No data	IoP (2000)

Table 1.4: Energy consumption and gaseous emissions factors used in the calculations for onshore deconstruction (platform topsides and jackets only)

Operation	Energy consumption (GJ/tonne)	Gaseous emissions (kg/tonne)				Source
		CO_2	NO_x	SO_2	CH_4	
Overall dismantling	1.15	No data	No data	No data	No data	IoP (2000)

Table 1.5: Energy consumption factors used in the calculations for vessel fuel consumption

Vessel	Fuel consumption (tonnes/day)				Source/ comments
	In port	In transit	Working	Waiting on weather	
Heavy Lift Vessel (HLV) with propulsion	10	50	20	25	IoP (2000)
HLV without propulsion	10	25	20	25	IoP (2000)
Accommodation Work Vessel (AWV)	2	26	18	9	IoP (2000) values for MSV
Supply vessel	2	10	5	5	IoP (2000)
Multi Support Vessel (MSV)	2	26	18	9	IoP (2000)
Construction Support Vessel (CSV)	2	26	18	9	IoP (2000) values for MSV
Diving Support Vessel (DSV)	3	22	18	10	IoP (2000)
Survey vessel	3	22	18	10	IoP (2000) factors for Remotely Operated Vehicle Support Vessel (ROVSV)
Tug	1	10	17	17	IoP (2000) factors for cargo barge tug

1.2 Background

This report presents an assessment of the energy use and gaseous emissions likely to arise during decommissioning of selected ConocoPhillips (UK) Limited (ConocoPhillips) infrastructure (pipelines, subsea support structures, topsides and jackets) in the Viking area of the southern North Sea (SNS) are summarised in Table 1.6. This infrastructure will be subject to Decommissioning Programmes (DPs), which cover the remaining Viking infrastructure (VDP2 and VDP3). Removal and disposal of wellheads are not included here as the plug and abandonment (P&A) well activities are not covered within the scope of these DPs.

Table 1.6: Number of structures due for decommissioning under VDP2 and VDP3

Structure	VDP2	VDP3	Total
Topsides	7	1	8
Jackets	7	1	8
Pipelines	12	4	16
Umbilicals	0	1	1
Subsea structures	3	2	5
Mattresses*	143	35	178
Grout bags**	Quantity unknown	Quantity unknown	Quantity unknown

*Mattress numbers are estimated from BMT Cordah (2015a). Each mattress is estimated to weigh 6 tonnes.

**Quantities and/or weights are unknown. Grout bags have therefore not been included within the scope of this assessment. However, these are only likely to result in a minimal contribution and should not noticeably affect the overall energy and emissions values.

1.3 Location

The VDP2 and VDP3 infrastructure identified in Table 1.6 are located in Quadrant 49 of the United Kingdom Continental Shelf (UKCS; Figure 1.1). The export pipelines (PL27 and PL161) transverse UKCS Quadrants 49, 48 and 47. This report will assess the energy and emissions contributions associated with the decommissioning of the Viking AR, KD, LD, BA, BC, BP and BD (VDP2) platforms and the Victor JD (VDP3) platform, associated pipelines, umbilicals and other subsea infrastructure.

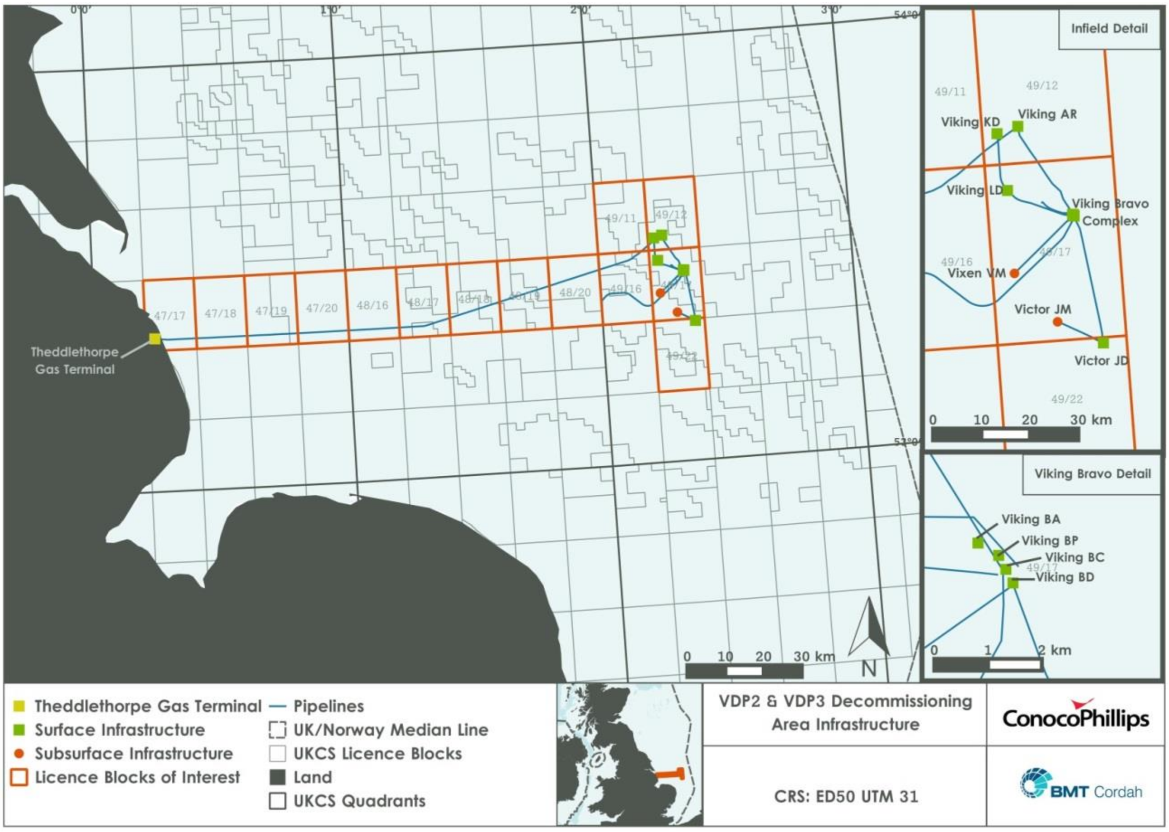

Figure 1.1: VDP2 and VDP3 infrastructure for decommissioning

2.0 ASSESSMENT METHODOLOGY

The IoP (2000) guidelines outline a standardised method to allow oil and gas operators to estimate the energy use and gaseous emissions from the decommissioning of different infrastructure components. This assessment incorporates site-specific assumptions as applicable. The principal steps of this method are as follows:

1. Identify all components (e.g. pipelines, platforms) to be decommissioned.
2. Establish a materials inventory for each component.
3. Identify all operations associated with decommissioning each component, where operations are defined as all the offshore and onshore activities of dismantling and transporting the components and recycling or treating any recovered materials. These operations may require power sources using different fuels for varying time periods.
4. Identify all end-points associated with decommissioning each component. Here end-points are defined as the final states of the materials at the cessation of the decommissioning operations, including the presence of material in landfill sites or on the seabed. If the end-point results in an otherwise-recyclable material being removed from the chain of utility, e.g. steel decommissioned in situ on the seabed or disposed as landfill, this is accounted for by a theoretical cost for the re-manufacture of the material. This has consequent energy use and emissions attributed to the decommissioning process.
5. For each operation and end-point, identify the associated activities that will be a source of energy use and gaseous emissions.
6. Select factors relating each activity to energy use and gaseous emissions, e.g. the energy typically used to recycle one tonne of steel or the fuel consumed per day by a supply vessel in transit.
7. Calculate the energy use and gaseous emissions based on these factors.

2.1 Scope of Assessment

The decommissioning stages included in the scope of the energy and emissions calculations include all operations occurring after the cessation of production and up to the final “sign-off” of the DP and close-out report by the Department for Business, Energy & Industrial Strategy (BEIS) following verification of debris removal. The current report also considers the energy and emissions associated with surveys that may be carried out in the ten years post-decommissioning.

This assessment therefore encompasses the following activities:

- Topside decommissioning.
- Jacket decommissioning.
- Pipeline decommissioning.
- Subsea structure decommissioning.

The sources of energy use and emissions included in the energy assessment for each stage of the VDP2 and VDP3 decommissioning, where applicable, have been identified as:

- Manufacturing of any new materials required for decommissioning.
- Use of helicopters for offshore personnel transportation.
- Use of vessels for transportation and offshore operations.
- Onshore dismantling and/or processing of materials.
- Onshore transportation to processing, recycling and landfill sites.
- Recycling.
- New manufacturing to replace recyclable materials decommissioned on the seabed or disposed of via landfill.

3.0 VDP2 AND VDP3 COMPONENTS FOR DECOMMISSIONING

The vessel requirements for the various decommissioning activities are listed in Table 3.1 and the materials associated with the various components of VDP2 and VDP3 are listed in Tables 3.2 and 3.3, respectively. The methods involved at each stage of decommissioning are described in the following sections:

- Topside decommissioning: Section 3.1.
- Jacket decommissioning: Section 3.2.
- Pipeline decommissioning (including pipeline stabilisation features, surveys, cleaning and remedial work): Section 3.3.
- Subsea structure decommissioning: Section 3.4.

Table 3.1: Summary of vessel use for decommissioning activities

Vessel	Jacket decommissioning	Topsides decommissioning	Pipeline decommissioning	Subsea structure decommissioning
HLV	✓	✓		
Tug	✓	✓*		
Supply vessel			✓	
AWV			✓	
CSV	✓	✓	✓	
DSV			✓	✓
Survey vessel**	✓		✓	✓
Rock dump vessel			✓	
MSV			✓	

*Tug only required if the "Single Lift" option for hub topsides removal is chosen (see Section 3.1.1).

**Survey vessels will be used to assess the condition of pipeline corridors and platform locations. The vessel days associated with surveys have been accounted for under pipeline decommissioning

Table 3.2: Inventory of materials (VDP2)

Components	Material	Weight (tonnes)
Topsides	Steel	11,658
	Plastic	48
	Wood	19
	Copper	117
	Lead	11
	Aluminium	36
	Residual oils and gases	45
	Miscellaneous	304
	Coal tar	0.42
	Total topsides	**12,238**
Jackets	Steel	4,588
	Concrete	40
	Aluminum	59
	Total jackets	**4,687**
Pipelines	Steel	55,061
	Concrete	108,032
	Coal tar	4,833
	Plastic	209
	Total pipelines	**168,135**
Mattresses	Concrete	858
	Total mattresses	**858**
Subsea structures	Steel	87
	Total subsea structures	**87**
	GRAND TOTAL	**186,005**

Sources: D3 (2015) and BMT Cordah (2015a).

Table 3.3: Inventory of materials (VDP3)

Components	Material	Weight (tonnes)
Topsides	Steel	692
	Coal tar	0.1
	Asbestos	0.2
	Plastic	1
	Copper	4
	Lead	5
	Paint	8
	Residual oils and gases	2
	Miscellaneous	38
	Total Topsides	**750**
Jackets	Steel	1,059
	Concrete	166
	Aluminium	10
	Total jackets	**1,235**
Pipelines	Steel	3,621
	Concrete	3,833
	Coal Tar	47
	Total pipelines	**7,501**
Mattresses	Concrete	210
	Total mattresses	**210**
Subsea structures	Steel	75
	Total subsea structures	**75**
	GRAND TOTAL	**9,771**

Sources: D3 (2015) and BMT Cordah (2015a)

3.1 Topsides Decommissioning

Preparatory work for the removal of the platform topsides will include engineering down, module sea-fastening and structural strengthening. During preparatory work for the topside removal all systems will be progressively depressurised, nitrogen purged and rendered safe for removal. In addition, pipework and tanks will be drained and/ or cleaned, to remove sources of potential spills of oils and other fluids.

ConocoPhillips plan to fully decommission the topsides and jackets of all the platforms associated with VDP2 and VDP3 via heavy lift removal, transportation to shore and disposal. Contractors have already been appointed for the decommissioning of the topsides on satellite platforms (Viking AR, KD, LD and Victor JD), which will be decommissioned by Single Lift (Section 3.1.1).

As contractors have not yet been appointed for the hub topsides decommissioning, the method of removal is subject to a comparative study of three options, the results of which are presented in Section 6.2. The three options are described in Sections 3.1.1 to 3.1.3.

3.1.1 Single lift

Following preparation activities, a HLV capable of lifting entire topsides in one lift will be utilised to remove them. The topsides will then be transported by self-propelled HLV to a sheltered location at the designated disposal yard where the topsides will be dismantled. The satellite topsides may be lifted with the supporting jacket where feasible.

3.1.2 Piece small

For piece small deconstruction, modules and other facilities on the topside would be dismantled offshore using manual hot and cold cutting techniques to break the facilities into small manageable sections, which would then be loaded (by HLV) into containers for transportation to shore on supply vessels.

3.1.3 Reverse installation

For reverse installation, modules would be separated offshore by deconstruction of the module interfaces and then removed by a self-propelled HLV. They would be back-loaded to the deck of the vessel or to a cargo barge and then transported to shore.

3.2 Jacket Decommissioning

As the weight (in air) of each jacket structures is less than 10,000 tonnes, these fall within the OSPAR 98/3 category of steel structures for which derogation cannot be sought (OSPAR, 1998). Therefore, the only option available for these platforms is complete removal. “Single Lift” is deemed to be the most appropriate option for the complete removal of the VDP2 and VDP3 jackets.

The planned high level process for the removal of each of the eight jackets is:

- Excavation of the area around the jacket piles where internal cutting is not possible;
- Cutting of the jacket piles to no less than 3 m below the seabed;
- HLV removal of each platform jacket; and
- Removal of additional subsea infrastructure.

A CSV may be used to perform the final cutting works (if required) and the jackets will be transported to a designated disposal yard where they will be dismantled.

3.3 Pipeline Decommissioning

Following the Comparative Assessment (CA), the option to “Decommission the Pipelines in situ with Minimum Intervention” was selected as the preferred option (BMT Cordah, 2015b). As such, the energy and emissions values associated with this decommissioning method are presented here.

The pipelines will initially be cleaned with the ends cut and decommissioned at their original locations and in their current state with minimum intervention. The exposed ends would be buried by jetting, or protected by graded rock. All pipeline stabilisation features (mattresses, grout bags and existing rock-placement) would also be decommissioned in situ to reduce the need for the introduction of additional pipeline support material into the marine environment.

A number of surveys will be carried out as part of the VDP2 and VDP3 pipeline decommissioning. Pre-decommissioning data has been collected to assess the pipeline condition and to provide accurate locations of the pipelines and associated stabilisation features. However, an additional pre-decommissioning survey has been considered as part of the energy and emissions calculations in the event that additional site-specific data is required. Once the decommissioning activities have been completed, an initial post-decommissioning overtrawl and clearance survey would be undertaken to:

- Include in the pre-decommissioning database.
- Establish the status of the newly buried ends.
- Ensure that there are no dropped objects.
- Provide accurate positioning of the cut pipeline and associated stabilisation features.

Ongoing monitoring surveys may be required to assess the condition of the pipeline over time. Currently, three surveys at two, five and ten years post-decommissioning, are assumed but the frequency and number of monitoring surveys will be agreed with BEIS.

3.4 Subsea Structure Decommissioning

The subsea structures include two manifolds, two tee-pieces and two pigging skids. These will be cut from the seabed (or from the surrounding infrastructure where applicable) removed from the seabed by DSV and taken to shore for deconstruction. The structures will be transported to a designated disposal yard where their steel components will be recycled.

4.0 ASSUMPTIONS

The assumptions that are relevant to the VDP2 and VDP3 decommissioning activities as a whole are provided in Section 4.1. Assumptions specific to particular components of the VDP2 and VDP3 infrastructure (topsides, jackets and pipelines) are listed in Sections 4.2 to 4.4.

