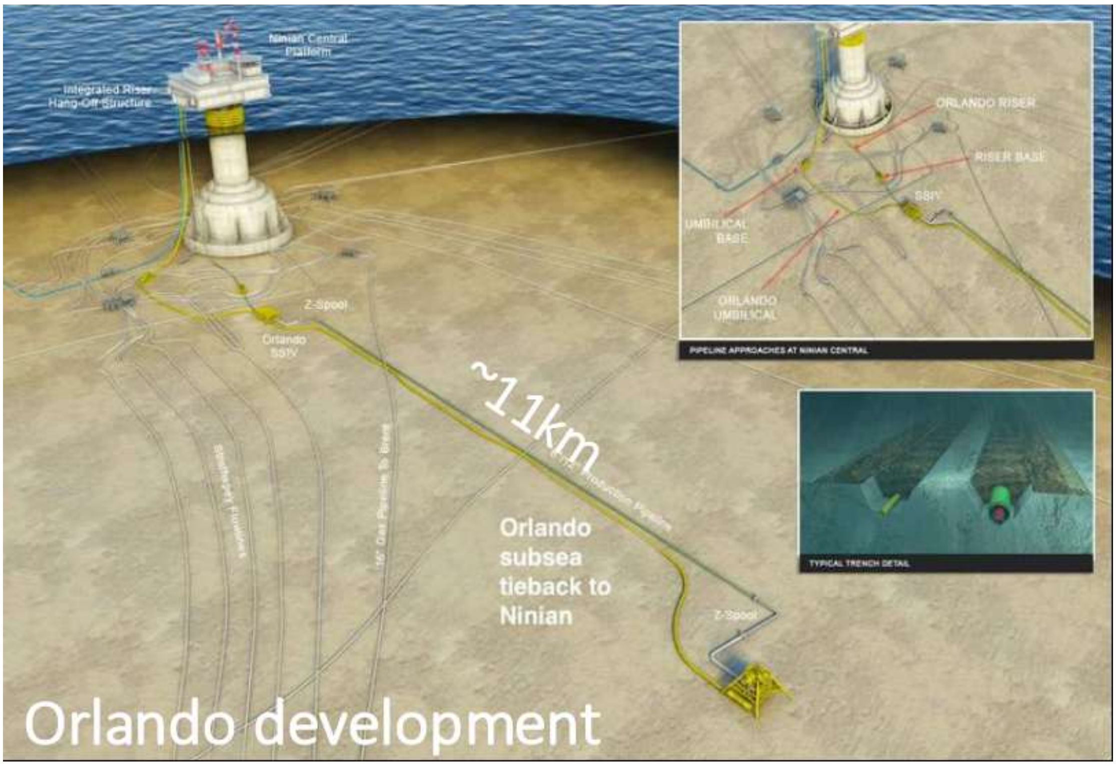

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Abbreviations

AIS	Automated Identification System
AOB	Apparently Occupied Burrow
AON	Apparently Occupied Nests
AOS	Apparently Occupied Sites
BAC	Background Assessment Concentration
BAT/BEP	Best Available Technique/Best Environmental Practice
BC	Background Concentration
BEIS	Department for Business, Energy and Industrial Strategy, now Department for Energy Security and Net Zero (DESNZ)
CA	Comparative Assessment
CCS	Carbon Capture and Storage
CEMP	Coordinated Environmental Monitoring Programme
CNRI	CNR International (UK) Limited
CoP	Cessation of Production
CPI	Carbon Preference Index
CSV	Construction Support Vessel
DECC	Department of Energy and Climate Change, a former name for BEIS and now DESNZ
DESNZ	Department of Energy Security and Net Zero
DP	Decommissioning Programme
DSV	Dive Support Vessel
EA	Environmental Appraisal
EEMS	Environmental and Emissions Monitoring System
EET	Ecological Effects Threshold
EIA	Environmental Impact Assessment
ENVID	Environmental Issues Identification
EPS	European Protected Species
ERL	Effects Range Low
ERRV	Emergency Rescue and Response Vessel
ES	Environmental Statement
FiSMaDiM	Fisheries Sensitivity Mapping and Displacement Modelling
FPV	Fall Pipe Vessel
GC-FID	Gas Chromatography-Flame Ionisation Detection
GC-MS	Gas Chromatography - Mass Spectrometry
GHG	Greenhouse Gas
HPAI	Highly Pathogenic Avian Influenza
HSEQ	Health, Safety, Environment, and Quality
ICES	International Council for the Exploration of the Sea
ICP-OES	Inductively Coupled Plasma-Optical Emission Spectrometry
INTOG	Innovation and Targeted Oil and Gas

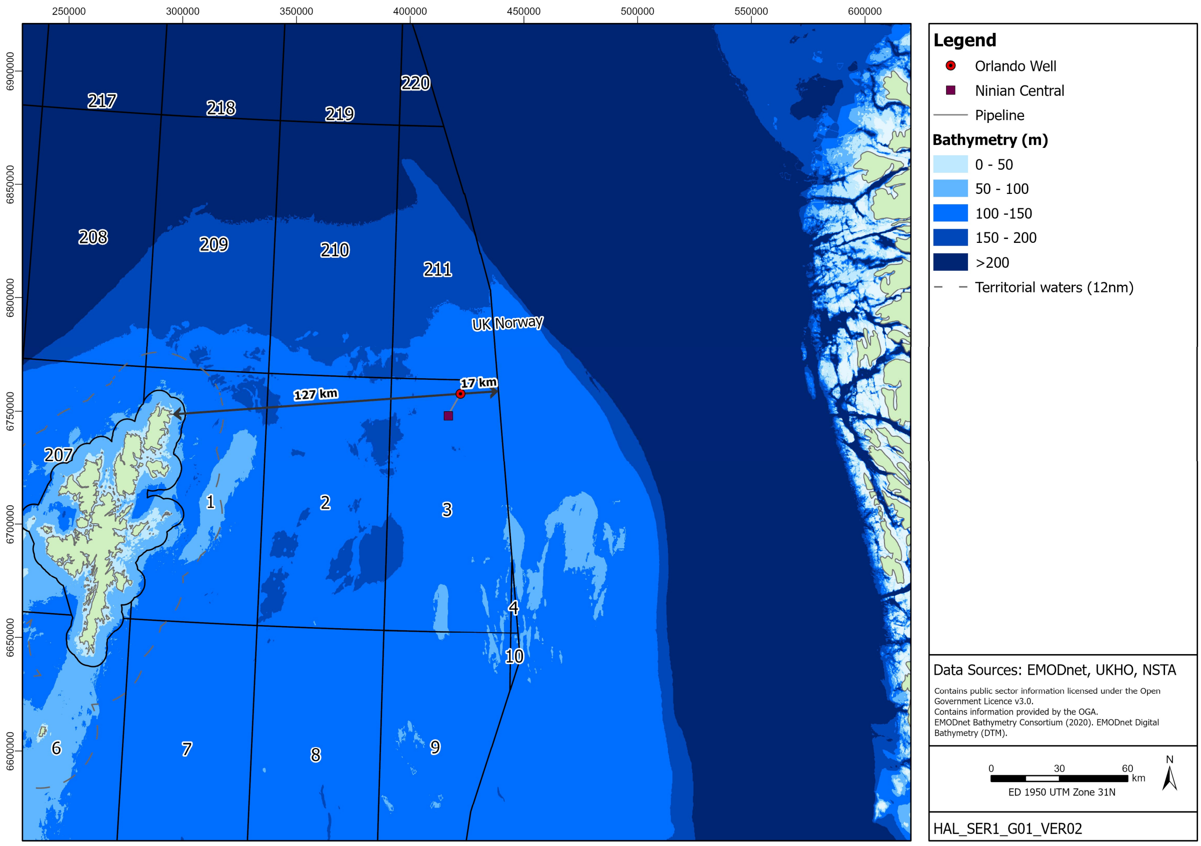
IOGP	International Association of Oil and Gas Producers
IPCC	Intergovernmental Panel on Climate Change
JNCC	Joint Nature Conservation Committee
LTOBF	Low Toxicity Oil Based Fluid
LTOBM	Low Toxicity Oil Based Mud
MAT	Master Application Template
MBES	Multibeam Echosounder
MNCR	Marine Nature Conservation Review
NCMPA	Nature Conservation Marine Protected Area
NCP	Ninian Central Platform
NNS	Northern North Sea
NS-IBTS	North Sea International Bottom Trawl Survey
NSTA	North Sea Transition Authority
OBM	Oil Based Mud
OEUK	Offshore Energies UK
OGA	Oil and Gas Authority, now trading as the North Sea Transition Authority
OGUK	Oil and Gas UK, now Offshore Energies UK (OEUK)
OPRED	Offshore Petroleum Regulator for Environment and Decommissioning, Department for Energy Security and Net Zero
OSPAR	Oslo and Paris Convention for the Protection of the Marine Environment of the North-East Atlantic
PAH	Polycyclic Aromatic Hydrocarbon
PMF	Priority Marine Feature
ROV	Remotely operated vehicle
SAC	Special Area of Conservation
SACFOR	Super-abundant, Abundant, Common, Frequent, Occasional, Rare
SAT	Subsidiary Application Template
SCANS	Small Cetaceans in European Atlantic waters and the North Sea
SFF	Scottish Fishermen's Federation
SPA	Special Protection Area
SSIV	Subsea Isolation Valve
tCO_2eq	Tonnes carbon dioxide equivalent. Standard unit for measuring the impact of different greenhouse gases on climate change, expressed in terms of the amount of CO_2 that would produce the same warming effect.
Te	Tonnes
THC	Total Hydrocarbon Content
TOC	Total Organic Carbon
UCM	Unresolved Complex Material
VMS	Vessel Monitoring System
VOCs	Volatile Organic Compounds
WBM	Water-Based Muds
WPS	Wellhead Protection Structure

1.0 Introduction

1.1 Introduction and Background

The Orlando Field is operated by Serica Energy Chinook Limited, a subsidiary of Serica Energy PLC (from now on referred to as Serica), and is located in the northern North Sea (Block 3/03b), approximately 127km east of Shetland, 17km from the UK/Norway Median Line and *ca*. 11km north east of the CNR International (UK) Limited (CNRI) operated Ninian Central Platform (NCP) (Figure 1-1). Water depths at Orlando are *ca*. 141m.

Figure 1-1: Location of the Orlando Field



The Orlando Field was discovered in 1988/89 (well 3/3-11) by Chevron. The licence covering the Field, and Block 3/3b, (P.1606) was acquired in 2009 in the 25th Seaward Licensing Round, and MPX North Sea Limited carried out an Environmental Impact Assessment (EIA) of the proposed development and submitted an Environmental Statement (ES) (the Orlando ES - DECC Ref: D/4130/2011) to the then Department of Energy and Climate Change (DECC) (now the Department for Energy Security & Net Zero), in December 2011. The Orlando Field was subsequently acquired by Iona Energy in 2012, and Decipher Energy in 2017, with the drilling of a single production well taking place in Q2 2018 (via re-entry and side-tracking of an existing appraisal well (3/3b-13z)), with pipeline installation and tie-in to Ninian Central Platform (NCP) completed in Q4 2018 (Figure 1-2, Figure 1-3, Figure 1-4). Production commenced in Q1 2019, and the Field was subsequently acquired by Tailwind Energy in 2021, and ultimately Serica in 2023.

The Orlando field produces via NCP process systems and is then exported with Ninian Field hydrocarbons to Sullom Voe oil terminal. Cessation of Production (CoP) for NCP is expected Q1-Q2 2027. Provision of services for Orlando will then become unjustifiable and uneconomic to continue production and hence Orlando CoP is envisaged to be concurrent with NCP CoP.

Figure 1-2: Orlando layout

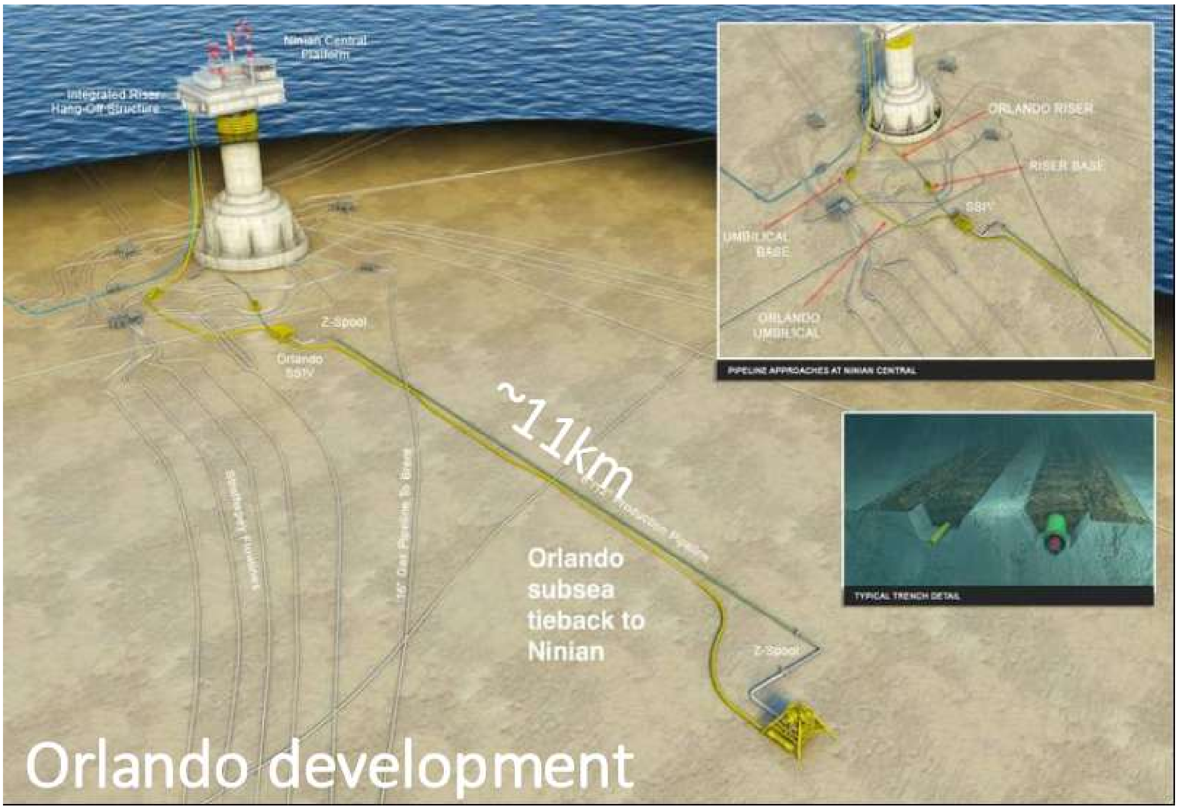


Figure 1-3: Orlando pipeline approaches at NCP

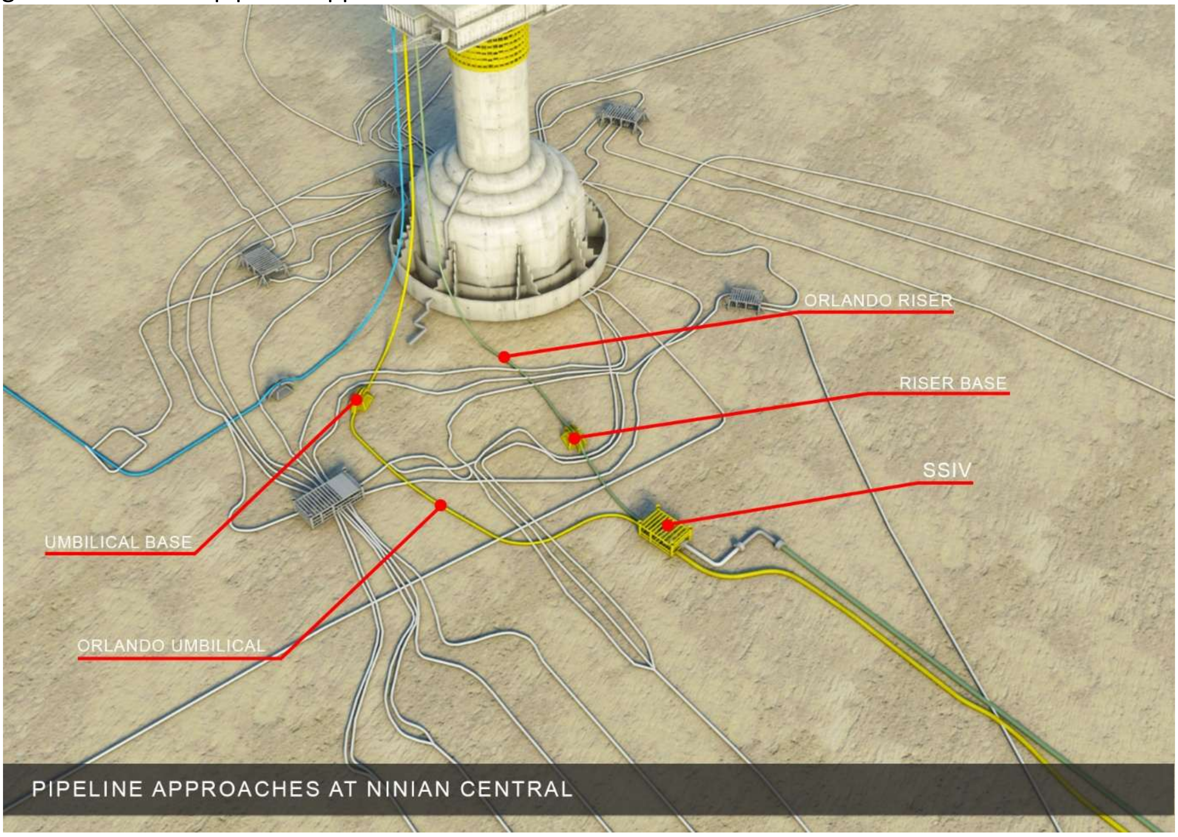
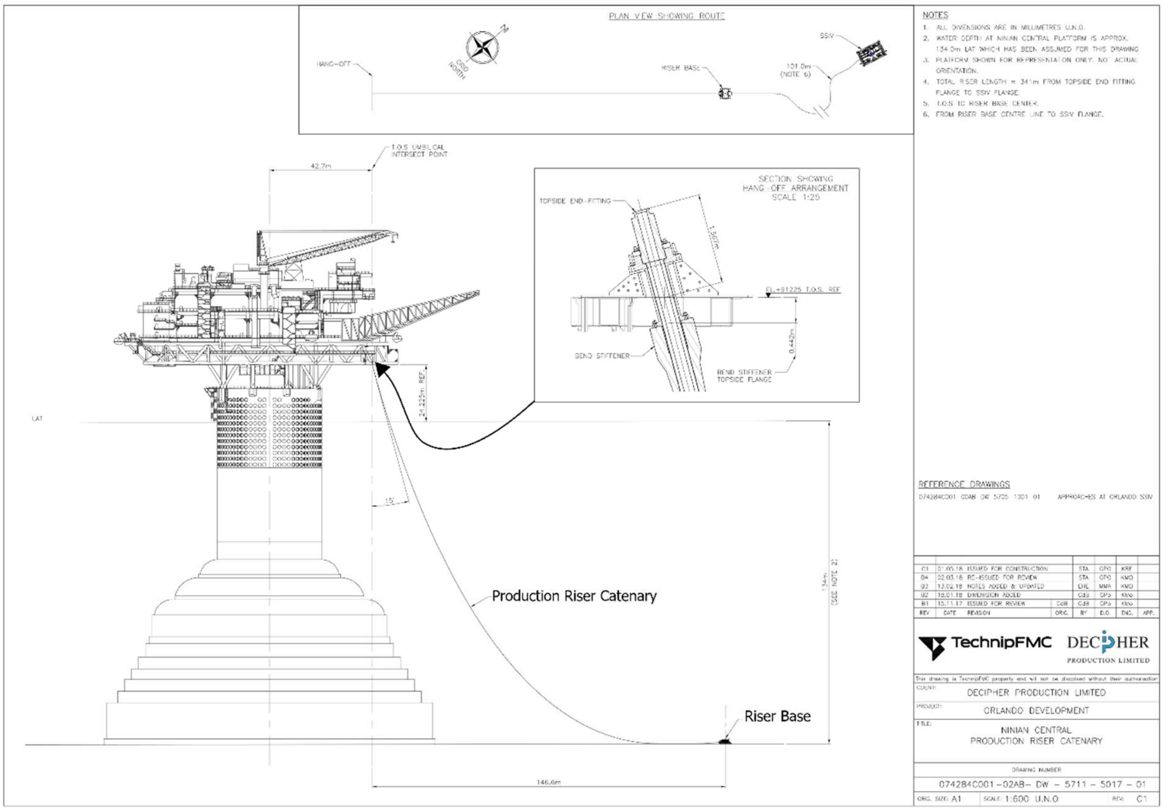