4.1 Site-Specific Assumptions

The following assumptions apply to all components of the VDP2 and VDP3 decommissioning:

- A return trip by helicopter to the centre of the VDP2 and VDP3 areas takes one hour and the helicopter (Superpuma) uses, approximately, 1,030 litres of aviation fuel per hour (Airbus, 2014).
- Recovered material is assumed to be landed at Hartlepool (Teesside docks) and subsequently taken to landfill and/or recycling sites, approximately, 1 km to the north of the landing site. Any steel component which has been exposed to production fluids is assumed to contain naturally occurring radioactive material (NORM), NORM material will be removed and transported to the Kings Cliffe disposal facility in Northamptonshire, approximately, 266 km to the south, for disposal to landfill. Any waste requiring incineration is assumed to be sent to Ellesmere Port on Merseyside, approximately, 150 km to the west of the landing site. Although sufficient information is currently not available to confirm which landing and onshore processing locations will be selected, it is necessary to make this assumption in order to account for onshore transportation within the energy and emissions budget.
- Material is transported by lorries with a capacity of approximately 33 tonnes. Lorries are assumed to use 0.46 litres of fuel per km (Defra & DECC, 2011) and are assumed to make a return trip from the landing site to the location of the disposal/ recycling facility.
- The energy use associated with offshore and onshore deconstruction of materials is calculated according to the IoP factor for “overall dismantling” (Section 1.1; IoP, 2000). This assumption has been made for two reasons. First, there is inconsistency in the level of information provided by contractors on the fuel use of their deconstruction equipment. Second, there is a lack of published data in general on the deconstruction of different types of materials and components. An overall value is used, therefore, to enable a comparison to be made between this and other studies.
- Conversion factors (IoP or otherwise) are not available for the emissions associated with “overall dismantling.” Therefore, atmospheric emissions values for dismantling are not included in the results for emissions associated with decommissioning of the various components.
- Recovered steel and anode material is recycled.
- A theoretical replacement value is calculated for recyclable material decommissioned in situ or disposed of in a landfill site.
- The energy use and gaseous emissions associated with recycling and the manufacture of new materials is calculated for all materials for which standard factors are available.

- In reality, a Single Lift Vessel (SLV) may be capable of lifting the jacket and topsides. However, energy use and gaseous emissions for carrying out work by HLV have been used here to account for a worst-case scenario.

4.2 Topside Assumptions

The following assumptions are specific to the decommissioning of the topsides:

- No material is decommissioned in situ.
- Some temporary steelwork is anticipated to be required to support the topsides during their removal. The quantity of steelwork required for each decommissioning option (Single Lift, Piece Small and Reverse Installation) is currently unknown, but quantities have been based on BMT Cordah's existing knowledge base for decommissioning projects with comparable platforms in the North Sea.
- All recovered material that can be recycled is recycled and any remaining material is sent to landfill.
- Where material is marked as miscellaneous, it is assumed that it will be sent to landfill. In reality, it may be possible to recycle or reuse some of this material. Therefore, the amount of material to be sent to landfill can be regarded as conservative.
- Material sent to landfill has been accounted for under "New Manufacture to Replace Recyclable Materials" where energy conversion factors are available for identifiable materials.
- Any steel pipework contaminated with NORM is assumed to have the NORM material removed at the receiving yard, with the subsequent transportation of the NORM material to the Kings Cliffe disposal facility in Northamptonshire, where the material will be disposed of to landfill. The pipework will remain at the receiving yard where it will be recycled. As it is currently unfeasible to estimate the quantity (and nature) of NORM in topsides pipework, the quantity of NORM to be transported to Kings Cliffe has been omitted from this assessment.
- An estimate of 20% wait on weather (WOW) contingency has been applied to all vessels involved with topsides removal. This estimate is based on working days only.

4.3 Jacket Assumptions

The following jacket-specific assumptions were made:

- No material is decommissioned in situ above the seabed.
- Individual jacket components (e.g. risers) are not easily distinguished from the total steel value.
- Some steel will remain in situ below the seabed. As the precise amount to be removed/ decommissioned in situ is governed by the location of the sub-seabed cut, it has been assumed that any steel below the seabed will be decommissioned in situ. This has not been accounted for in this assessment due to the unknown quantities of steel below the sea bed. It has been assumed that all jacket steel will be removed and recycled.
- Any steel pipework contaminated with NORM is assumed to have the NORM material removed at the receiving yard, with the subsequent transportation of the NORM material to the Kings Cliffe disposal facility in Northamptonshire, where the material

will be disposed of to landfill. The pipework will remain at the receiving yard where it will be recycled. As it is currently unfeasible to estimate the quantity (and nature) of NORM in topsides pipework, the quantity of NORM to be transported to Kings Cliffe has been omitted from this assessment.

- An estimate of 20% WOW contingency has been applied to all vessels involved with topsides removal above sea level. For CSV activity that involves subsea activity, a 50% WOW contingency has been applied. These estimates are based on working days only.
- Post–decommissioning seabed surveys (including overtrawl and debris clearance surveys) for the seabed area surrounding the jacket location will be undertaken concurrently with the pipeline surveys. The vessel use for these surveys is therefore accounted for included in the pipeline decommissioning activities.

4.4 Pipeline Assumptions

The following assumptions apply to pipeline decommissioning:

- Where energy and emissions values are available for a particular material, items decommissioned in situ or disposed of via landfill, these have been accounted for in the energy and emissions calculations for replacement. This assessment does not include the materials which do not have representative energy and emissions values for re-manufacture.
- It is assumed that any steel pipelines removed (and associated coal tar) will be transported from their location offshore to the Hartlepool dock. Any NORM material will be removed and transported to the Kings Cliffe disposal facility. The pipelines would remain at Hartlepool where they would be recycled.
- Pipeline NORM values are based on Scotoil Service’s (2014) pipeline investigations. NORM contaminated scale quantities are estimated to be 1.8 kg per metre of pipeline (based on known quantities of scale observed in the gas pipeline at the adjacent Viking GD platform).
- It is assumed that where NORM material cannot be separated from the pipeline materials, these materials will also be transported to the treatment facility at Kings Cliffe. Currently, only the quantity of NORM contaminated scale has been accounted for. This may therefore provide an underestimate of the quantity of material to be transported overland, and therefore an underestimate of the energy and emissions associated with this.
- Recovered concrete and plastic associated with the pipelines is assumed to be removed and taken directly to landfill.
- In addition to the post-decommissioning survey, a pre-decommissioning survey has been included in the calculations in the event that additional site-specific data is required prior to the arrival of the work vessels.
- If pipelines and pipeline stabilisation features (mattresses and grout bags) are decommissioned in situ, further monitoring surveys are likely to be required. For the purpose of this assessment, it is assumed that three post-decommissioning surveys will be undertaken at intervals of two, five and ten years.
- No WOW value has been applied to pipeline cleaning activities as these will be undertaken from the adjacent topsides.

- For all vessels undertaking subsea operations involving diving operations, a WOW of 70% has been applied to account for safety constraints. For all CSV and rock-placement activities, a 50% WOW has been applied.
- Rock-placement and/or trenching may be used as a burial method for the pipeline ends. Rock-placement has been accounted for in the “Manufacture of New Materials Required for Decommissioning” and in the “Vessels for Transportation and Offshore Operations.” Trenching activities (where applicable) have been accounted for in “Vessels for Transportation and Offshore Operations.”
- Vessels associated with rock-placement for the AWV stabilisation have not been incorporated in this assessment. This is due to uncertainties surrounding the quantity of rock required for stabilisation at the various platforms and therefore the number of vessels and duration of activity required to carry out the operations. If rock is required for AWV stabilisation at any of the locations, this will result in an increase in energy use and gaseous emissions.

4.5 Subsea Structure Assumptions

- No seabed structures will remain in situ.
- It is assumed that any steel components will be transported from their location offshore to the Hartlepool dock. Any NORM material will be removed and transported to the Kings Cliffe disposal facility. The steel components would remain at Hartlepool where they would be recycled.
- Any steel pipework contaminated with NORM is assumed to have the NORM material removed at the receiving yard, with the subsequent transportation of the NORM material to the Kings Cliffe disposal facility in Northamptonshire, where the material will be disposed of to landfill. The pipework will remain at the receiving yard where it will be recycled. As it is currently unfeasible to estimate the quantity (and nature) of NORM in topsides pipework, the quantity of NORM to be transported to Kings Cliffe has been omitted from this assessment.
- For DSV activity, a 70% WOW contingency has been applied. These estimates are based on working days only.
- Post–decommissioning seabed surveys (including overtrawl and debris clearance surveys) for the seabed area surrounding the subsea structure locations will be undertaken concurrently with the pipeline surveys. The vessel use for these surveys is therefore accounted for included in the pipeline decommissioning activities.

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5.0 RESULTS

The results of this assessment are presented for the different decommissioning elements (where applicable), as follows:

- Manufacture of new components or materials required for decommissioning – this includes, for example, quarried rock for cut ends.
- Vessel and helicopter use and power generation – this includes use of vessels and helicopters for offshore and inshore operations, surveys and transportation of material to shore.
- Onshore transportation – this includes lorry transport of recovered materials to landfill, recycling and processing sites.
- Onshore deconstruction – this includes all dismantling activities, such as cutting and crushing, prior to recycling or landfill.
- Recycling of material – this includes recycling of recovered materials for which energy factors are available.
- New manufacture to replace materials – this includes the theoretical energy use for manufacturing to replace materials, for which energy factors are available, that are decommissioned in situ or disposed of via landfill.

Note that standard gaseous emission factors are not consistently available for all of the gases considered here (Section 6). Consequently, the total gaseous emissions calculated do not always include certain gases:

- CO_2 factors are available for all elements except during the dismantling process.
- NO_X factors are available for all elements apart from the recycling of copper cables and during the dismantling process.
- SO_2 factors are available for all elements apart from during the dismantling process.
- CH_4 factors are only available for marine diesel and aviation fuel.

In addition, the Global Warming Potential (GWP), a measure of the radiative effect of a given gas relative to that for CO_2, may be used to compare the potential contribution of different atmospheric emissions to climate change (IPCC, 2007). A "CO_2 equivalent" may be calculated by multiplying the estimated emissions by the relevant GWP for each gas. However, GWPs are not available for every potential greenhouse gas owing to a lack of experimental data or a wide variation in results from experiments. The only gas where a GWP value was available was CH_4, however, energy and emissions factors are not available for this gas. Consequently, it was concluded that CO_2-equivalent values would not make a meaningful contribution to the assessment and are not presented here.

The following sections outline the results of the energy and emissions calculations for VDP2 and VDP3:

- Satellite platform topsides, including preparation activities (Section 5.1).
- Hub platform topsides, including preparation activities (Section 5.2).
- Jackets (including riser components) (Section 5.3).
- Pipelines, including cleaning, remedial action and associated surveys (Section 5.4).

- Subsea structures (Section 5.5).

5.1 Satellite Platform Topsides Decommissioning

Sections 5.1.1 and 5.1.2 show the calculated energy use and emissions values for activities carried out during the removal of the VDP2 and VDP3 satellite platform topsides by “Single Lift”.

5.1.1 VDP2 satellite platform topsides

The greatest energy use can be attributed to vessel use and power generation, amounting to approximately 60% of the total energy use (Table 5.1 and Figure 5.1). The recycling of topsides components also contributes to a significant proportion (34%) of the total energy use. As a result, vessel and power generation and recycling are the significant contributors to CO_2 emissions, contributing approximately 55% and 44% (respectively) of the total CO_2 value (Table 5.2 and Figure 5.2).

Table 5.1: Energy use (GJ) for decommissioning the VDP2 satellite topsides

Decommissioning element	Energy use (GJ)*
Manufacture of temporary steel for structural strengthening	425
Vessel use and power generation	34,588
Onshore transportation	11
Onshore deconstruction	2,624
Recycling	19,613
New manufacture to replace recyclable materials decommissioned sent to landfill	574
Total	**57,835**

*Where >1, figures are rounded to nearest whole number.

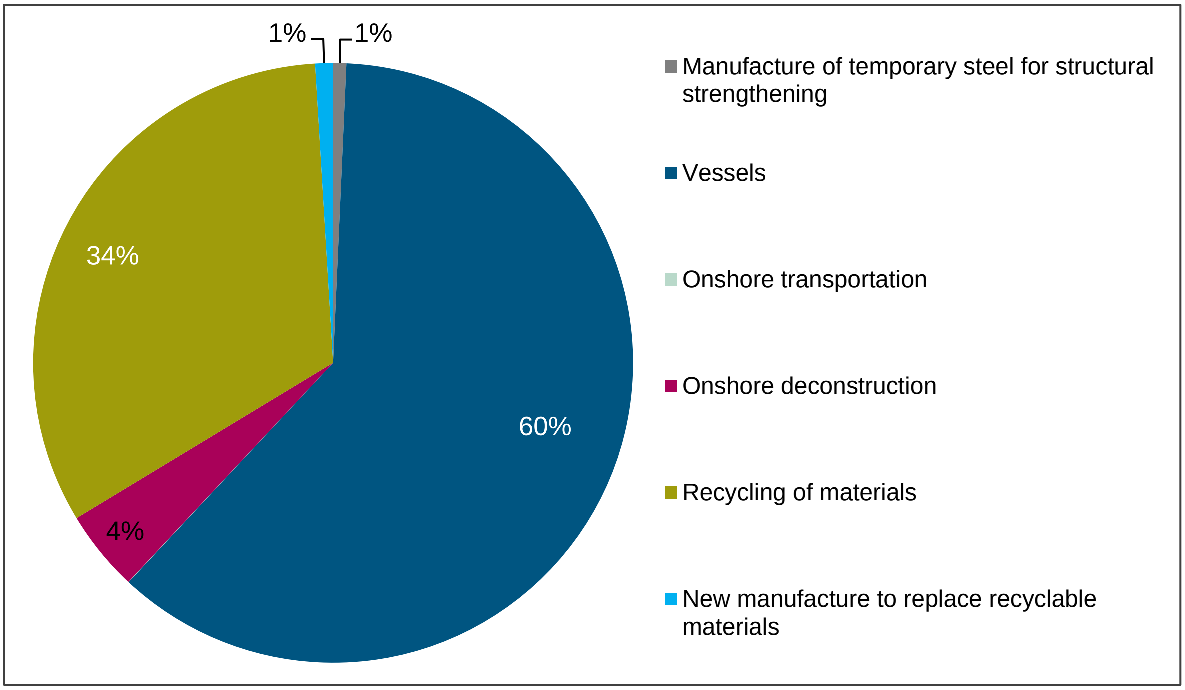
Table 5.2: Emissions (tonnes) for decommissioning the VDP2 satellite topsides

Decommissioning element	Emissions (tonnes)*			
	CO_2	NO_x	SO_2	CH_4
Manufacture of temporary steel for structural strengthening	32	<0.1	<0.1	ND
Vessel use and power generation	2,568	47	3	0.2
Onshore transportation	0.8	<0.1	<0.1	ND
Onshore deconstruction	ND	ND	ND	ND
Recycling**	2,034	3	10	ND
New manufacture to replace recyclable materials decommissioned taken to landfill	17	ND	ND	ND
Total	**4,652**	**50**	**13**	**0.2**

“ND” indicates that no data is available to enable a conversion to be made between a particular operation and the resulting gaseous emissions.

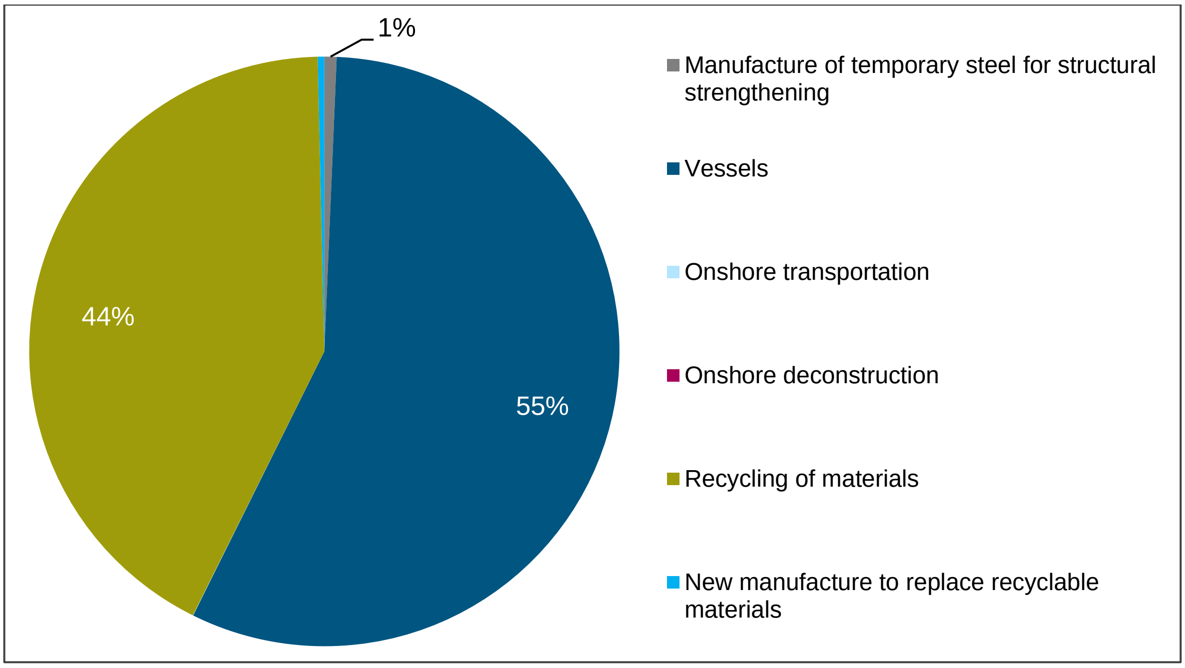
*Where >1, figures are rounded to nearest whole number.

**Note: emissions values are underestimated for recycling as CO_2 and SO_2 values are only available for steel and copper and NO_x values are only available for steel (not for copper).



Note: Categories shown in the legend but not displayed in the pie chart contribute less than 1% to energy use.

Figure 5.1: Energy (GJ) associated with VDP2 satellite topsides decommissioning activities



Note: No conversion factors are available for emissions associated with onshore deconstruction. Categories shown in the legend but not displayed in the pie chart contribute less than 1% to CO_2 emissions.

Figure 5.2: Emissions (tonnes CO_2) associated with VDP2 satellite topsides decommissioning activities

5.1.2 VDP3 satellite platform topside

The greatest energy use for the VDP3 topside decommissioning activities can also be attributed to vessel use and power generation, amounting to approximately 61% of the total energy use (Table 5.3 and Figure 5.3). As a result, CO_2 emissions are also significantly higher for vessel and power generation, contributing approximately 56% of the total CO_2 value (Table 5.4 and Figure 5.4). Recycling accounts for 33% and 43% of the energy use and CO_2 emissions, respectively.

Table 5.3: Energy use (GJ) for decommissioning the VDP3 satellite topside

Decommissioning element	Energy use (GJ)*
Manufacture of temporary steel for structural strengthening	143
Vessel use and power generation	11,529
Onshore transportation	9
Onshore deconstruction	864
Recycling	6,323
New manufacture to replace recyclable materials decommissioned sent to landfill	129
Total	**18,997**

*Where >1, figures are rounded to nearest whole number.

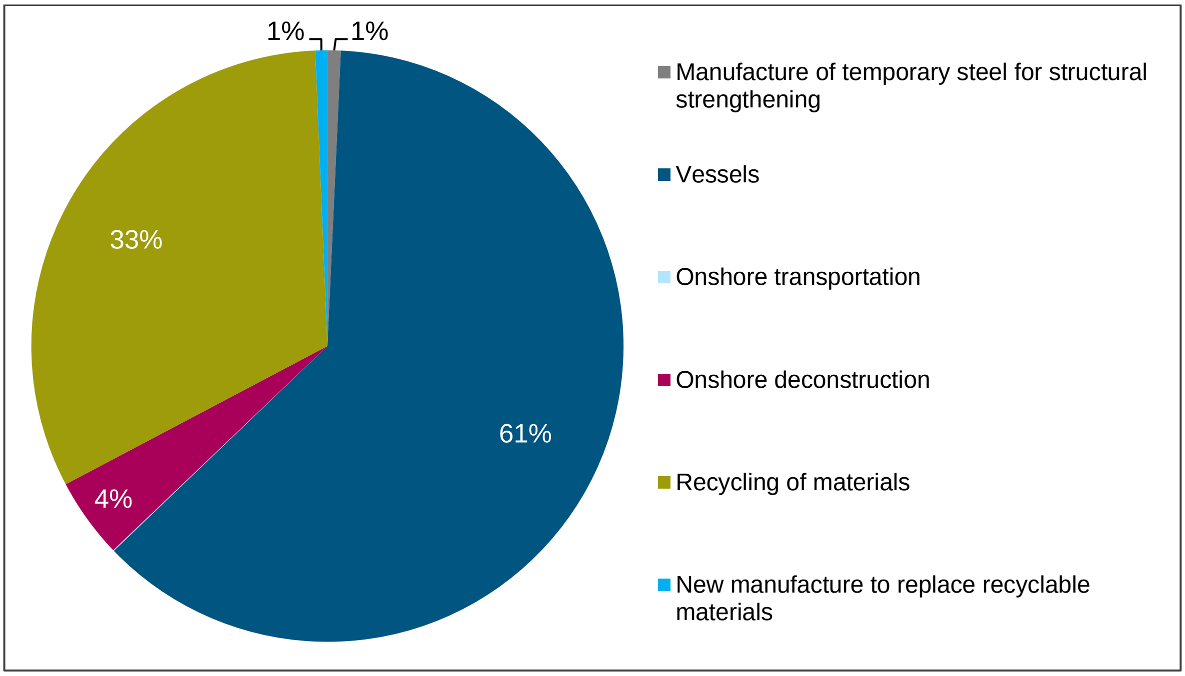
Table 5.4: Emissions (tonnes) for decommissioning the VDP3 satellite topside

Decommissioning element	Emissions (tonnes)*			
	CO_2	NO_x	SO_2	CH_4
Manufacture of temporary steel for structural strengthening	11	<0.1	<0.1	ND
Vessel use and power generation	856	16	1	<0.1
Onshore transportation	0.7	<0.1	<0.1	ND
Onshore deconstruction	ND	ND	ND	ND
Recycling**	666	1	3	ND
New manufacture to replace recyclable materials decommissioned taken to landfill	4	ND	ND	ND
Total	**1,538**	**17**	**4**	**<0.1**

"ND" indicates that no data is available to enable a conversion to be made between a particular operation and the resulting gaseous emissions.

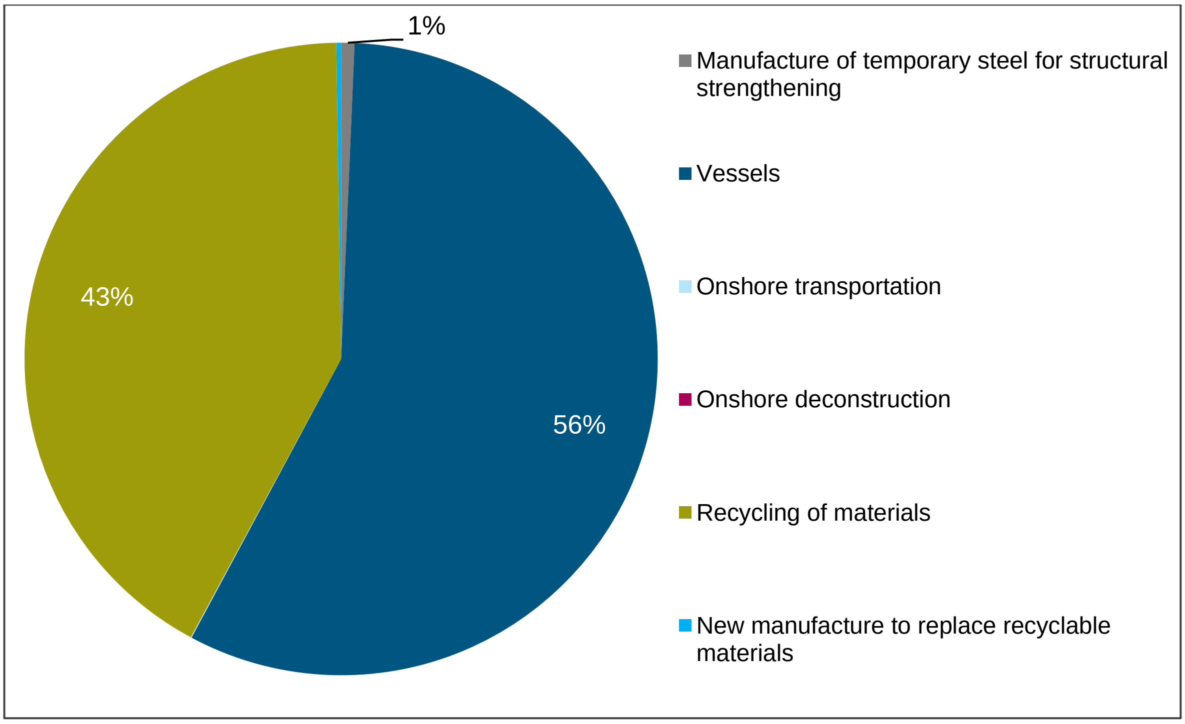
*Where >1, figures are rounded to nearest whole number.

**Note: emissions values are underestimated for recycling as CO_2 and SO_2 values are only available for steel and copper and NO_x values are only available for steel (not for copper).



Note: Categories shown in the legend but not displayed in the pie chart contribute less than 1% to energy use.

Figure 5.3: Energy (GJ) associated with VDP3 satellite topside decommissioning activities



Note: No conversion factors are available for emissions associated with onshore deconstruction. Categories shown in the legend but not displayed in the pie chart contribute less than 1% to CO_2 emissions.

Figure 5.4: Emissions (tonnes CO_2) associated with VDP3 satellite topside decommissioning activities

5.2 Hub Platform Topsides Decommissioning

Sections 5.2.1, 5.2.2 and 5.1.3 show the calculated energy use and emissions values for activities carried out during the removal of the VDP2 hub platform topsides by “Single Lift”, “Piece Small” and “Reverse Installation”, respectively. A comparison of the three options is presented in Section 5.2.4. Preparation operations are included in the vessel calculations and are not listed separately due to the concurrent nature of these operations.

5.2.1 Single lift

The greatest energy use for the VDP2 topsides decommissioning by Single Lift can be attributed to recycling of the topsides components, amounting to approximately 61% of the total energy use (Table 5.5 and Figure 5.5). As a result, recycling is the most significant contributor to CO_2 emissions, making up approximately 74% of the total CO_2 value (Table 5.6 and Figure 5.6). Vessel use and power generation contributes a large proportion to the energy and emissions for Single Lift, accounting for 27% and 24% of the energy use and CO_2 emissions, respectively.

Table 5.5: Energy use (GJ) for VDP2 hub topsides removal by Single Lift

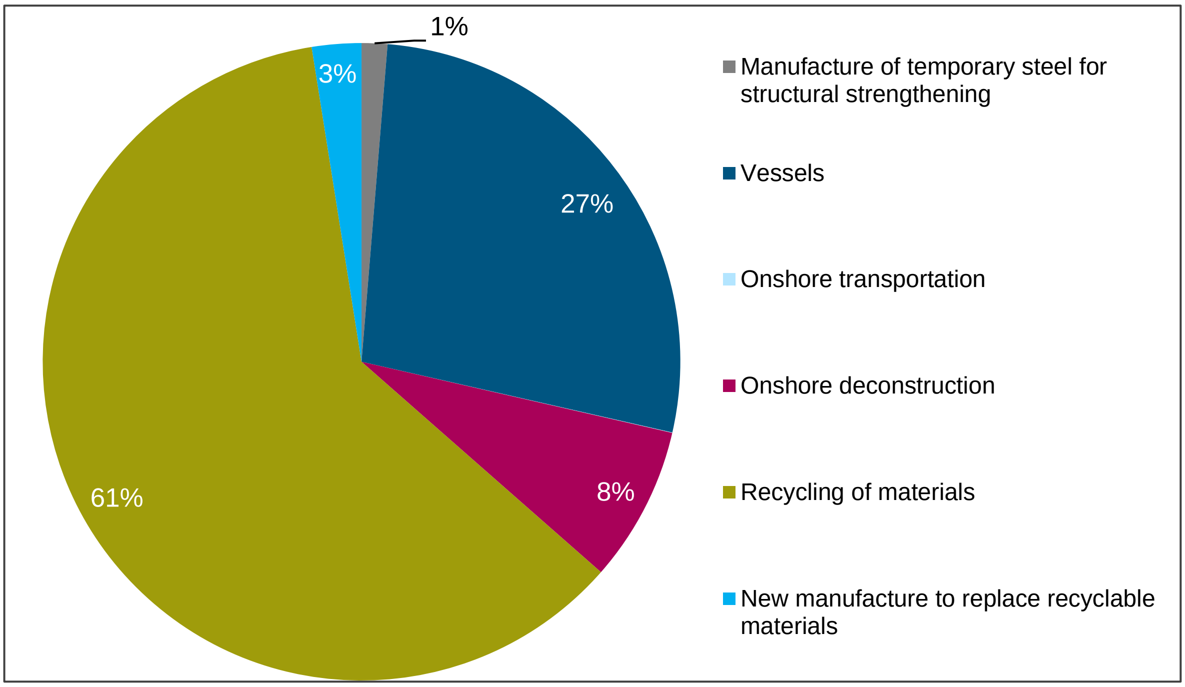
Decommissioning element	Energy use (GJ)*
Manufacture of temporary steel for structural strengthening	1,900
Vessel use and power generation	39,652
Onshore transportation	28
Onshore deconstruction	11,489
Recycling	88,766
New manufacture to replace recyclable materials decommissioned sent to landfill	3,640
Total	**145,475**

*Where >1, figures are rounded to nearest whole number.