Figure 1-4: Orlando production riser catenary



1.2 Offshore Decommissioning Regulatory and Policy Context

OSPAR Decision 98/3 prohibits the dumping and leaving wholly or partly in place disused offshore installations within the OSPAR Maritime area. Orlando is a subsea tie-back development and as such falls within the OSPAR 98/3 definition of a steel installation, which must be completely removed (BEIS 2018).

There is a regulatory requirement to submit a Decommissioning Programme (DP) to the competent authority (the Offshore Petroleum Regulator for Environment and Decommissioning, Department for Energy Security & Net Zero – OPRED), for the decommissioning of offshore infrastructure.

Although there is no statutory requirement to undertake an Environmental Impact Assessment (EIA) at the decommissioning stage (e.g. as required for other Petroleum Act related activities under the Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020), OPRED guidance (BEIS 2018) states that, *"Under the Petroleum Act 1998, there is a "…requirement to undertake an assessment of the potential environmental impacts of the decommissioning proposals…",* and also that an EA must be submitted alongside the DP. The Orlando Decommissioning EA report follows the guidance (BEIS 2018), including conducting an Environmental Issues Identification (ENVID) exercise as part of the overall assessment process.

The Conservation of Habitats and Species Regulations 2017 (the Habitats Regulations), and The Conservation of Offshore Marine Habitats and Species Regulations 2017 (the Offshore Habitats Regulations), provide for the designation of sites for the protection of habitats and species of international importance (Special Areas of Conservation (SACs)). These Regulations also provide for the classification of sites for the protection of rare and vulnerable birds and for regularly occurring migratory species within the UK and internationally (Special Protection Areas (SPAs)). In offshore Scottish waters where Orlando is located, Nature Conservation Marine Protected Areas (NCPMAs) may be designated for a range of priority features under the Marine and Coastal Access Act 2009. These sites together form part of the UK's national site network. Sites designated under these regulations, along with OSPAR threatened and/or declining habitats, have been identified in the EA and the potential for effects on these from the decommissioning activities have been considered.

A range of permits, consents and licences are required under various legislation in order to undertake activities required to decommission the Orlando infrastructure. The Orlando decommissioning activities will be undertaken in compliance with Health and Safety Executive regulations and with Offshore Energies UK (OEUK) (previously the Oil and Gas UK (OGUK)) guidelines. Relevant applications will be submitted to OPRED-EMT (Environmental Management Team) (i.e. Master Application Templates (MAT) and the relevant Subsidiary Application Templates (SAT)) in support of the proposed activities and the environmental baseline from this EA will inform those applications.

The Orlando infrastructure does not include any topside or jacket structures, therefore, a relatively small amount of material will be returned to shore on its removal. While the receiving port for this is still to be determined, this is expected to be in the UK and the *Transfrontier Shipment of Waste Regulations 2007* (as amended) should not be applicable. In the unlikely event that material is taken to a non-UK port, Serica will comply with the applicable Regulations for the transport of waste.

The Orlando infrastructure lies within an area covered by Scotland's National Marine Plan (Scottish Government 2015)[1]. Serica is cognisant of the plan and polices which are relevant to their operations in Scottish waters, including those which are consistent with decommissioning taking place in line with standard practice and as allowed by international obligations (e.g. policy Oil&Gas2).

Legislation and compliance requirements may change over time and as part of their management system, Serica has processes in place to monitor for new legislation relevant to their activities and will ensure that all relevant regulations are complied with for the decommissioning of the Orlando infrastructure.

1.3 Environmental Appraisal Process

The environmental appraisal process considers the range of activities relevant to the decommissioning of the Orlando infrastructure and their potential impact on the receiving environment, focusing on those impacts that have been identified as potentially significant, and identifying practical mitigation and monitoring measures to be carried forward into the engineering, execution and legacy of the decommissioning activities. This process is informed by information including engineering studies, amongst others (e.g. ENVID) (see Section 5). It also forms part of the information base submitted to OPRED in support of the Orlando Decommissioning Programme (ORL-SECL-HSE-DOC-0008).

[1] It is noted that an update to the National Marine Plan, NMP2 is in the process of development - https://consult.gov.scot/marine-scotland/national-marine-plan-2-planning-position-statement/

Fate of material (including waste) returned to shore is included in summary to provide context, but is not included in the appraisal, this being an onshore issue and not relevant to impacts in the marine environment. Accidental events are also not included in this appraisal, this not being a requirement of the EA supporting the decommissioning programmes; assessment of this, along with a major environmental impact assessment will be included in the permitting and consenting process prior to decommissioning activities being carried out offshore.

1.4 Net Zero and Emissions Reduction

Serica recognises the UK Government commitment to reach net zero emissions by 2050 and the NSTA introduced Stewardship Expectation 11 (SE11). Serica is therefore committed to aligning with SE11 and the NSTA's Decommissioning Strategy when undertaking the Orlando decommissioning activities.

1.5 Document Purpose and Scope of Environmental Appraisal

This Environmental Appraisal (EA) supports the Orlando DPs submitted by Serica to OPRED, as required under the Petroleum Act 1998 (as amended). The scope of the EA is aligned with the Orlando DPs and covers:

- All offshore installations including:
  - Production Xmas Tree including Wellhead Protection Structure (WPS)
  - Production and umbilical riser base structures

- The following submarine pipelines and associated apparatus:
  - PL4383 pipeline
  - PLU4384 umbilical
  - Associated spools (including Wellhead Valve Spool structure), risers and subsea isolation valve (SSIV) structure
  - Surface laid/exposed pipeline/umbilical protective and stabilisation materials (concrete mattresses and grout bags)

Serica has also submitted a Comparative Assessment (CA) in support of the DPs (ORL-SECL-HSE-DOC-0007). This describes and assesses the decommissioning options considered for the pipeline and umbilical.

1.6 Stakeholder Engagement and Consultation

To identify potential environmental issues associated with the decommissioning of Orlando, Serica engaged with a number of stakeholders during the planning stage. In particular, Serica wanted to ensure:

- awareness of all relevant environmental information for the area,
- identification of stakeholder issues and concerns to be considered in the environmental impact assessment process.

Serica had virtual meetings with consultees, at which a summary of the proposed decommissioning activities, the environment of the area and the key issues were presented, with consultees invited to discuss the proposals and raise any questions. Consultees were also given the opportunity to subsequently raise any further issues or concerns and provide details of new relevant information.

The consultees were the Joint Nature Conservation Committee (JNCC) (online meeting 6th February 2025), and the Scottish Fishermen's Federation (SFF) (online meeting 23rd January 2025). The Department for Energy Security and Net Zero – OPRED (environmental section) was also consulted in a regulatory capacity (online meeting – 5th December 2024, 25th February 2025, 26th June 2025).

2.0 Description of Proposed Activities

2.1 Facilities to be Decommissioned

A summary of the Orlando offshore installations and submarine pipelines being decommissioned is provided in Table 2.1, with further details provided in the following sections. The layout of the Orlando Field is shown in Figure 1-2 above.

Table 2.1: Summary of Orlando facilities to be decommissioned

Orlando Facilities	Description
Offshore installations	
Production Xmas Tree including WHPS	The Orlando P1 production Xmas Tree and integrated WHPS will be recovered as part of the well P&A programme. The Xmas Tree and WHPS structure is primarily made from steel (4.3m x 4.28m x 4.79m, 42 tonnes).
Production and umbilical riser base structures	Production riser base (4.758m x 5.289m x 2.261m) and umbilical riser base (4.758m x 7.440m x 2.261m) structures which connect and support the production and umbilical catenary risers within the NCP's safety zone will be recovered as part of decommissioning. Both bases consist primarily of steel (*ca*. 54 tonnes each) with clump weights (29.2 and 31.3 tonnes for the production and umbilical riser base, respectively).
Submarine pipelines and associated apparatus	
PL4383 – Orlando production pipeline to NCP	10,813m, 8"/12" pipe-in-pipe production pipeline (PL4383 ID No. 3)[2] which connects via 8" rigid spool pieces (44m length, PL4383 ID No. 2) to the Orlando wellhead valve spool (9m length, PL4383 ID No. 1) structure (6.4m x2.3m x1.7m, 8.4 tonnes) which is attached to the production Xmas Tree, and at the other end of the pipeline, via 8" rigid spool pieces (58m length, PL4383 ID No. 4) to the SSIV (11m length, PL4383 ID No. 5) structure, within the 500m safety zone of the NCP. The tie-in at NCP is via the SSIV structure (10.8m x 6.7m x 3.62m, 91.2 tonnes) and a flexible 7" production catenary riser (341m length, PL4383 ID No. 6) which hangs off the NCP topsides. The pipeline crosses the not-in-use 12" Alwyn to South Cormorant oil pipeline (PL1526) and the active 16" NCP to Brent gas pipeline (PL917), this latter crossing is within the NCP 500m safety zone. The production pipeline (PL4383 ID No. 3) will be decommissioned *in situ*. The spool pieces, wellhead valve spool structure, SSIV structure and production riser will be recovered.

Orlando Facilities	Description
PLU4384 – Orlando umbilical from NCP	11,000m static umbilical (PLU4384 ID No. 2) in a separate trench, with an outside diameter of 169mm, providing electrical, chemical and hydraulic control between the SSIV and the Orlando wellhead. The tie-in at NCP is via the SSIV structure and a dynamic riser umbilical (450m length, PLU4384 ID No. 1) which hangs off the NCP topsides. The umbilical also crosses the 12" Alwyn to South Cormorant oil pipeline (PL1526) and the 16" NCP to Brent gas pipeline (PL917). The umbilical (PLU4384 ID No. 2) will be decommissioned *in situ*. The jumpers and the dynamic riser umbilical will be recovered.
Pipeline stabilisation features (Section 2.3.3)	
Mixture of protective material located at crossing locations, approaches and tie-ins to infrastructure	Concrete mattresses (total quantity 144, total weight 1,019 tonnes), comprising of the following: Pipeline: 58 (total), 9 (buried), 2 (at trench transition), 47 (estimated to be recovered of which 19 mattresses (10m x 3.0 x 0.3m) and 28 (6m x 3.0 x 0.15m)). Umbilical: 68 (total), 3 (buried), 1 (at trench transition), 64 (estimated to be recovered of which all mattresses (6m x 3.0 x 0.15m)). Dynamic riser: 7 (total), 7 (estimated to be recovered of which 3 mattresses (6m x 3.0 x 0.15m) and 4 (10m x 3.0 x 0.3m)). Dynamic umbilical: 11 (total), 11 (estimated to be recovered of which 4 mattresses (6m x 3.0 x 0.15m) and 7 (10m x 3.0 x 0.3m)). Grout bags (1,360 (25kg) bags), 34 tonnes in total. For assessment, assume 34 x 1 tonne bags (0.9m x 0.9m) (to be removed) Rock (36,971 tonnes) (to be decommissioned *in situ*) Aim will be to recover all exposed mattresses and grout bags that become redundant where condition allows. The rock present will be decommissioned *in situ* as it continues to provide a protective function, as will the mattresses which are buried under the rock. Where mattresses are used at trench transitions (and may be partially buried), full recovery at end of field life. (If practical difficulties are encountered, Serica will consult with OPRED to agree an alternative approach). Assessment of seabed disturbance (Section 6.1) includes disturbance from material move/removal.

Notes: [1] At installation, trenching and burial was to at least 0.6m depth, and the production pipeline and umbilical remain buried – see below. [2]Reference to pipelines includes PWA pipeline identification number.

A high level inventory of Orlando materials is shown in Table 2.2. The current intention is to reuse or recycle as much of the material as possible and minimise, as far as practicable, the waste to landfill. Wastes generated during the decommissioning activities will be segregated and transported to shore to a licensed waste contractor.

Table 2.2: High level materials inventory

Description	Total mass (tonnes)	To be recovered (tonnes)
Subsea Installations (P1 wellhead tree including WHPS, 2 riser bases and 2 clump weights)		
Steel (all grades)	210.58	210.58
Non-ferrous	0	0
Plastics	0.84	0.84
Total	**211.42**	**211.42**
Submarine Pipelines (pipeline and umbilical, related spools and wellhead valve spool structure, risers, SSIV and controls equipment)		
Steel (all grades)	2,816.3	206.6
Non-ferrous	74.52	3.42
Plastics	60.86	8.4
Other materials (umbilical packing materials and armouring)	44.07	0
Total	**2,995.75**	**218.42**
Pipeline Stabilisation Features Inventory (concrete mattresses, grout bags and rock)		
Concrete (mattresses)	1,018.8	946.9[1]
Grout	34	34
Rock	36,971	0
Total	**38,023.8**	**980.9**

Note: [1]Includes the 3 partly buried mattresses at trench transitions described in Table 2.1 above.

At time of submission of the DPs and supporting documents, the production lines remain in use, and will still have to be cleaned and flushed once production has ceased. Options for this cleaning and flushing programme are being discussed with CNRI, the NCP operator, prior to decommissioning. As the final cleaning and flushing strategy is yet to be confirmed, two options have been subject to assessment, which are:

1. Flush from the P1 well back to the NCP: this option would require a Dive Support Vessel (DSV), and would allow for the use of pigs, if required, and sampling at the NCP. The option would lead to discharges at NCP, including of the flushing water and any related chemicals used in the cleaning process.
2. Flush from NCP to the P1 well, downhole: this option may require additional flushing equipment, related use of deck space and personnel at NCP, however would not result in discharges at NCP. Sampling would, however, not be possible.

The preferred option being to flush downhole. It is anticipated that the pipeline flush volumes will be based on a minimum of three line volumes of seawater (including gel pigs and chemicals) to be confirmed during detailed engineering. Once the cleaning and flushing is completed, the production pipeline will be left with only residual hydrocarbons present with seawater. Decommissioning activities will only be carried out after the production line has been cleaned and flushed. As there are no testing facilities on the well, to ascertain the remaining residual hydrocarbon at completion of the three line flushes, an estimate of worst case oil in water has been made to inform the assessment (see Section 5.1).

The umbilical line contains cores the contents of which are hydraulic fluid (hydraulic cores), corrosion inhibitor, wax inhibitor, MEG/Water (80/20) and methanol (chemical cores). The base case for these will be that chemical cores will be flushed through into the pipeline via the tree and dropdown spool, with hydraulic fluid discharged to sea when cores are cut. The hydraulic cores are not being flushed as, in order to facilitate pipeline flushing, well control is required, i.e. subsea control system valve functioning (via hydraulics) is required for the tree and SSIV. Additionally, it is not practicable to displace the hydraulic fluid into the pipeline for flushing since the hydraulic system is a closed system (separate to the pipeline) and diver intervention would be required to manually override valves and displace hydraulic core volumes into the pipeline. The hydraulic fluid used is Oceanic HW443 R, an OCNS C banded chemical, with a substitution warning. A risk assessment of a full discharge to sea of the Oceanic HW443 R present in the system at disconnect has been made to inform the assessment (see Section 5.1).

A wax deposition study has been undertaken which has modelled historical operations and future operations to CoP. The model has been validated against pressure/temperature data and includes wax property parameters based on laboratory testing. The conclusion of the wax deposition study is there will be minimal wax deposition in the pipeline (between wellhead & SSIV) at CoP (<0.9% of pipeline volume). The SSIV and riser section are predicted to have slightly higher levels of wax deposition but these sections are to be removed to shore. A risk assessment of the predicted wax present in the pipeline system at disconnect has been made to inform the assessment (see Section 5.1).