Table 5.6: Emissions (tonnes) for VDP2 hub topsides removal by Single Lift

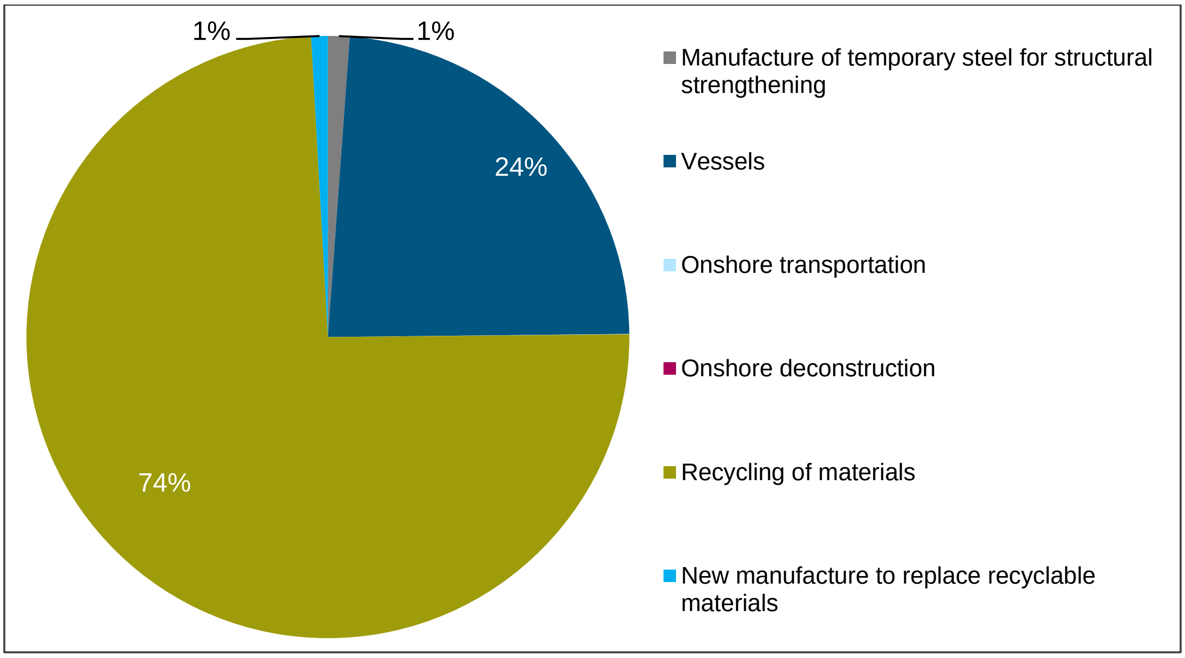
Decommissioning element	Emissions (tonnes)*			
	CO_2	NO_x	SO_2	CH_4
Manufacture of temporary steel for structural strengthening	144	0.3	0.4	ND
Vessel use and power generation	2,944	54	4	0.3
Onshore transportation	2	<0.1	<0.1	ND
Onshore deconstruction	ND	ND	ND	ND
Recycling**	9,231	15	48	ND
New manufacture to replace recyclable materials decommissioned or taken to landfill	110	ND	ND	ND
Total	**12,431**	**69**	**52**	**0.3**

“ND” indicates that no data is available to enable a conversion to be made between a particular operation and the resulting gaseous emissions. *Where >1, figures are rounded to nearest whole number. **Note: emissions values are underestimated for recycling as CO_2 and SO_2 values are only available for steel and copper and NOx values are only available for steel (not for copper).



Note: Categories shown in the legend but not displayed in the pie chart contribute less than 1% to energy use.

Figure 5.5: Energy (GJ) associated with Single Lift VDP2 hub topsides decommissioning activities



Note: No conversion factors are available for emissions associated with onshore deconstruction. Categories shown in the legend but not displayed in the pie chart contribute less than 1% to CO_2 emissions.

Figure 5.6: Emissions (tonnes CO_2) associated with Single Lift VDP2 hub satellite topsides decommissioning activities

5.2.2 Piece small

The greatest energy use for the VDP2 topsides decommissioning by Piece Small can be attributed to vessel use, amounting to approximately 55% of the total energy use (Table 5.7 and Figure 5.7). As a result, vessel use is the most significant contributor to CO_2 emissions, making up approximately 50% of the total CO_2 value (Table 5.8 and Figure 5.8). Recycling of materials contributes a large proportion to the energy and emissions for Piece Small, accounting for 38% and 48% of the energy use and CO_2 emissions, respectively.

Table 5.7: Energy use (GJ) for VDP2 hub topsides removal by Piece Small

Decommissioning element	Energy use (GJ)*
Helicopter use	2,583
Vessel use and power generation	129,300
Onshore transportation	28
Onshore deconstruction	11,489
Recycling	88,766
New manufacture to replace recyclable materials decommissioned sent to landfill	3,740
Total	**235,906**

*Where >1, figures are rounded to nearest whole number.

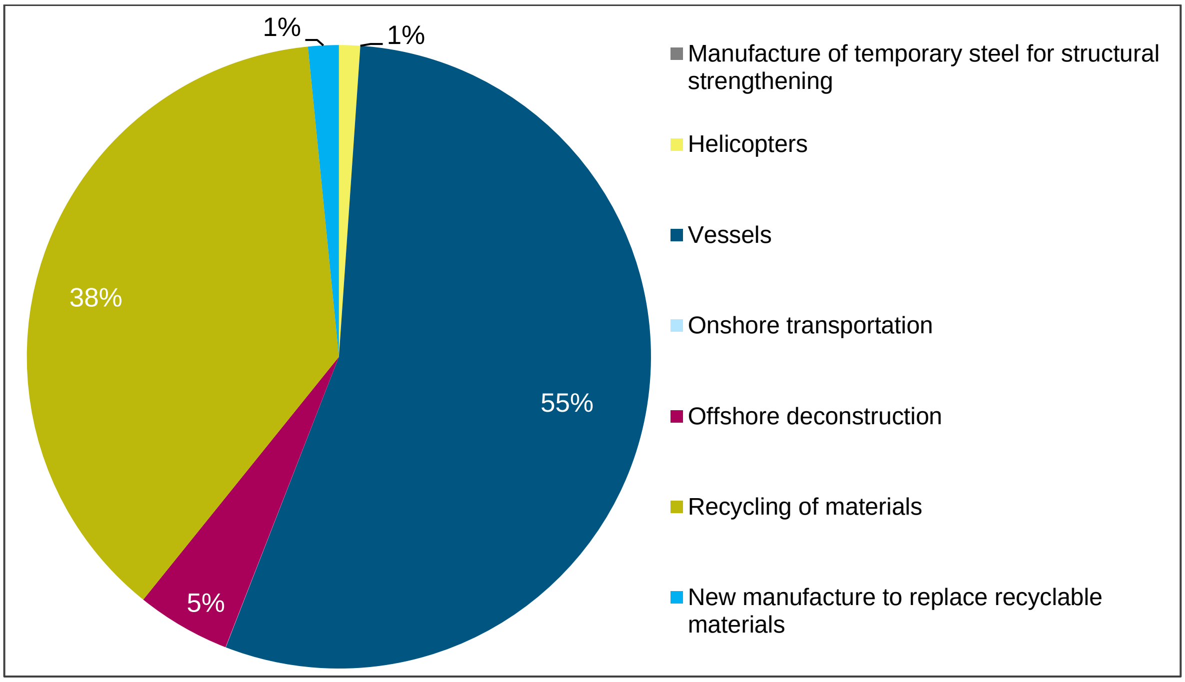
Table 5.8: Emissions (tonnes) for VDP2 hub topsides removal by Piece Small

Decommissioning element	Emissions (tonnes)*			
	CO_2	NO_x	SO_2	CH_4
Helicopter use	179	0.7	0.2	<0.1
Vessel use and power generation	9,600	177	12	0.8
Onshore transportation	2	<0.1	<0.1	ND
Onshore deconstruction	ND	ND	ND	ND
Recycling**	9,231	15	48	ND
New manufacture to replace recyclable materials decommissioned taken to landfill	110	ND	ND	ND
Total	**19,122**	**193**	**60**	**0.8**

"ND" indicates that no data is available to enable a conversion to be made between a particular operation and the resulting gaseous emissions.

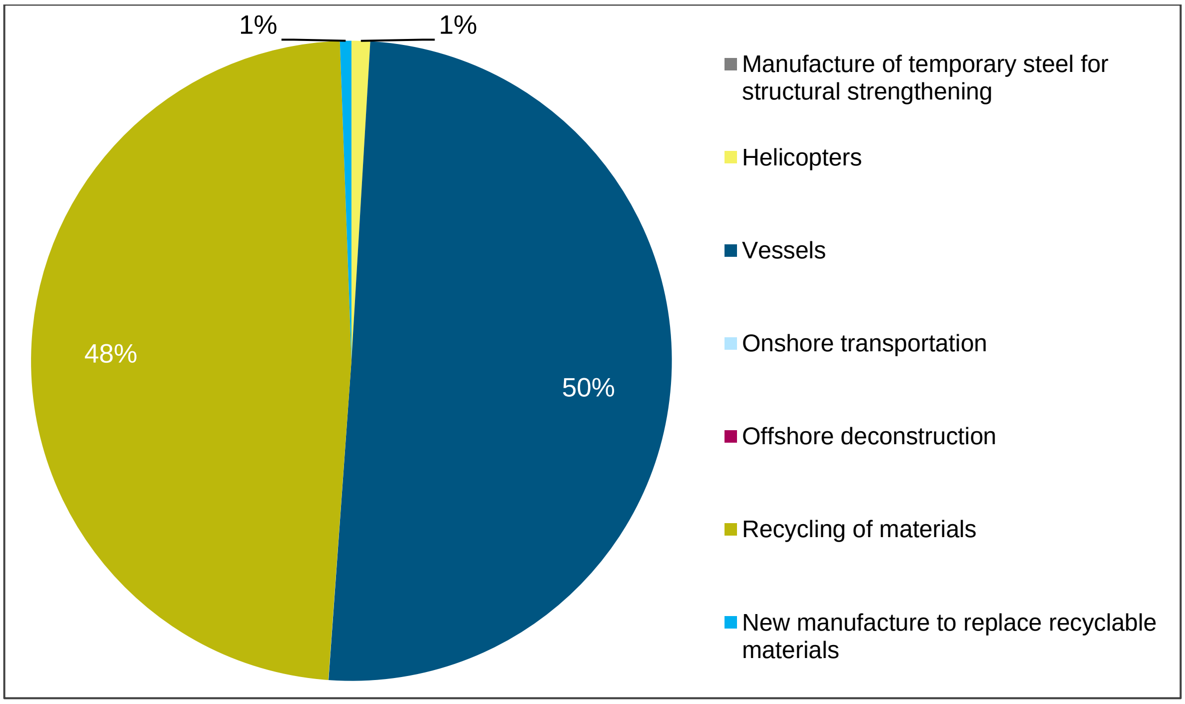
*Where >1, figures are rounded to nearest whole number.

**Note: emissions values are underestimated for recycling as CO_2 and SO_2 values are only available for steel and copper and NO_x values are only available for steel (not for copper).



Note: Categories shown in the legend but not displayed in the pie chart contribute less than 1% to energy use.

Figure 5.7: Energy (GJ) associated with Piece Small VDP2 hub topsides decommissioning activities



Note: No conversion factors are available for emissions associated with onshore deconstruction. Categories shown in the legend but not displayed in the pie chart contribute less than 1% to CO_2 emissions.

Figure 5.8: Emissions (tonnes CO_2) associated with Piece Small VDP2 hub topsides decommissioning activities

5.2.3 Reverse installation

The greatest energy use for topside decommissioning by Reverse Installation can be attributed to vessel use and power generation, amounting to approximately 55% of the total energy use (Table 5.9 and Figure 5.9). As a result, CO_2 emissions are also significantly higher for vessel and power generation, contributing to approximately 50% of the total CO_2 value (Table 5.10 and Figure 5.10). Recycling accounts for 37% and 48% of the energy use and CO_2 emissions, respectively.

Table 5.9: Energy use (GJ) for VDP2 hub topsides removal by Reverse Installation

Decommissioning element	Energy use (GJ)*
Manufacture of temporary steel for structural strengthening	3,000
Vessel use and power generation	130,162
Onshore transportation	28
Onshore deconstruction	11,489
Recycling	88,766
New manufacture to replace recyclable materials decommissioned sent to landfill	3,740
Total	**237,185**

*Where >1, figures are rounded to nearest whole number.

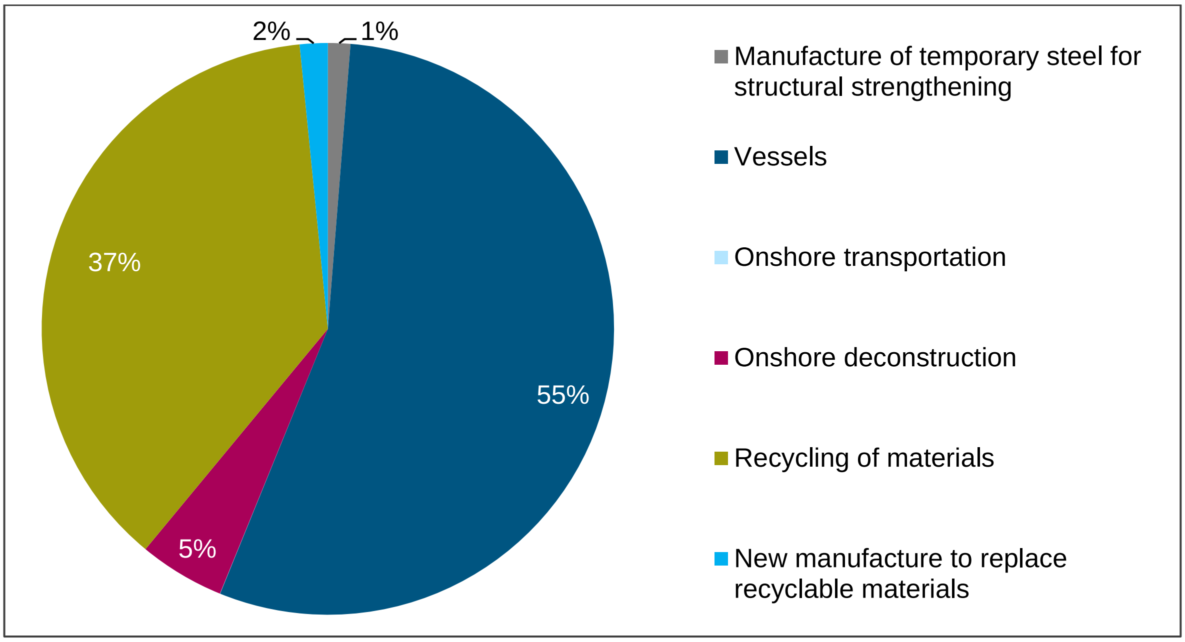
Table 5.10: Emissions (tonnes) for VDP2 hub topsides removal by Reverse Installation

Decommissioning element	Emissions (tonnes)*			
	CO_2	NO_x	SO_2	CH_4
Manufacture of temporary steel for structural strengthening	227	0.4	0.7	ND
Vessel use and power generation	9,664	178	12	0.8
Onshore transportation	2	<0.1	<0.1	ND
Onshore deconstruction	ND	ND	ND	ND
Recycling**	9,231	15	48	ND
New manufacture to replace recyclable materials decommissioned taken to landfill	110	ND	ND	ND
Total	**19,234**	**193**	**61**	**0.8**

"ND" indicates that no data is available to enable a conversion to be made between a particular operation and the resulting gaseous emissions.

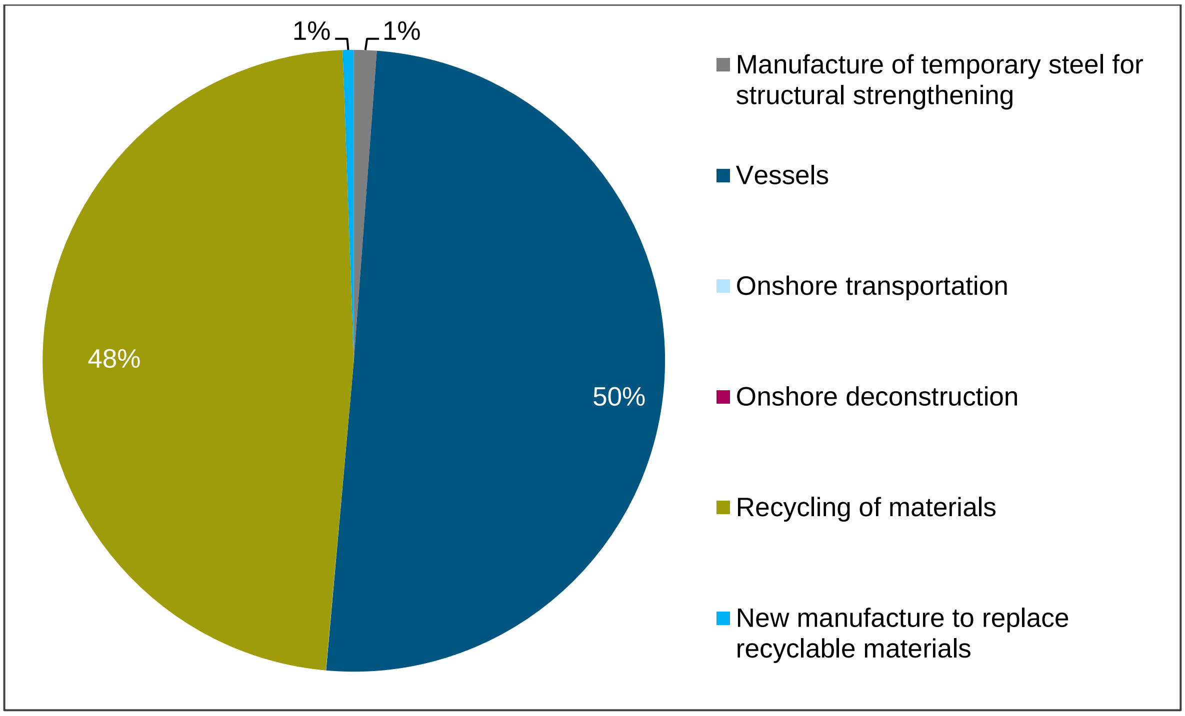
*Where >1, figures are rounded to nearest whole number.