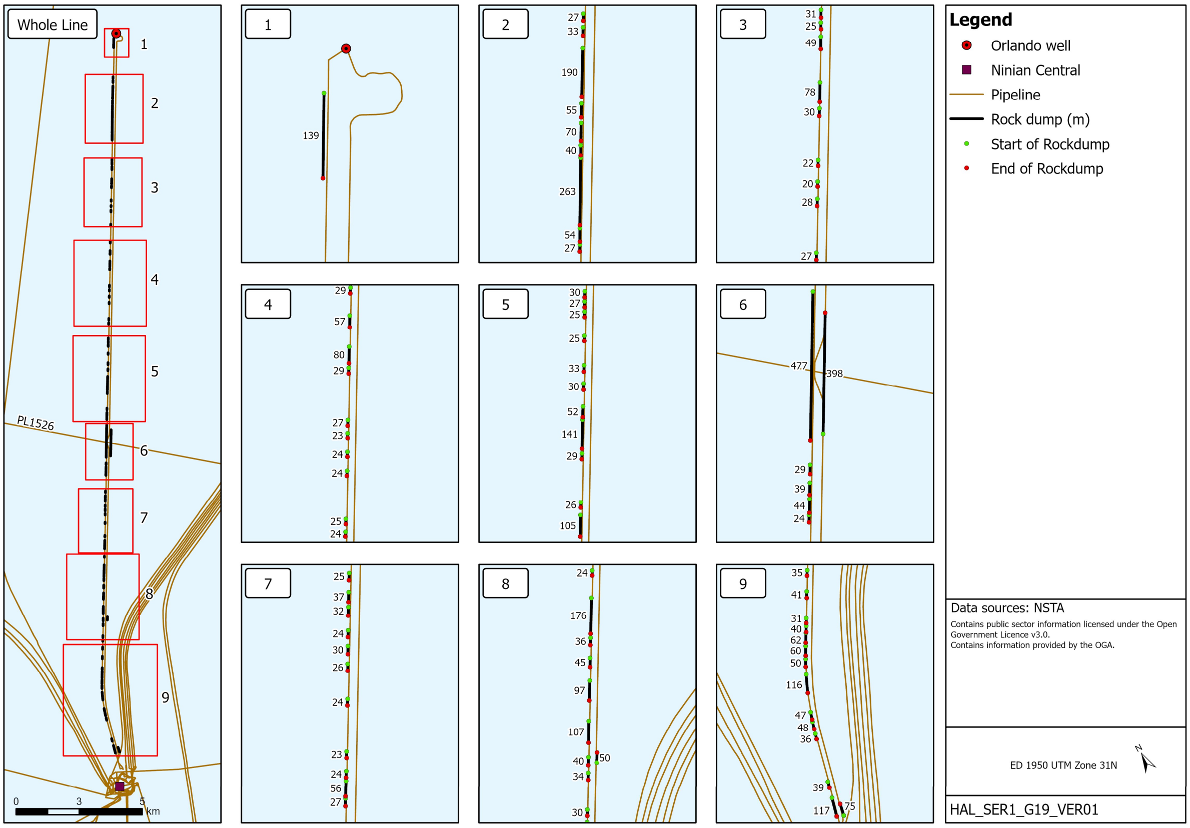
No feasible re-use option for the pipeline or umbilical has been identified, and in line with regulator guidance[2], a CA has been undertaken to inform decisions relating to the decommissioning of the pipeline system. Drawing from OSPAR 98/3, BEIS Decommissioning Guidance (BEIS 2018) and the OGUK Guidance on Comparative Assessment (OGUK 2015), Serica undertook a CA using qualitative and quantitative data to evaluate alternative decommissioning options for the pipeline system which is reported in the supporting CA document (ORL-SECL-HSE-DOC-0007).

The preferred options from the CA were to decommission the pipeline and umbilical *in situ*, minimising the potential impact on the seabed and related habitats.

While the pipeline was mechanically backfilled in its trench, it was subject to a significant volume of rock deposits to mitigate against potential upheaval buckling (Figure 2-1). Additionally, a number of concrete mattresses have been used at the tie-in to the SSIV and at the P1 well, and at pipeline crossings, and a number of grout bags have also been used (see Table 2.1).

[2] Pipelines are not covered by OSPAR Decision 98/3, however, the framework for their decommissioning is contained within the Petroleum Act 1998. See Section 10 of BEIS (2018) decommissioning guidance notes and OGUK (2015) Guidelines for Comparative Assessment in decommissioning programmes.

Figure 2-1: Rock cover associated with the Orlando pipeline and umbilical



No areas of pipeline or umbilical exposure were noted in a recent (2024) inspection survey (Figure 2-2 and Figure 2-3). An exposed pipeline is where a section of the pipeline can be seen on the surface of the seabed but is not free-spanning and the pipeline remains in contact with the seabed.

Figure 2-2: Depth of burial (PL4383)

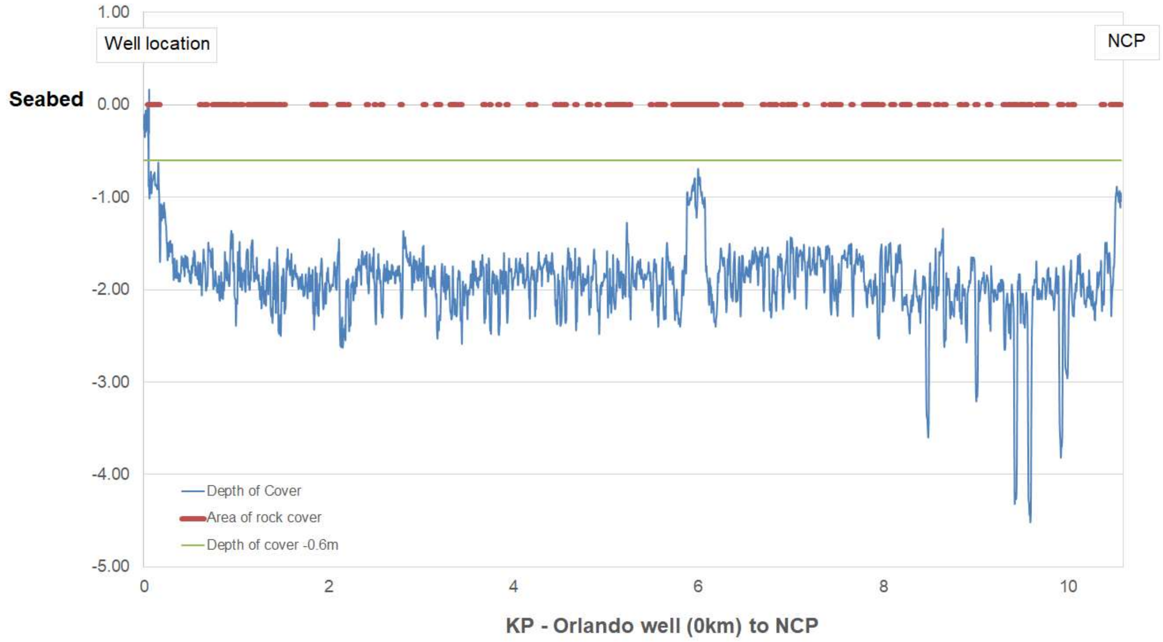
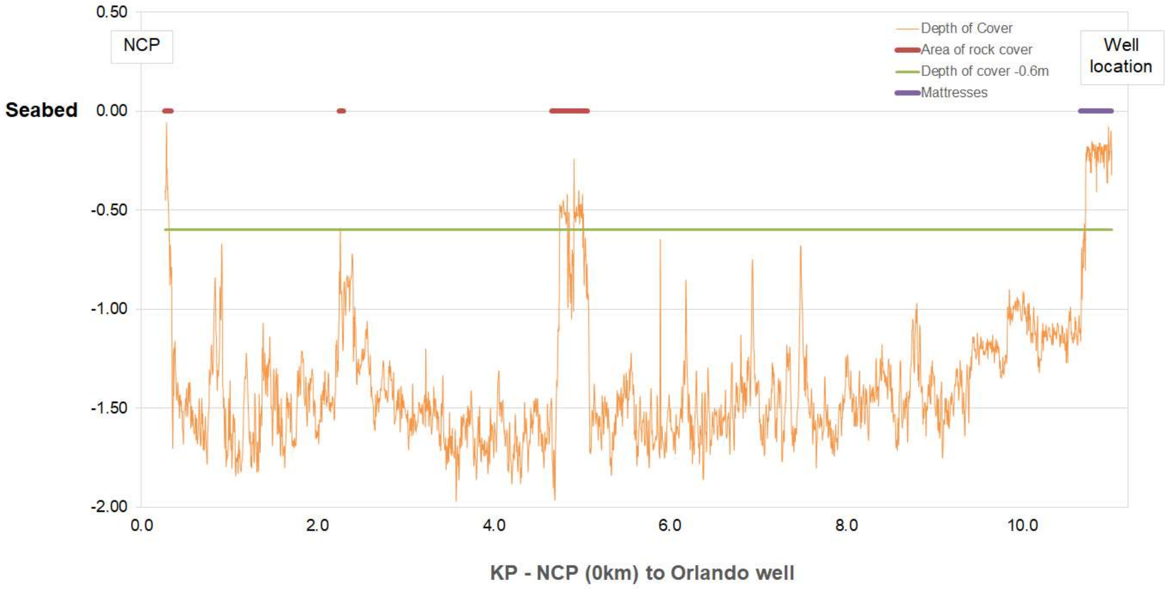


Figure 2-3: Depth of burial (PLU4384)

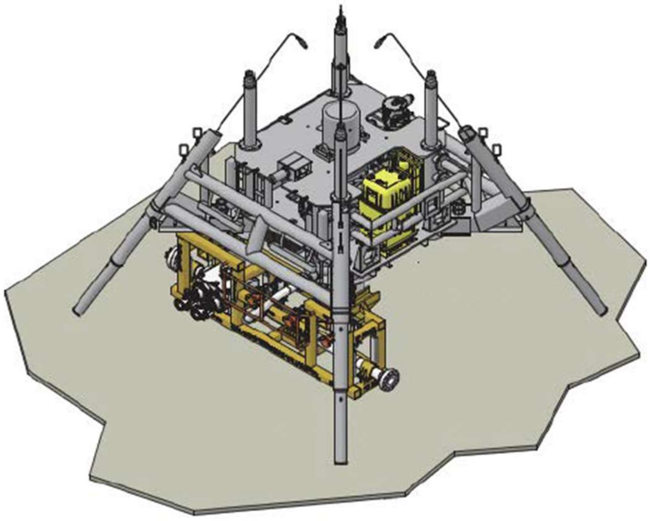


Note: For both figures, horizontal green line is the BEIS (2018) minimum depth of burial (0.6m), KP = Kilometre Post. At approximately KP 6.0 on the pipeline (Figure 2.2) and KP 5.0 on the umbilical (Figure 2.3), where depth of cover <0.6m, the pipeline and umbilical crosses the 12" Alwyn to South Cormorant oil pipeline (PL1526) and there is associated rock cover over the crossing location.

2.2 Well

The Orlando (P1) well (3/3b-13y) was drilled in 2018 as a sidetrack to the former appraisal well 3/3b-13z. A schematic of the Production Xmas Tree and WHPS which also includes the attached Wellhead Valve Spool structure at the Orlando P1 well is shown in Figure 2-4.

Figure 2-4: Orlando Xmas Tree including WHPS and attached Wellhead Valve Spool Structure



Note: Wellhead Valve Spool Structure shown in orange.

The final well decommissioning strategy is in development and will be drafted in accordance with the OEUK Well Decommissioning Guidelines Issue 7 (November 2022). The well will be plugged and abandoned using a semi-submersible drilling rig. A rig site survey for final rig positioning is expected to be carried out, and a consent to locate application with appropriate supporting vessel traffic survey, will be applied for. Final rig selection is still to be made, but a semi-submersible representative of the type which would be used is shown in Figure 2-5.

This type of rig is effectively a deck supported on pontoons which contain ballast tanks, which floats at all times. The height of the deck above the sea surface can be altered by pumping ballast (sea) water in or out of the pontoons. During operations, the deck is lowered but still kept above wave height.

Rigs are towed to location by 2-3 anchor handler tug vessels and are maintained on station using anchors. Rig anchoring typically involves the deployment by anchor handler vessel of eight or more *ca*. 12 tonne seabed penetrating anchors.

The anchors are attached to the rig by cable and near the anchor by chain, of which a proportion (a minimum of 100m) lies on the seabed (the catenary contact). Hauling or paying out of cable can make minor adjustments to the rig position following anchor deployment.

Figure 2-5: Typical semi-submersible rig

The precise arrangement of anchors around the rig will be defined by a mooring analysis which will be undertaken prior to bringing the rig into the field and taking account of water depth, tidal and other current, winds and seabed features.

The relationship between water depth and lateral extent of the anchor pattern is not linear and a typical radius of an anchor patterns for a semi-submersible drilling rig operating in a water depth of 100m (water depth at the Orlando well is ~140m) is 1,300-1,500m. Upon completion of activities, anchors are retrieved by anchor handler vessels by means of pennant wires which slide down the cable towards the anchor allowing a more or less vertical retrieval, facilitating anchor breakout from the seabed. The rig is then towed off station by the tugs.

It is estimated the rig will be on location for *ca*. 40 days including an operational and weather contingency of 10 days. The rig will be supported by a standby vessel, supply vessels and personnel transfers via helicopter.

As the well abandonment programme for the well has yet to be finalised, final chemical use and discharge, including cement, is unknown at this stage. Chemical use and discharge will be kept to a minimum as far as technically practicable, and, as well plug and abandonment involves the setting of cement plugs within the well, the majority of cement used during these operations is expected to remain downhole. All required environmental permits will be applied through OPRED's permit portal, prior to any offshore activity being carried, out, and this will include a full assessment of chemical use and discharge.

2.3 Rig and Vessel Requirements

Along with the semi-submersible rig and supporting vessels, a variety of different vessels will be required during the decommissioning activities. While final vessel selection is still to be made, the types of vessels required are known, as is their typical fuel consumption, and these are summarised in Table 2.3: Approximate rig and vessel requirements for Orlando decommissioning. In the absence of named vessels, this information and estimated duration on locations, forms the basis of estimating vessel atmospheric emissions from the decommissioning activities.

The rig may require bunkering during the well activities but none of the other vessels are expected to require refuelling while on location. The rig and other vessels will operate to MARPOL standards for Special Areas. The rig will complete an as left survey following completion of well abandonment activities as will the vessel completing the subsea decommissioning campaign.

Table 2.3: Approximate rig and vessel requirements for Orlando decommissioning

Activity	Approximate no. days	Fuel consumption rate tonnes/day[1]	Fuel type	Total fuel consumption (tonnes)
Well Plug and Abandon				
Anchor handler/tug (x 3)	10[2]	16 (per vessel)	Diesel	464
Rig on location	40	18	Diesel	720
Supply vessels	-[3]	15 tonnes per trip	Diesel	176
Standby vessel (ERRV)	40	3.5	Diesel	140
Rig site survey	6	15	Diesel	84
Helicopter	-[4]	1.08 tonnes per trip	Helifuel	19
Subsea infrastructure removal				
Pipeline flushing	8	15	Diesel	113
Cutting and removal of spool pieces, jumpers and protective material, pipeline / umbilical end removal and remediation	21	15	Diesel	320
Recovery of SSIV, riser bases, risers, and associated protective material	6	15	Diesel	90
Rock FPV	7	20	Diesel	140
Post-decommissioning surveys				
Survey vessel	6	15	Diesel	92
Total Diesel Consumption (all activities (excluding helicopter), including contingency use of rig to decommission the well)				**2,358**
Total helifuel consumption				**19**

Notes: All values rounded to nearest whole number, a 10% time contingency is assumed for all operations (e.g. for waiting on weather) other than survey operations offshore, which have a 25% weather contingency, [1]All times shown include mob and demob; fuel consumption under these conditions can be less than that shown, however, for assessment, worse case fuel consumption has been used; DSV = Dive Support Vessel, FPV = Fall Pipe Vessel, [2]assumes transit back to and from port between anchor handling and towing operations, [3]assumes two trips per week for the duration of the campaign, [4]assumes three trips per week.

2.4 Fate of Infrastructure and Post-decommissioning Monitoring

A relatively small quantity of material will be returned to shore for processing, i.e. material from the offshore installations (e.g. Xmas Tree and integrated WPS, riser bases), submarine pipelines and associated apparatus (e.g. spools, wellhead valve spool structure, SSIV structure, jumpers and risers), and pipeline stabilisation features (e.g. exposed concrete mattresses and grout bags) (see Table 2.2). The final receiving port and yard for processing the waste is still to be determined, although Serica will ensure the selected port and yard will have the appropriate environmental and operational licenses and consents to receive and process the material. All waste will be documented in a waste inventory, which will record the types, quantities and fate of all waste, following a waste hierarchy consistent with the Waste Framework Directive.

A post decommissioning survey, centred on the 500m safety zone at the Orlando well location, and along the full pipeline/umbilical route (50m either side of the pipeline/umbilical), including the approaches to Ninian Central, in consultation with CNRI, will be conducted when the decommissioning activity has been concluded; in the event any Orlando related debris is identified, this will be recovered and returned to shore for recycling or disposal. This will be undertaken using non-intrusive methods, such as muti-beam echosounder (MBES). An over-trawl survey will be undertaken if deemed necessary to confirm no snagging hazards are present, post decommissioning and, a targeted environmental survey will be conducted post-decommissioning.

2.5 Indicative Timetable and Potential for Alternative Use

The schedule for decommissioning activities is subject to change, but current estimates anticipate CoP in Q1-Q2 2027. The activities include flushing and cleaning (either from NCP downhole via the P1 well or from the P1 well back to NCP), the Orlando pipeline and umbilical (expected Q1 2027 – Q3 2027), prior to disconnection and removal of the spools, jumpers and protective materials from the seabed and remediation of the cut ends of the pipeline and umbilical (expected Q1 2027 – Q3 2028). The P1 well will then be plugged and abandoned (expected Q4 2027 – Q3 2029), with the production Xmas Tree including wellhead protection structure and attached wellhead valve spool structure recovered as part of these operations. With respect to the decommissioning of the Clause 16.2 facilities by CNRI, the disconnection and laydown of the Orlando production and umbilical risers, recovery of the risers, riser bases and SSIV structure is expected Q1 2029 – Q2 2030. The relevant permits and consents for decommissioning activities can only be sought following the approval of the DPs; these will be applied for in the future prior to any offshore activities taking place.

Serica has considered the possibility for *in situ* re-use or redevelopment of the field. However, no further exploitation of the field is considered economically viable. Accordingly, decommissioning will focus on the plug and abandonment of the Orlando well, removal of the associated subsea infrastructure and stabilisation/protective material, and the decommissioning options derived from the CA for the pipeline and umbilical.

3.0 Environmental Description

Information for the environmental description has been drawn from a number of sources, including previous site surveys from the Orlando area, and primary and grey literature sources.

3.1 Seabed Topography and Sediments

Survey coverage

To support the Orlando development, a baseline survey was undertaken at the proposed rig/well location and along the proposed pipeline route to NCP which included both environmental and geophysical/geotechnical scopes (Fugro 2011a). Subsequently, three surveys have been undertaken with a focus on collecting geophysical (mg3 2017) and inspection data (undertaken by Deep Ocean in 2021 and Fugro in 2024). A further geophysical and environmental site survey across the Orlando field was completed in 2021 to inform siting of a drilling rig for a well workover (see Table 3.1 and Figure 3-1). As part of this, a series of grab samples were collected around the Orlando development well location and along the Orlando to NCP pipeline with the aim of identifying any changes in the physical, chemical, and biological aspects of the seabed potentially as a result of previous drilling operations, as well as a number of camera transects to inform a characterisation of seabed habitats. Analysis of the geophysical data and video/still photography transects was completed and survey reports produced in 2021 (Fugro 2021a,b), however, the physico-chemical and faunal analysis of the grab samples were not undertaken, but were stored for potential future consideration. The physico-chemical and faunal analysis of these samples was recently completed and survey report produced (Fugro 2025).