**Note: emissions values are underestimated for recycling as CO_2 and SO_2 values are only available for steel and copper and NO_x values are only available for steel (not for copper).



Note: Categories shown in the legend but not displayed in the pie chart contribute less than 1% to energy use.

Figure 5.9: Energy (GJ) associated with Reverse Installation VDP2 hub topsides decommissioning activities



Note: No conversion factors are available for emissions associated with onshore deconstruction. Categories shown in the legend but not displayed in the pie chart contribute less than 1% to CO_2 emissions.

Figure 5.10: Emissions (tonnes CO_2) associated with Reverse Installation VDP2 hub topsides decommissioning activities

5.2.4 Comparison of hubs topsides decommissioning options

Figure 5.11 and 5.12 provide a comparison of the energy use and CO_2 emissions for the Single Lift, Piece Small and Reverse installation options. Reverse Installation has the highest values for both energy use (237,185 GJ) and CO_2 emissions (19,234 tonnes) and will therefore be taken as the worst- case scenario when considering total energy use and CO_2 emissions for VDP2. However it should be noted that there is not much difference in energy usage or CO_2 emissions between piece small or reverse installation.

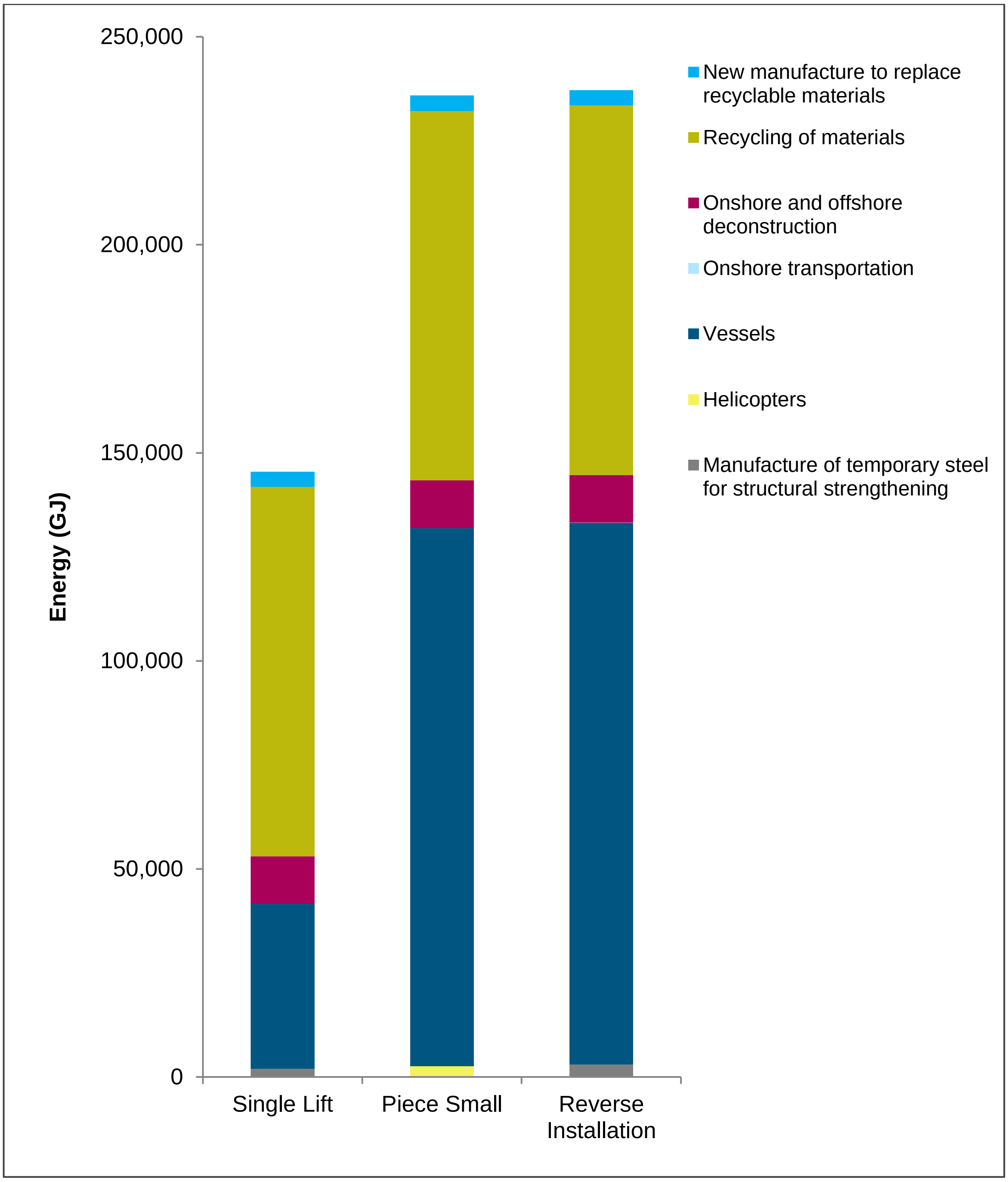


Figure 5.11: Comparison of energy use (GJ) associated with hub topsides decommissioning by Single Lift, Piece Small and Reverse Installation methods

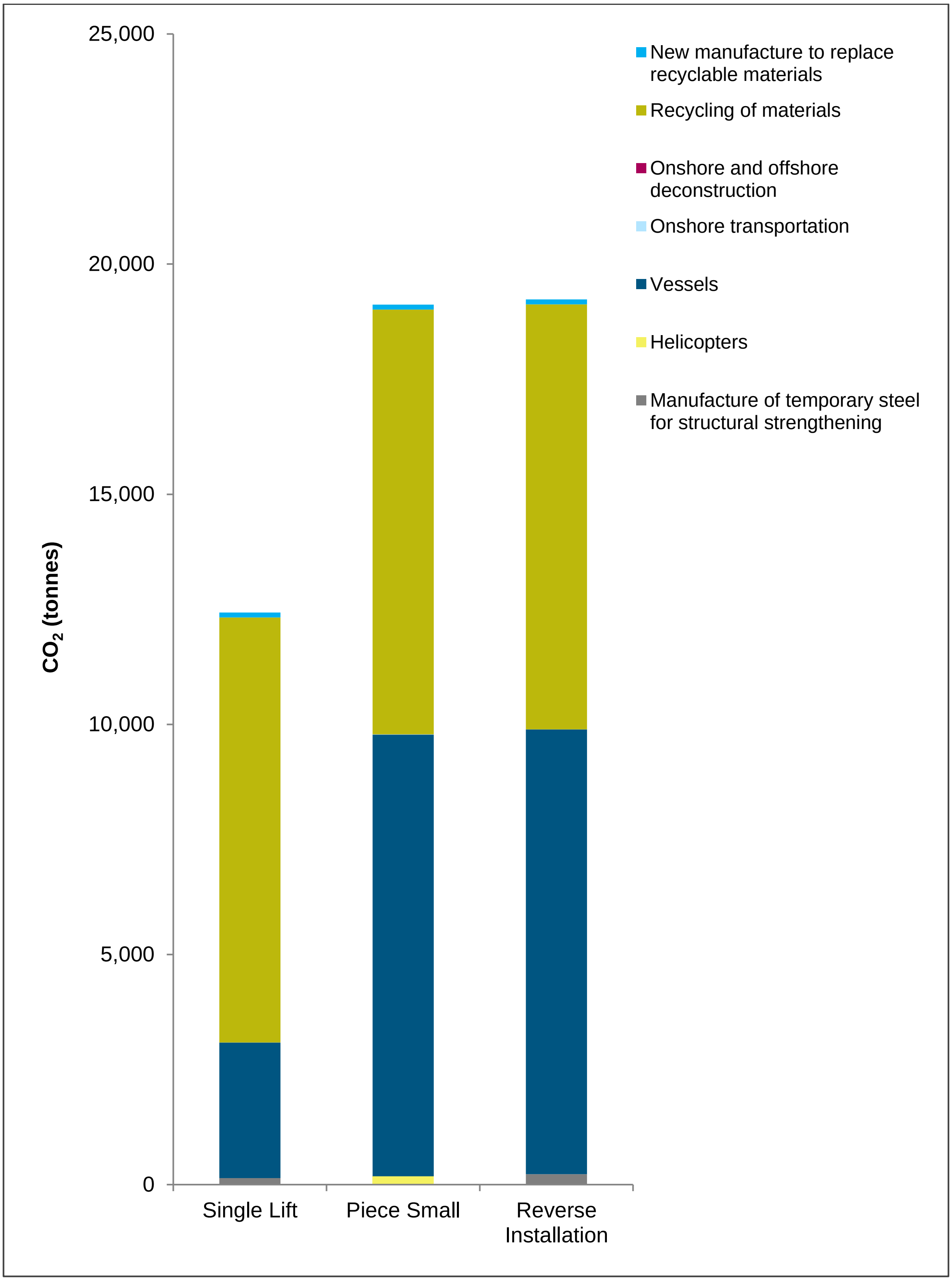


Figure 5.12: Comparison of emissions (tonnes CO_2) associated with hub topsides decommissioning by Single Lift, Piece Small and Reverse Installation methods

5.3 Jacket Decommissioning

Sections 5.3.1 and 5.3.2 present the calculated energy use and emissions values for activities carried out during the removal of the VDP2 and VDP3 jackets, respectively.

5.3.1 VDP2 jackets

The greatest energy use for jacket decommissioning can be attributed to vessel use and power generation, amounting to approximately 69% of the total energy use (Table 5.11 and Figure 5.13). As a result, CO_2 emissions are also significantly higher for vessel and power generation, contributing to approximately 64% of the total CO_2 value (Table 5.12 and Figure 5.14). Recycling is also a large contributor to the total energy use (27%) and CO_2 emissions (36%) for the VDP2 jacket decommissioning.

Table 5.11: Energy use (GJ) for decommissioning the VDP2 jackets

Decommissioning element	Energy use (GJ)*
Helicopter use	188
Vessel use and power generation	108,433
Onshore transportation	4
Onshore deconstruction	5,390
Recycling	42,174
New manufacture to replace recyclable materials decommissioned taken to landfill	40
Total	**156,229**

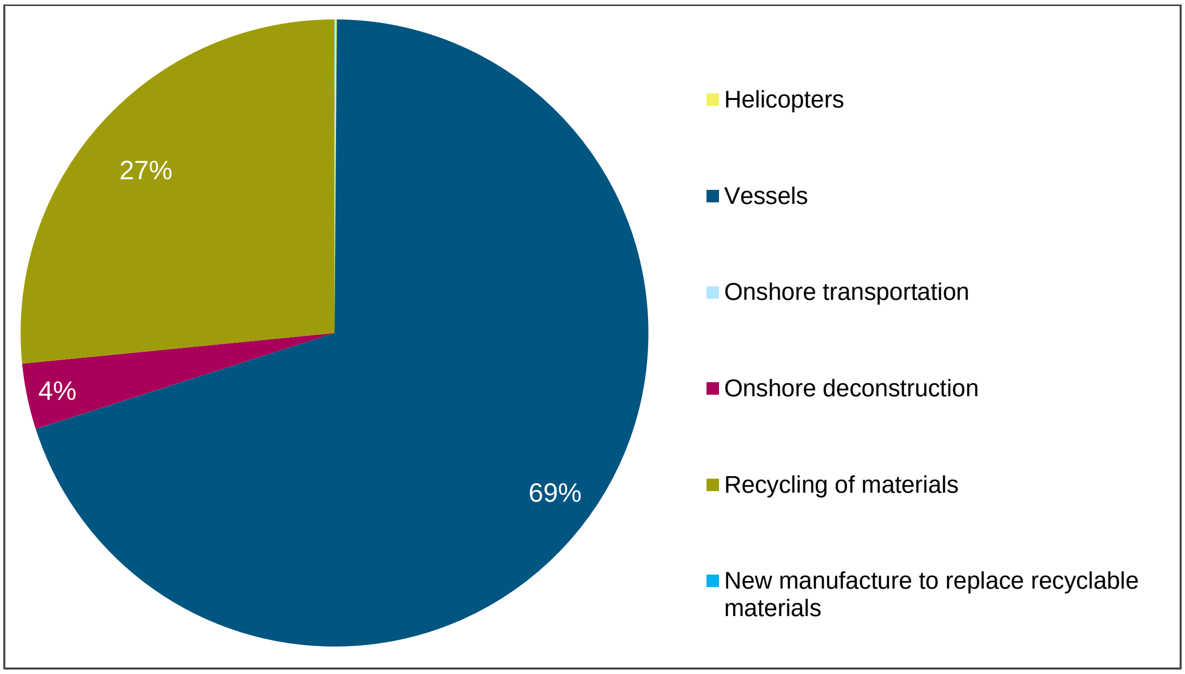
*Where >1, figures are rounded to nearest whole number.

Table 5.12: Emissions (tonnes) for decommissioning the VDP2 jackets

Decommissioning element	Emissions (tonnes)*			
	CO_2	NO_x	SO_2	CH_4
Helicopter use	13	<0.1	<0.1	<0.1
Vessel use and power generation	8,051	148	10	0.7
Onshore transportation	0.3	<0.1	<0.1	ND
Onshore deconstruction	ND	ND	ND	ND
Recycling	4,468	<0.1	1	ND
New manufacture to replace recyclable materials decommissioned taken to landfill	36	<0.1	<0.1	ND
Total	**12,568**	**148**	**11**	**0.7**

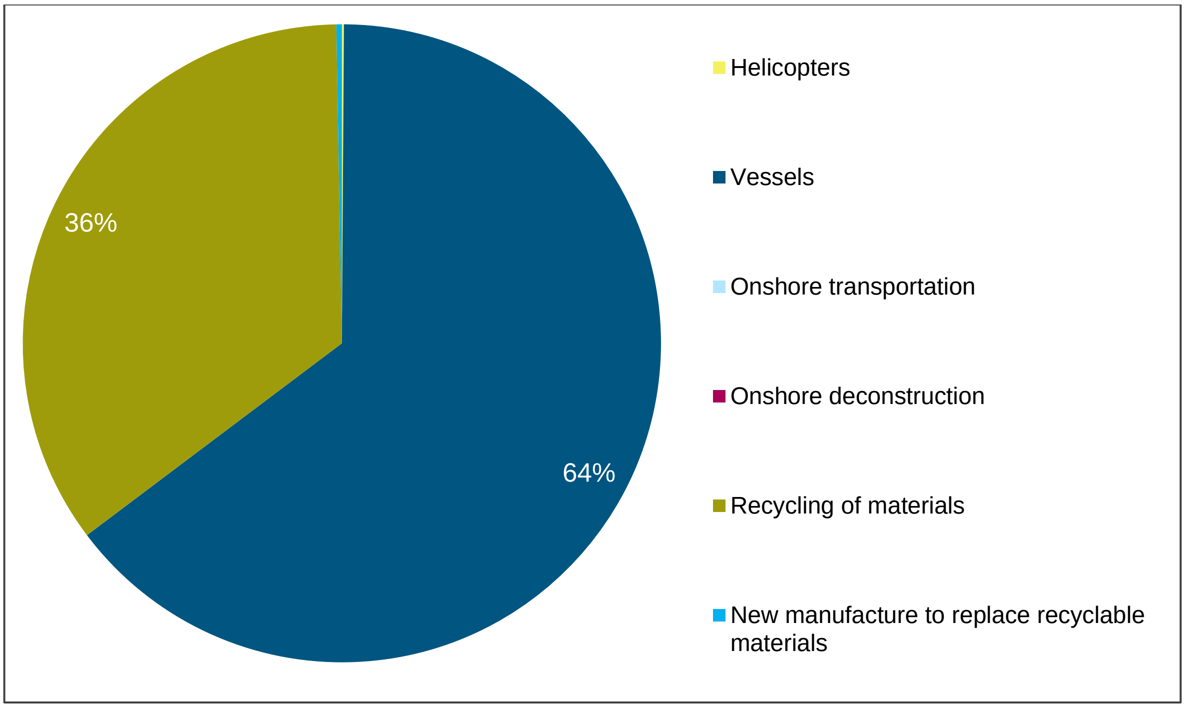
"ND" indicates that no data is available to enable a conversion to be made between a particular operation and the resulting gaseous emissions.

*Where >1, figures are rounded to nearest whole number.



Note: Categories shown in the legend but not displayed in the pie chart contribute less than 1% to energy use.

Figure 5.13: Energy (GJ) associated with VDP2 jacket decommissioning activities



Note: No conversion factors are available for emissions associated with onshore deconstruction. Categories shown in the legend but not displayed in the pie chart contribute less than 1% to CO_2 emissions.

Figure 5.14: Emissions (tonnes CO_2) associated with VDP2 jacket decommissioning activities

5.3.2 VDP3 jackets

The greatest energy use for jacket decommissioning for VDP3 can again be attributed to vessel use and power generation, amounting to approximately 58% of the total energy use (Table 5.13 and Figure 5.15). As a result, CO_2 emissions are also significantly higher for vessel and power generation, contributing to approximately 50% of the total CO_2 value (Table 5.14 and Figure 5.16). Recycling also contributes a large amount to the total energy use and gaseous emissions, representing 36% of the total energy use and 44% of the total CO_2 emissions.

Table 5.13: Energy use (GJ) for decommissioning the VDP3 jacket

Decommissioning element	Energy use (GJ)*
Helicopter use	27
Vessel use and power generation	15,878
Onshore transportation	1
Onshore deconstruction	1,420
Recycling	9,681
New manufacture to replace recyclable materials decommissioned taken to landfill	166
Total	**27,173**

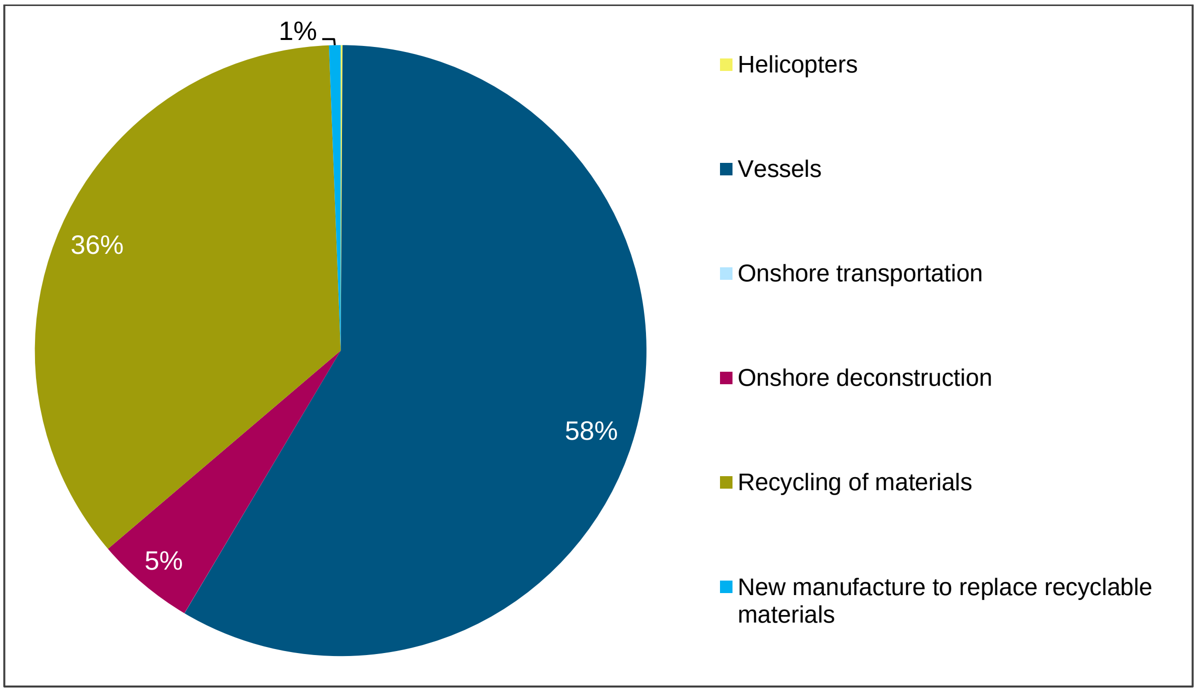
*Where >1, figures are rounded to nearest whole number.

Table 5.14: Emissions (tonnes) for decommissioning the VDP3 jacket

Decommissioning element	Emissions (tonnes)*			
	CO_2	NO_x	SO_2	CH_4
Helicopter use	2	<0.1	<0.1	ND
Vessel use and power generation	1,179	22	1	0.1
Onshore transportation	<0.1	<0.1	<0.1	ND
Onshore deconstruction	ND	ND	ND	ND
Recycling**	1,027	<0.1	0.2	ND
New manufacture to replace recyclable materials decommissioned taken to landfill	146	<0.1	<0.1	ND
Total	**2,354**	**22**	**1**	**0.1**

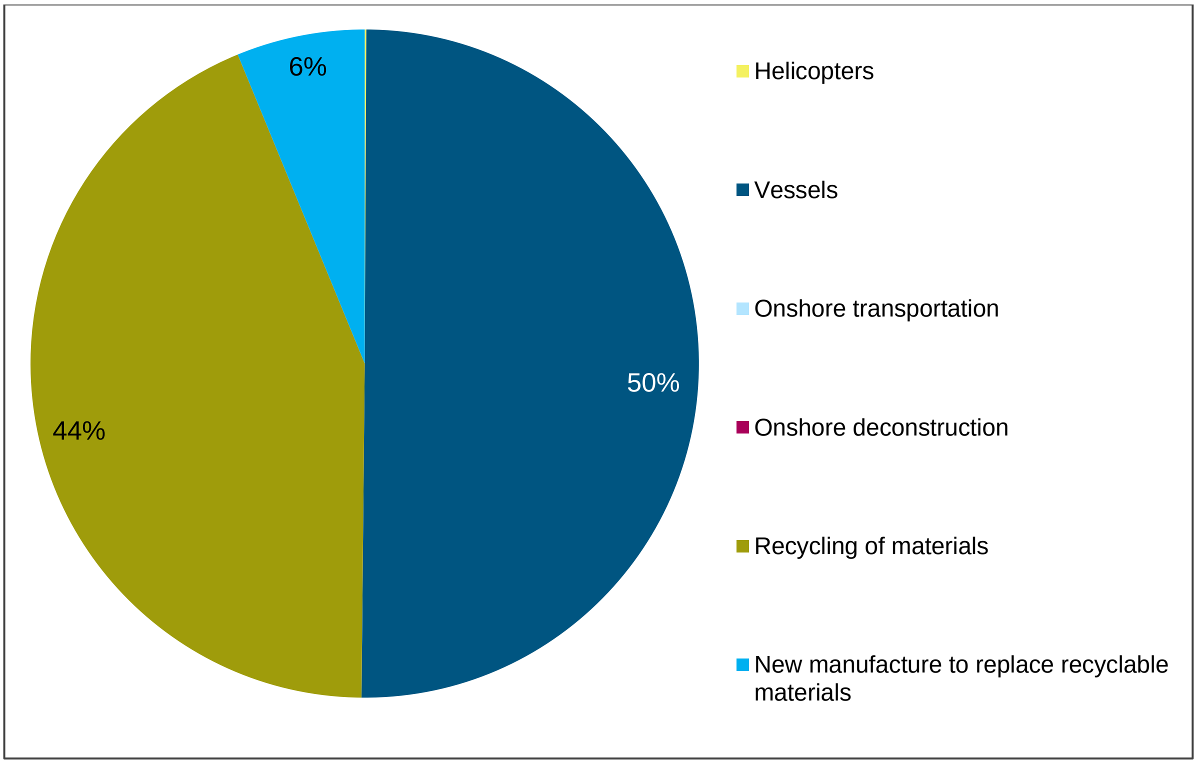
"ND" indicates that no data is available to enable a conversion to be made between a particular operation and the resulting gaseous emissions.

*Where >1, figures are rounded to nearest whole number.



Note: Categories shown in the legend but not displayed in the pie chart contribute less than 1% to energy use.

Figure 5.15: Energy (GJ) associated with VDP3 jacket decommissioning activities



Note: No conversion factors are available for emissions associated with onshore deconstruction. Categories shown in the legend but not displayed in the pie chart contribute less than 1% to CO_2 emissions.

Figure 5.16: Emissions (tonnes CO_2) associated with VDP3 jacket decommissioning activities

5.4 Pipeline Decommissioning

The following sections outline the calculated energy use and predicted emissions for VDP2 (Section 5.4.1) and VDP3 (Section 5.4.2) pipeline decommissioning in situ with minimum intervention.

5.4.1 VDP2 pipelines

The results displayed in Tables 5.15 and 5.16 include the energy and emissions (respectively) for cleaning, surveys and rock-placement activities associated with the VDP2 infrastructure.

The greatest energy use is attributed to new manufacture, to account for recyclable materials decommissioned in situ or sent to landfill, accounting for 1,507,050 GJ and 84% of the total energy (Table 5.15 and Figure 5.17). As a result, emissions are also significantly higher for new manufacture, contributing to approximately 91% of the total emissions (Table 5.16 and Figure 5.18). Total vessel use amounts to 273,454 GJ of energy use and 20,303 tonnes of CO_2 emissions. The majority of vessel use can be attributed to cleaning operations (Table 5.17 and Table 5.18).

Table 5.15: Energy use (GJ) for decommissioning VDP2 pipelines in situ (minimum intervention)

Decommissioning element	Energy use (GJ)*
Manufacture of new materials required for decommissioning (aggregate)	35
Helicopter use	3,044
Vessel use - operations	52,775
Vessel use - surveys	59,383
Vessel use – mattress removal	4,120
Vessel use – cleaning	145,514
Vessel use – rock-placement	11,662
Onshore transportation	10
Recycling	133
New manufacture to replace recyclable materials decommissioned in situ or sent to landfill	1,507,050
Total	**1,783,726**

*Where >1, figures are rounded to nearest whole number.

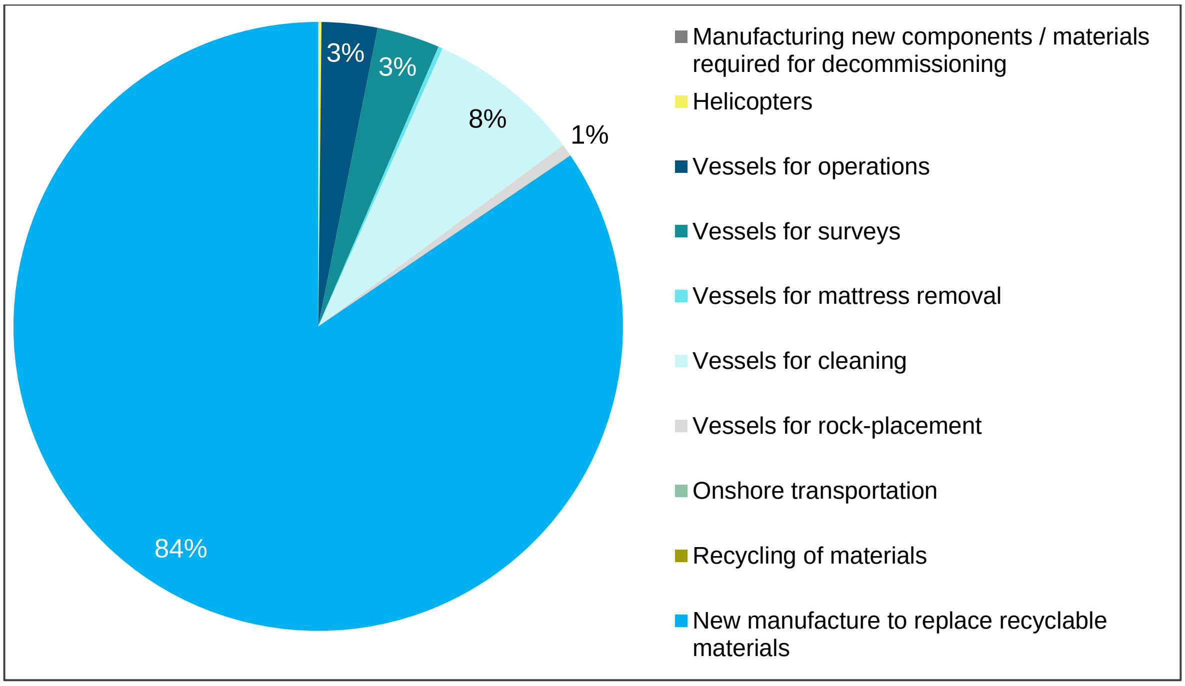
Table 5.16: Emissions (tonnes) for decommissioning VDP2 pipelines in situ (minimum intervention)

Decommissioning element	Emissions (tonnes)*			
	CO_2	NO_x	SO_2	CH_4
Manufacture of new components or materials required for decommissioning	2	ND	ND	ND
Helicopter use	211	0.8	0.3	<0.1
Vessel use - operations	3,918	72	5	0.3
Vessel use - surveys	4,409	81	6	0.4
Vessel use – mattress removal	306	6	0.4	<0.1
Vessel use – cleaning	10,804	199	13	0.9
Vessel use – rock-placement	866	16	1	<0.1
Onshore transportation	0.7	<0.1	<0.1	ND
Recycling**	14	<0.1	<0.1	ND
New manufacture to replace recyclable materials decommissioned in situ or taken to landfill	200,472	781	314	<0.1
Total	**221,003**	**1,156**	**340**	**2**

“ND” indicates that no data is available to enable a conversion to be made between a particular operation and the resulting gaseous emissions.