Table 3.1: Surveys relevant to Orlando

Block	Survey company	Survey year	Coverage and purpose	Scope								
				Bathymetry (MBES)	Seabed (SSS)	Physico-chemical	Shallow geology	Debris/obstructions	Hazards	Macrofauna	Video	Habitat Assessment
3/3	Fugro	2011	Rig site and pipeline route survey. A dual van Veen grab was used to acquire samples for faunal and physico-chemical analyses at eight stations. Underwater video and stills recorded.	✓	✓	✓	✓	-	-	✓	✓	✓
3/3	mg3	2017	Geophysical survey at the Orlando well location to inform installation and operation of a semi-submersible rig.	✓	✓	-	✓	✓	✓	-	✓	-

Block	Survey company	Survey year	Coverage and purpose	Scope								
				Bathymetry (MBES)	Seabed (SSS)	Physico-chemical	Shallow geology	Debris/obstructions	Hazards	Macrofauna	Video	Habitat Assessment
3/3	Deep Ocean	2021	Visual inspection of the Orlando well, flexible riser, dynamic umbilical and SSIV.	-	-	-	-	-	-	-	✓	-
3/3	Fugro	2021	Rig site and pipeline route survey. A dual van Veen grab was used to acquire samples for faunal and physico-chemical analyses at eleven stations. Underwater video and stills recorded.	✓	✓	✓	✓	✓	✓	✓	✓	✓
3/3	Fugro	2024	Visual inspection of the Orlando well, and pipeline/umbilical.	✓	✓	-	-	-	-	-	✓	-

Seabed topography

Water depths recorded across the Orlando well site by the most recent 2021 survey ranged from a minimum water depth of 139.1m close to the eastern corner of the survey limits to a maximum water depth of 143.8m on the north-west border of the survey area (Figure 3-2). The seabed within the survey area deepened very gently from the south-east to the north-west with an average seabed gradient <1° (Fugro 2021a).

Water depths along the pipeline route ranged between 132.6m and 140.6m, shoaling in the direction of the NCP (Figure 3-3), and with a gradient not exceeding <0.1° along the route (Fugro 2011 survey, Fugro 2012b).

Seabed substrates

Previous surveys interpreted surface sediments as predominantly loose to medium dense silty, gravelly sand with numerous areas of shell, gravel, cobbles and occasional boulders at the Orlando well site and the pipeline route corridor, with areas of high reflectivity interpreted as shells, gravels and cobbles.

The sediments within the 2021 survey area were dominated by the sand fraction, with the sediment composition indicating a largely homogenous sediment type throughout. All stations were classed as 'very fine sand' with the exception of station G01, which was classed as 'fine sand' by the Wentworth description (Table 3.1). Comparison with the NNS mean background value indicated that the seafloor sediments at the well site stations and at the pipeline stations had a higher fines fraction than the wider area (Fugro 2025).

Figure 3-1: Existing seabed environmental survey coverage

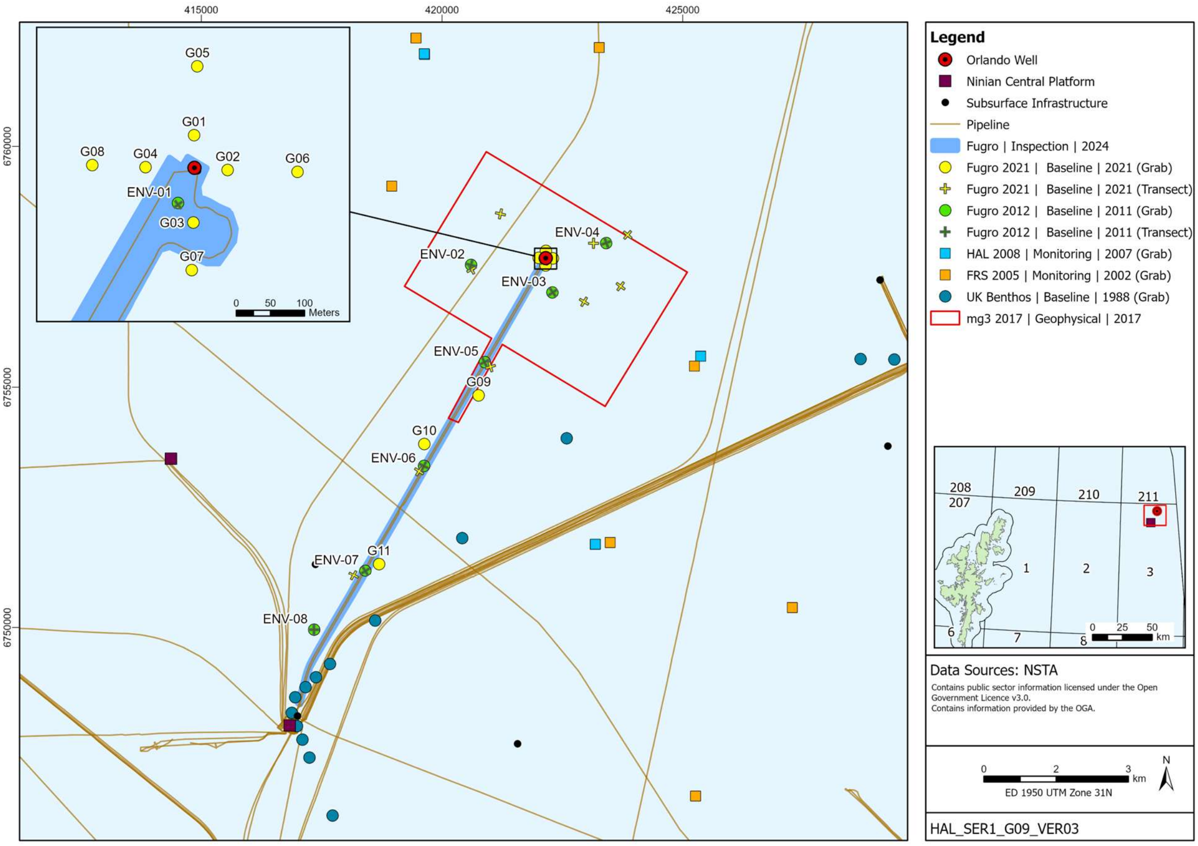
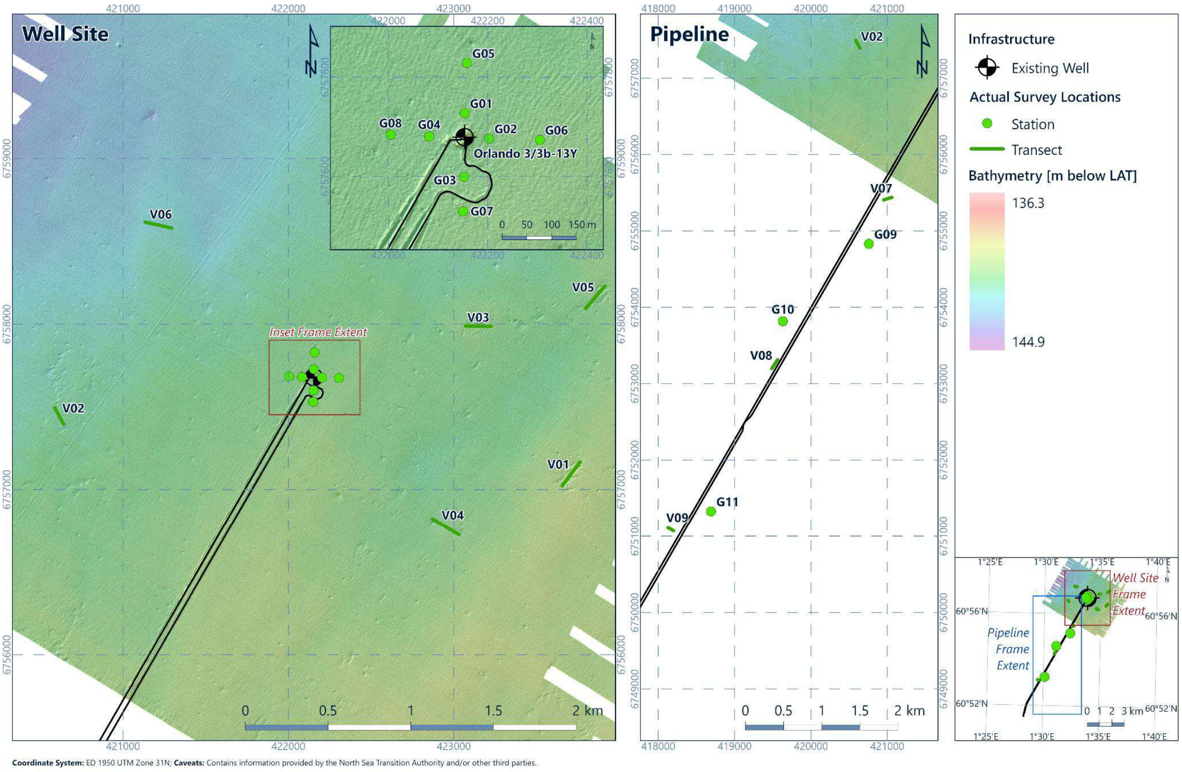
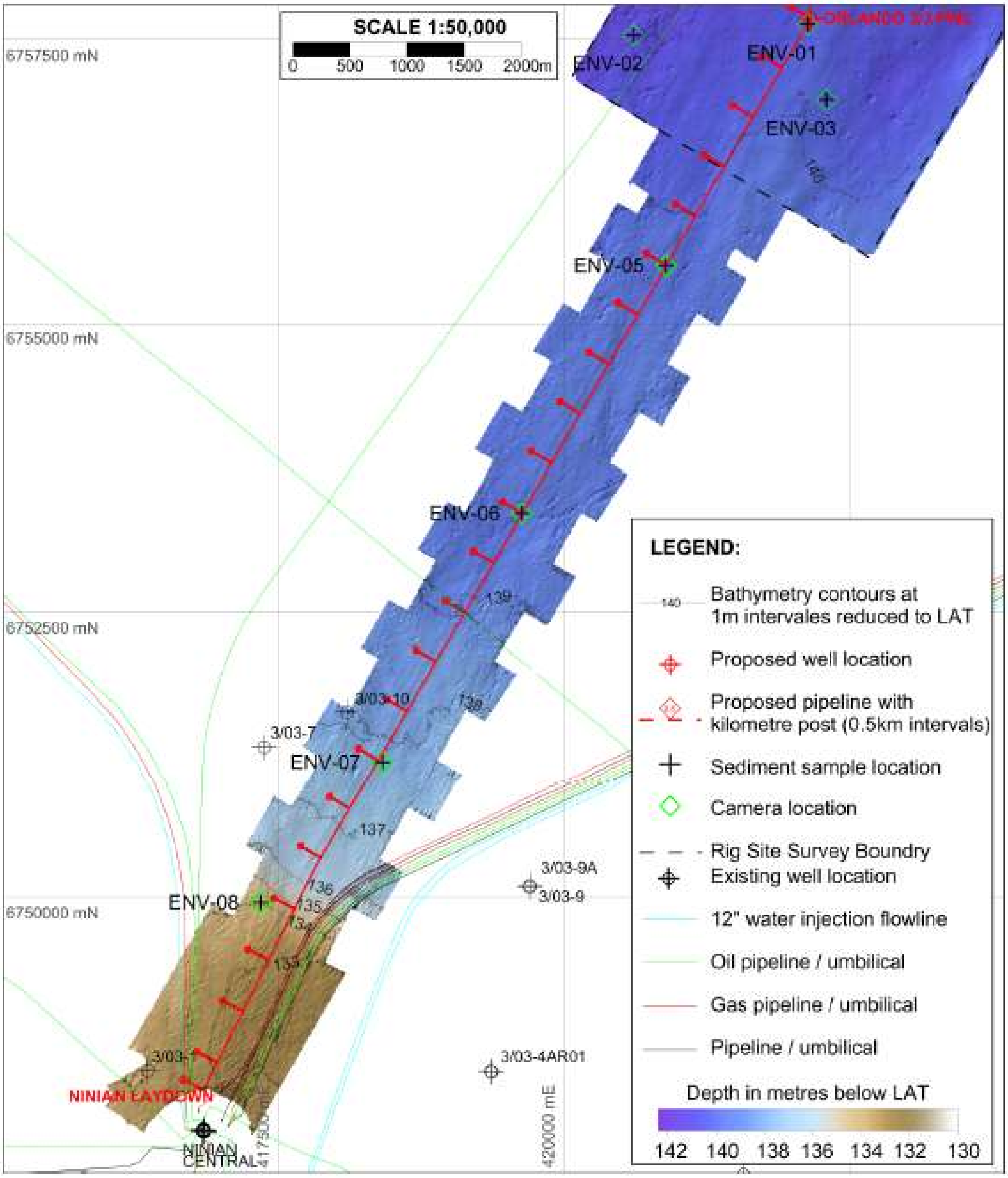