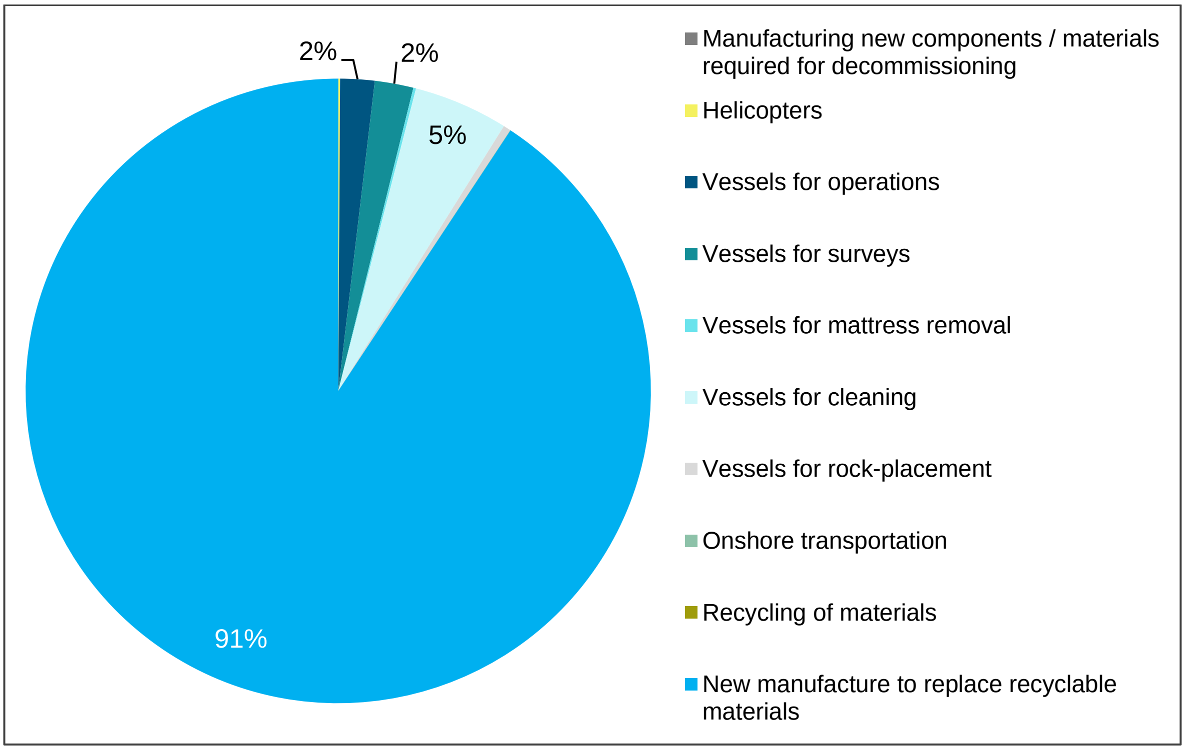
*Where >1, figures are rounded to nearest whole number.

**No emissions factor available for plastic therefore these values are not directly comparable to other NO_x and SO_2 values.



Note: Categories shown in the legend but not displayed in the pie chart contribute less than 1% to CO_2 emissions.

Figure 5.17: Energy use (GJ) associated with VDP2 pipeline decommissioning activities



Note: Categories shown in the legend but not displayed in the pie chart contribute less than 1% to CO_2 emissions.

Figure 5.18: Emissions (tonnes CO_2) associated with VDP2 pipeline decommissioning activities

5.4.2 VDP3 pipelines

The results in Tables 5.17 and 5.18 also include the energy and emissions for associated cleaning, surveys and rock-placement associated with the decommissioning of the VDP3 pipelines.

As with the VDP2 pipelines, the greatest energy use is attributed to new manufacture to replace materials decommissioned in situ or sent to landfill, accounting for 94,498 GJ and 54% of the total energy (Table 5.17 and Figure 5.19). New manufacture also contributes to the majority (approximately 64%) of the total CO_2 emissions associated with VDP3 pipeline decommissioning (Table 5.18 and Figure 5.20). Total vessel use also represents a large proportion (45%) of the total energy use (78,923 GJ) and as a result, emissions are also significantly higher for vessel use, contributing 5,860 tonnes of CO_2, which represents 35% of the total emissions.

Table 5.17: Energy use (GJ) for decommissioning VDP3 pipelines in situ (minimum intervention)

Decommissioning element	Energy use (GJ)*
Manufacture of new materials required for decommissioning	8
Helicopter use	1,046
Vessel use - operations	20,623
Vessel use - surveys	11,335
Vessel use – mattress removal	1,691
Vessel use – cleaning	42,376
Vessel use – rock-placement	2,898
Onshore transportation	10
Recycling	29
New manufacture to replace recyclable materials decommissioned in situ	94,498
Total	**174,514**

*Where >1, figures are rounded to nearest whole number.

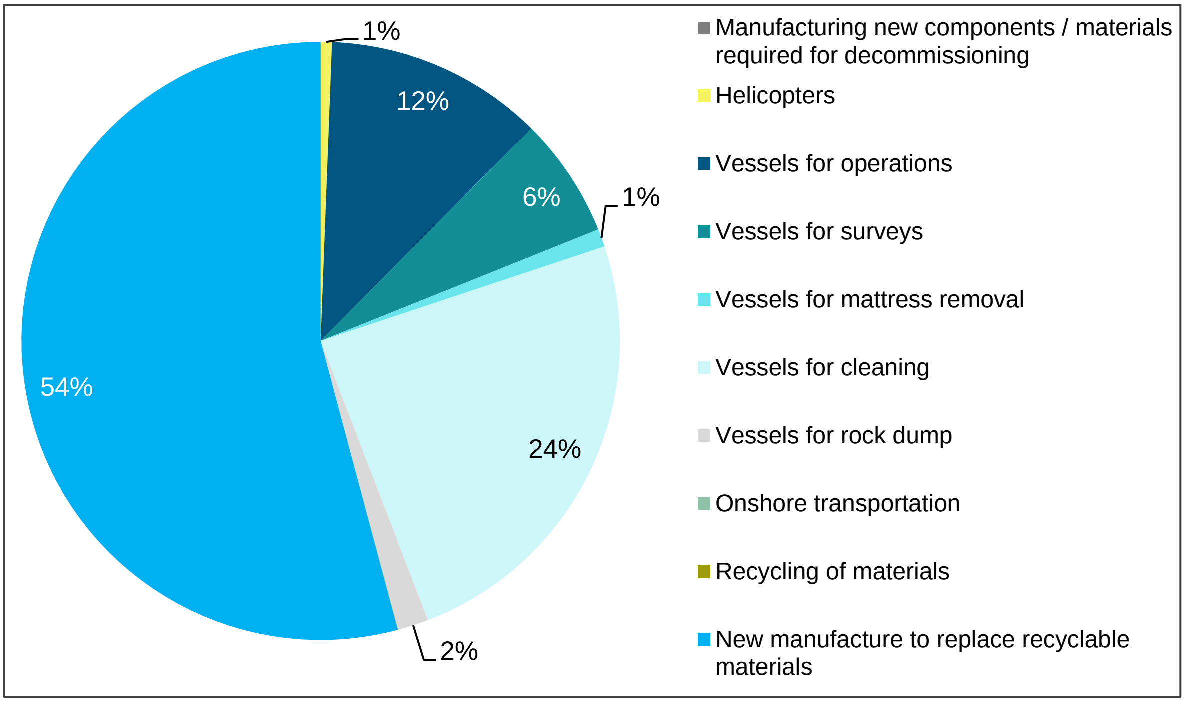
Table 5.18: Emissions (tonnes) for decommissioning VDP3 pipelines in situ (minimum intervention)

Decommissioning Element	Emissions (tonnes)*			
	CO_2	NO_x	SO_2	CH_4
Manufacture of new components or materials required for decommissioning	0.4	ND	ND	ND
Helicopter use	73	0.3	<0.1	<0.1
Vessel use - operations	1,531	28	2	0.1
Vessel use - surveys	842	16	1	<0.1
Vessel use – mattress removal	126	2	0.1	<0.1
Vessel use – cleaning	3,146	58	4	0.3
Vessel use – rock-placement	215	4	0.3	<0.1
Onshore transportation	0.7	<0.1	<0.1	ND
Recycling**	3	<0.1	<0.1	ND
New manufacture to replace recyclable materials decommissioned in situ or taken to landfill	10,392	34	<0.1	<0.1
Total	**16,329**	**142**	**7**	**0.4**

"ND" indicates that no data is available to enable a conversion to be made between a particular operation and the resulting gaseous emissions.

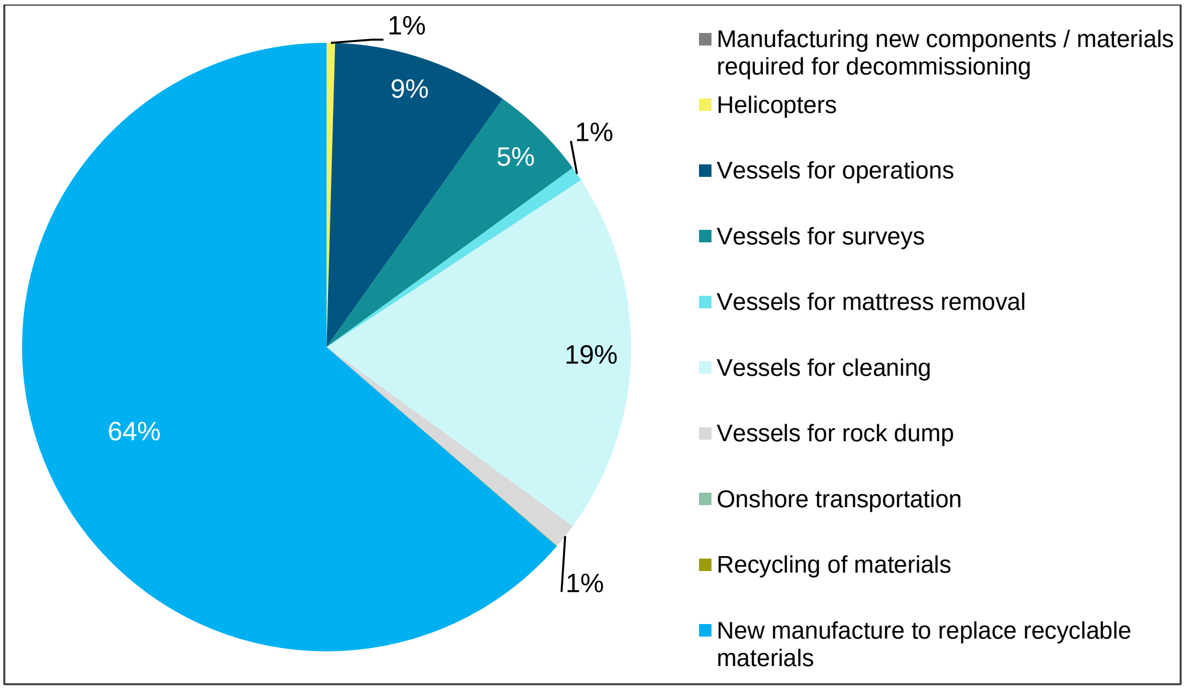
*Where >1, figures are rounded to nearest whole number.

**No emissions factor available for plastic therefore these values are not directly comparable to other NO_x and SO_2 values



Note: Categories shown in the legend but not displayed in the pie chart contribute less than 1% to CO_2 emissions.

Figure 5.19: Energy use (GJ) associated with VDP3 pipelines decommissioning activities



Note: Categories shown in the legend but not displayed in the pie chart contribute less than 1% to CO_2 emissions.

Figure 5.20: Emissions (tonnes CO_2) associated with VDP3 pipelines decommissioning activities

5.5 Subsea Structure Decommissioning

The following sections outline the calculated energy use and predicted emissions for VDP2 (Section 5.5.1) and VDP3 (Section 5.5.2) subsea structure decommissioning.

5.5.1 VDP2 subsea structures

The results displayed in Tables 5.19 and 5.20 include the energy and emissions (respectively) for the VDP2 subsea infrastructure.

The greatest energy use is attributed to vessel use, accounting for 94% of the total energy (Table 5.19 and Figure 5.21). As a result, CO_2 emissions are also significantly higher for vessel use, contributing approximately 93% to total emissions (Table 5.20 and Figure 5.22).

Table 5.19: Energy use (GJ) for the decommissioning the VDP2 subsea structures

Decommissioning element	Energy use (GJ)*
Vessels for removal operations	13,706
Onshore transportation	<0.1
Onshore deconstruction	89
Recycling of materials	694
Total	**14,489**

*Where >1, figures are rounded to nearest whole number.

Table 5.20: Emissions (tonnes) associated with the removal and disposal of the VDP2 subsea structures

Decommissioning element	Emissions (tonnes)*			
	CO2	NOx	SO2	CH4
Vessels for removal operations	1,018	19	1	<0.1
Onshore transportation	<0.1	<0.1	<0.1	ND
Onshore deconstruction	ND	ND	ND	ND
Recycling of materials	74	0.1	0.3	ND
Total	**1,092**	**19**	**1**	**<0.1**

"ND" indicates that no data is available to enable a conversion to be made between a particular operation and the resulting gaseous emissions.

*Where >1, figures are rounded to nearest whole number.

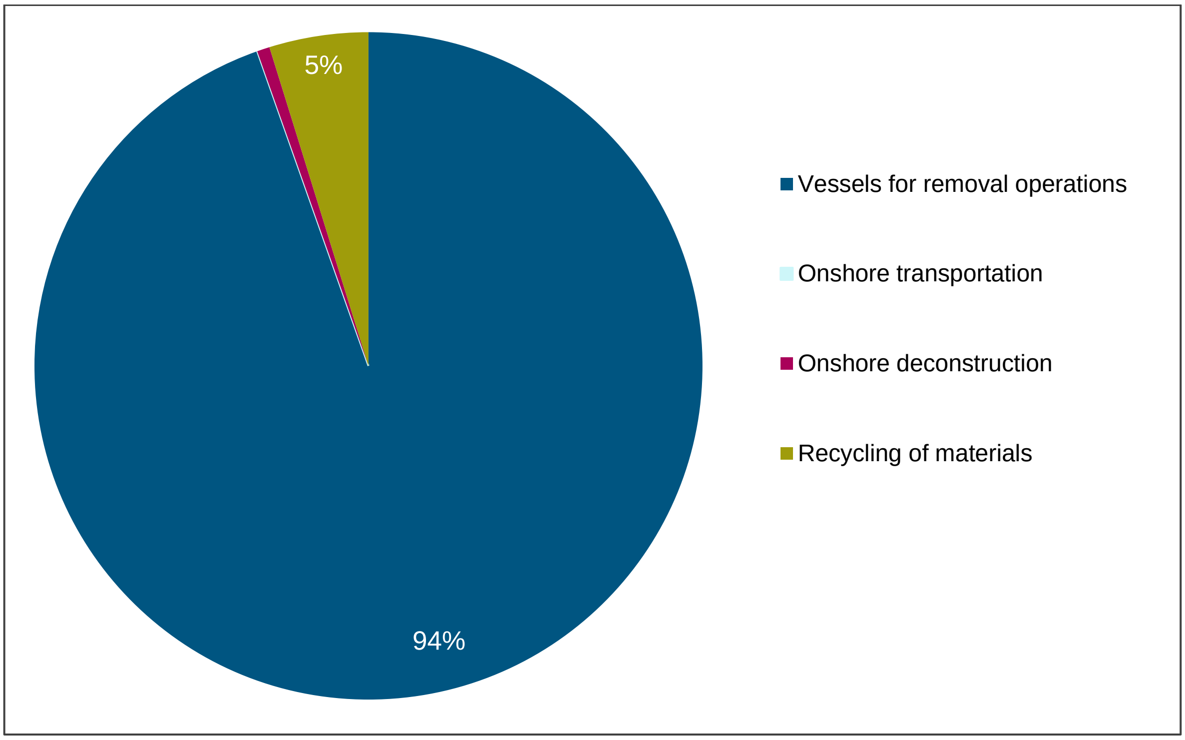
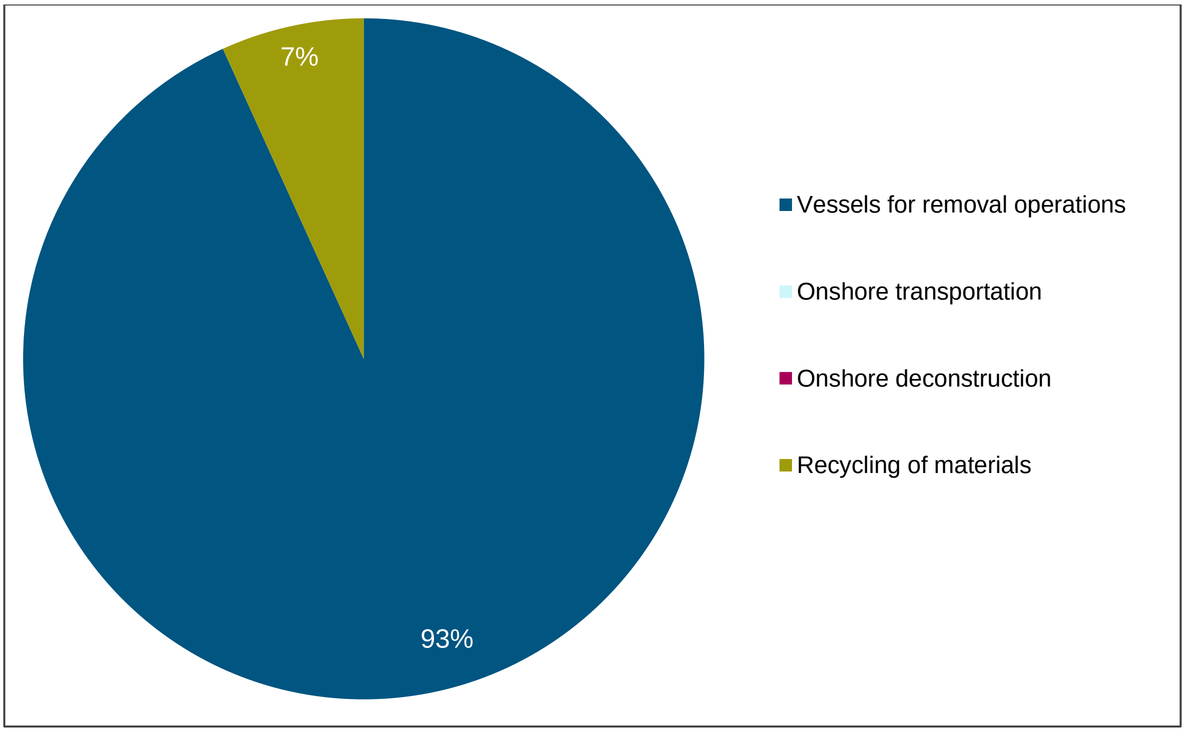


Figure 5.21: Energy use (GJ) associated with the removal of the VDP2 subsea structures



Note: No conversion factors are available for emissions associated with onshore deconstruction. Categories shown in the legend but not displayed in the pie chart contribute less than 1% to CO_2 emissions.

Figure 5.22: Emissions (tonnes CO_2) associated with the removal of the VDP2 subsea structures

5.5.2 VDP3 Subsea Structures

The results displayed in Tables 5.21 and 5.22 include the energy and emissions (respectively) for the VDP3 subsea structures.

As with VDP2, the greatest energy use is attributed to vessel use, accounting for 91% of the total energy (Table 5.23 and Figure 5.23). As a result, CO_2 emissions are also significantly higher for vessel use, contributing approximately 89% to total emissions (Table 5.24 and Figure 5.24).

Table 5.21: Energy use (GJ) for decommissioning the VDP3 subsea structures

Decommissioning element	Energy use (GJ)*
Vessels for removal operations	9,137
Onshore transportation	0.1
Onshore deconstruction	98
Recycling of materials	769
Total	**10,004**

*Where >1, figures are rounded to nearest whole number.

Table 5.22: Emissions (tonnes) for decommissioning the VDP3 subsea structures

Decommissioning element	Emissions (tonnes)*			
	CO_2	NO_x	SO_2	CH_4
Vessels for removal operations	678	13	0.9	0.1
Onshore transportation	<0.1	<0.1	<0.1	ND
Onshore deconstruction	ND	ND	ND	ND
Recycling of materials	82	0.1	0.3	ND
Total	**760**	**13**	**1**	**0.1**

“ND” indicates that no data is available to enable a conversion to be made between a particular operation and the resulting gaseous emissions.

*Where >1, figures are rounded to nearest whole number.

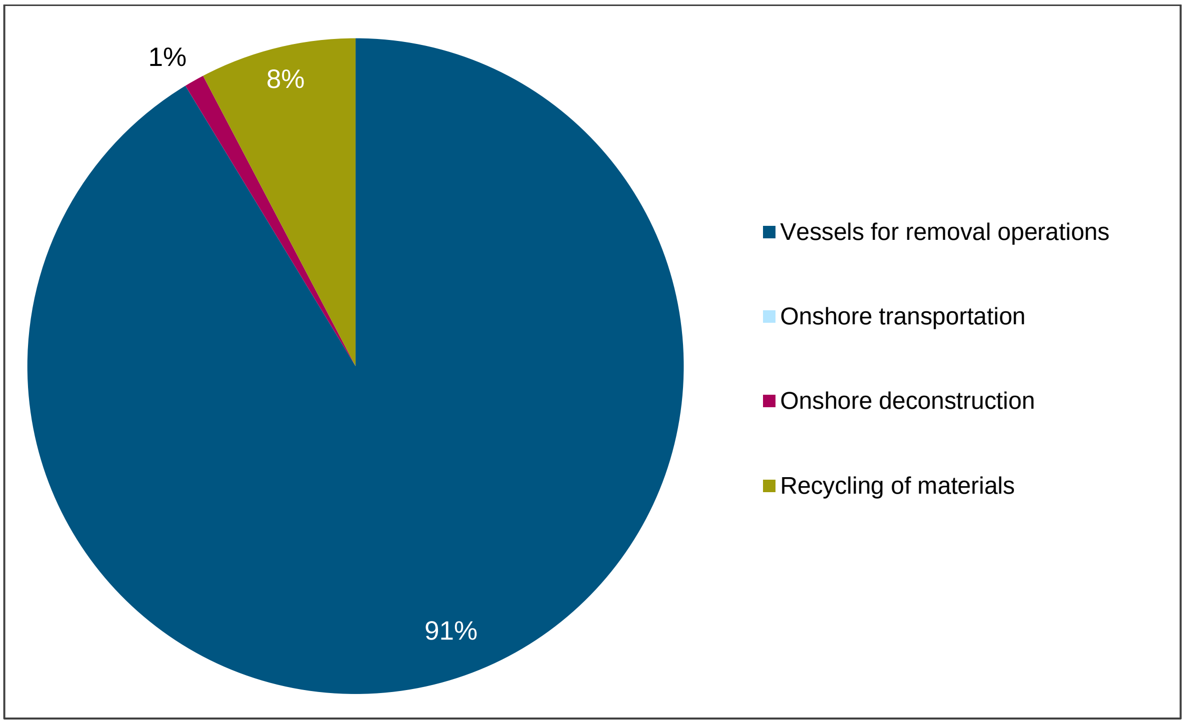
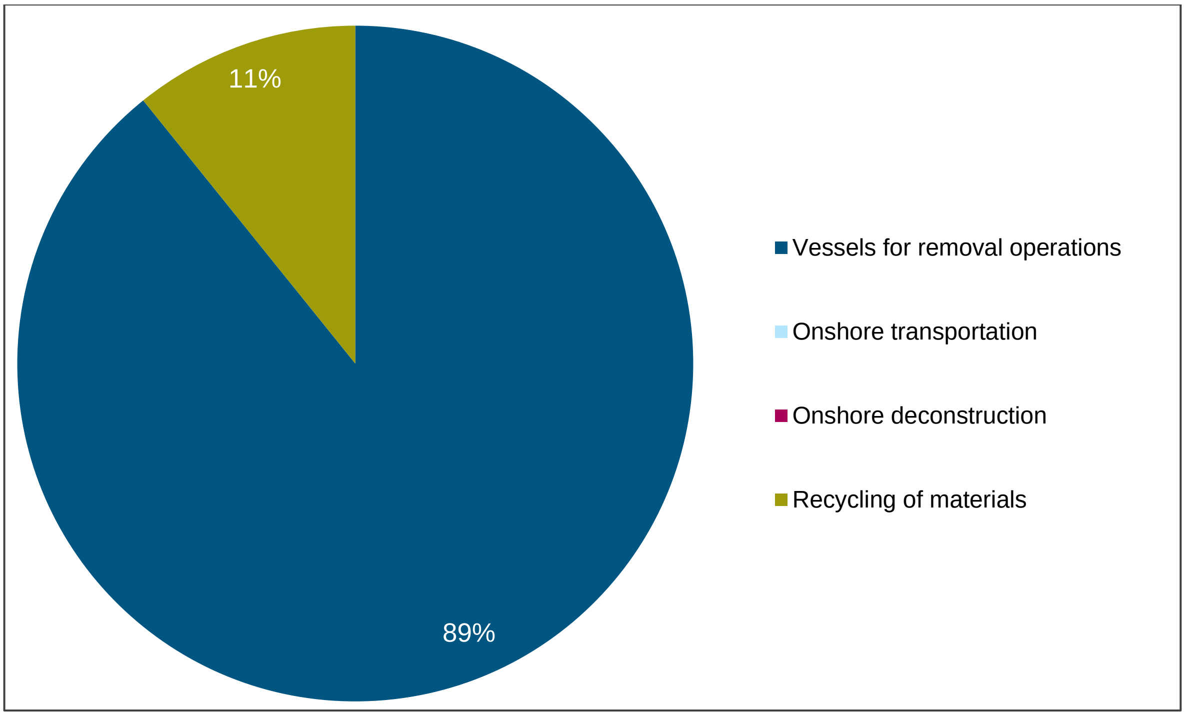


Figure 5.23: Energy use (GJ) associated with the removal of the VDP3 subsea structures



Note: No conversion factors are available for emissions associated with onshore deconstruction. Categories shown in the legend but not displayed in the pie chart contribute less than 1% to CO_2 emissions.

Figure 5.24: Emissions (tonnes CO_2) associated with the removal of the VDP3 subsea structures

6.0 SUMMARY

The total energy use and emissions for the decommissioning of the VDP2 and VDP3 infrastructure (platforms and pipelines) are summarised in Tables 6.1 and 6.2, respectively.

Table 6.1: Total energy and emissions values for the decommissioning of the VDP2 infrastructure

	Satellite topsides	Hub topsides*	Jackets	Pipelines	Subsea structures	Total
Energy (GJ)	57,835	237,185	156,229	1,783,726	14,489	**2,249,464**
Emissions (tonnes CO_2)	4,652	19,234	12,568	221,003	1,092	**258,549**

*As a worst case scenario, the Reverse Installation removal method for hub topsides has been used in the calculation of these totals.

Table 6.2: Total energy and emissions values for the decommissioning of the VDP3 infrastructure

	Topsides	Jackets	Pipelines	Subsea structures	Total
Energy (GJ)	18,997	27,173	174,514	10,004	**230,688**
Emissions (tonnes CO_2)	1,538	2,354	16,329	760	**20,981**

7.0 STUDY CONSTRAINTS

The following points should be considered in conjunction with the results of this analysis:

- The estimates of energy use and gaseous emissions will contain an inherent uncertainty. IoP (2000) reports a typical inherent uncertainty of, approximately, 30% to 40% with these calculations. However, the primary function of the IoP approach is to compare decommissioning options rather than to obtain absolute estimates of energy use and gaseous emissions. Care has been taken throughout this assessment to document the assumptions and ensure consistency of assumptions between and within components of the VDP2 and VDP3 decommissioning.
- Materials other than steel, aluminium, copper, plastic and concrete have not been included in the recycling and replacement calculations due to lack of data on energy and emissions conversion factors. As a result, the energy use associated with recycling and replacement may be underestimated. However, the included materials represent 97% of VDP2 and 98.9% of VDP3 components and so the conclusions of this assessment are unlikely to be affected.
- All dismantling operations for topsides and jackets, including cutting, crushing and drilling, have been parameterised using the IoP (2000) “overall dismantling” factor (Section 1.1). In reality, the energy use of the combination of activities required for each decommissioning option will vary.
- All recovered recyclable material is assumed to be recycled. In reality, some recovered material may not be recycled. For example, it may be found to be too degraded. In consequence, the actual energy use would be lower because landfill disposal would use less energy than recycling; however, the assessed energy use would be higher because of the inclusion of a theoretical cost for replacing the material “lost” to society. Given that the actual onshore landing and processing locations have not been finalised at this time, the final energy budget may differ.
- Rock-placement may be required for extra support and stability for the AWV when working on site. As this is dependent on local seabed topography at each platform site, it is not possible to provide an estimate at this stage. Rock-placement requirements will be applied for via the BEIS Deposit Consent process and the environmental implications of this will be assessed in a supporting Environmental Assessment.

8.0 CONCLUSIONS

Within the bounds of uncertainty, as discussed above, the following conclusions may be drawn for VDP2 (Section 8.1) and VDP3 (Section 8.2):

8.1 VDP2 Energy and Emissions Use

- The satellite topsides decommissioning activity expected to generate the largest energy use (and, consequently, generate the largest volume of gaseous emissions) under VDP2 would be vessel use and power generation, amounting to approximately 60% of the total energy use. Emissions also contribute to approximately 55% of the total CO_2 value of all activities associated with satellite topsides decommissioning.
- Decommissioning of the hub topsides via the Reverse Installation method is expected to generate the largest volume of energy and emissions (when compared to Single Lift and Piece Small methods). Vessel use and power generation is expected to be the main contributor to the energy use (55%) and CO_2 emissions (50%) values for the decommissioning of the hub topsides. Recycling of decommissioned materials also contributes to a large proportion of the expected energy use (37%) and CO_2 emissions (48%).
- Vessel use and power generation is also expected to contribute the largest energy use (69%) and gaseous emissions (64%) to jacket decommissioning under VDP2.
- The greatest energy use for pipeline decommissioning can also be attributed to new manufacture to replace materials decommissioned in situ, amounting to over 84% of the total energy use. Vessel use and power generation also contributes a significant amount (approximately 15%) to the total energy use for pipeline decommissioning.
- Emissions are also significantly higher for the new manufacture to replace materials decommissioned in situ, contributing approximately 91% CO_2 emissions. Vessel use and power generation contributes approximately 9% of the total CO_2 emissions associated with pipeline decommissioning.
- The decommissioning of subsea structures associated with VDP2 is expected to generate energy use, of which vessel use is expected to contribute to 94% of the total energy. Vessel use is also expected to contribute to 93% of the total CO_2 emissions.
- The predicted total energy use during the proposed VDP2 decommissioning activities is 2,249,465 GJ.
- The total CO_2 emissions for VDP2 (258,549 tonnes) represents 1.8% of the total emissions for the UKCS in 2013 (14,310,000 tonnes of CO_2; OGUK, 2014).

8.2 VDP3 Energy and Emissions Use

- The topsides decommissioning activity expected to generate the largest energy use (and, consequently, generate the largest volume of gaseous emissions) for VDP3 would be vessel use and power generation, amounting to approximately 61% of the total energy use. Emissions related to these activities contribute to approximately 56% of the total CO_2 value of all activities associated with topsides decommissioning. Recycling of decommissioned materials also contributes to a large proportion of the expected energy use (33%) and CO_2 emissions (43%).
- Vessel use and power generation is also expected to contribute the largest energy use (58%) and gaseous emissions (50% of CO_2) to jacket decommissioning under VDP3. Recycling contributes to most of the remaining energy use and CO_2 emissions (36% and 44%, respectively).
- The greatest energy use for VDP3 pipeline decommissioning can also be attributed to new manufacture to replace materials decommissioned in situ, amounting to over 54% of the total energy use. Vessel use and power generation also contributes a significant amount (approximately 45%) to the total energy use for pipeline decommissioning.
- Emissions are also significantly higher for the new manufacture to replace materials decommissioned in situ, contributing approximately 64% CO_2 emissions. Vessel use and power generation contributes approximately 35% of the total CO_2 emissions associated with VDP3 pipeline decommissioning.
- The decommissioning of subsea structures associated with VDP3 is expected to generate energy use, of which vessel use is expected to contribute to 91% of the total energy. Vessel use is also expected to contribute to 89% of the total CO_2 emissions
- The predicted total energy use during the proposed VDP3 decommissioning activities is 230,688 GJ.
- The total CO_2 emissions for VDP3 (20,981 tonnes) represents 0.15% of the total emissions for the UKCS in 2013 (14,310,000 tonnes of CO_2; OGUK, 2014).

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