Figure 3-2: Bathymetry of the Orlando well site from 2021 seabed survey



Source: Fugro (2025).

Figure 3-3: Bathymetry and sampling locations along the Orlando pipeline route



Source: Fugro (2011a).

Comparison of the well site stations with the pipeline stations showed a slightly lower gravel content and fines content at the pipeline stations (with associated increase in sand content, Table 3.2, Figure 3-4). The highest gravel content was observed at stations closest to the well (e.g. G01, Figure 3-4), suggesting that the sediment around the well was modified (Fugro 2025).

At the well site stations, the 2021 mean particle size (µm) was lower than the 2011 site survey. At the pipeline stations, the current mean particle size (µm) was higher than the 2011 pipeline survey. This may be a result of sediment redistribution or spatial variability in the vicinity of the Orlando field (Fugro 2025).

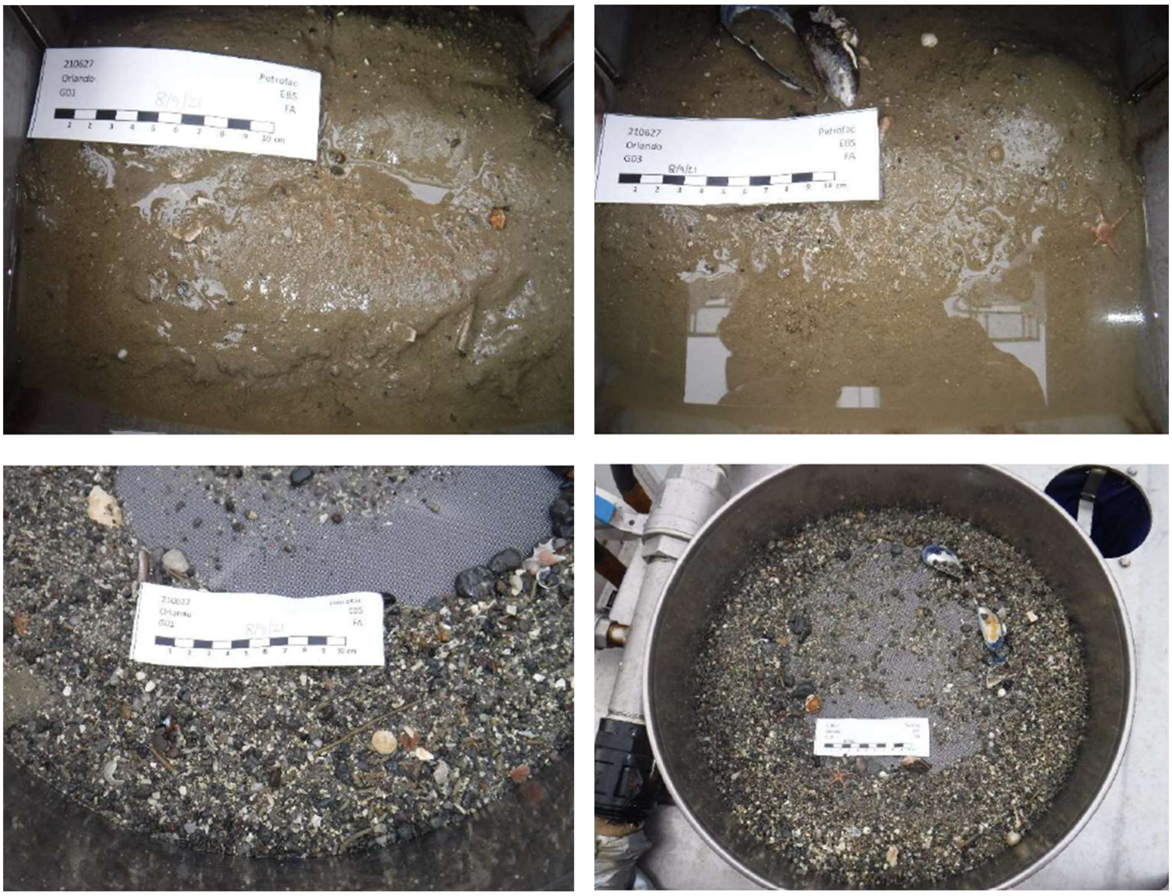
Table 3.2: Summary of PSA results, rig site and pipeline survey, 2021

Station	Mean (µm)	Mean Phi	Fines (%)	Sand (%)	Gravel (%)	Description (Wentworth)
Well site stations 2021						
G01	147	2.76	22.3	68.5	9.2	Very poorly sorted, Fine sand
G02	91	3.46	28.0	69.7	2.3	Poorly sorted, Very fine sand
G03	120	3.05	26.2	66.4	7.4	Very poorly sorted, Very fine sand
G04	87	3.52	29.6	69.3	1.1	Poorly sorted, Very fine sand
G05	118	3.08	26.3	71.9	1.8	Very poorly sorted, Very fine sand
G06	113	3.15	26.7	70.2	3.1	Very poorly sorted, Very fine sand
G07	84	3.57	30.4	68.9	0.7	Poorly sorted, Very fine sand
G08	90	3.47	29.0	70.1	0.9	Poorly sorted, Very fine sand
Mean	**106**	**3.26**	**27.3**	**69.4**	**3.3**	-
Pipeline stations 2021						
G09	114	3.13	22.8	76.0	1.2	Poorly sorted, Very fine sand
G10	107	3.23	22.1	77.7	0.2	Poorly sorted, Very fine sand
G11	124	3.01	20.8	78.6	0.6	Poorly sorted, Very fine sand
Mean	**115**	**3.12**	**21.9**	**77.4**	**0.7**	-
Well site stations 2011 (Fugro 2012a)						
Mean	**158.3**	**2.84**	**26.1**	**72.8**	**1.1**	**-**
Pipeline stations 2011 (Fugro 2012a)						
Mean	**86.8**	**3.54**	**30.0**	**69.7**	**0.2**	**-**

Notes: fines: <63µm; sand: 63µm to 2mm; gravel: >2mm. Source: Fugro (2025)

Figure 3-4: Examples of grab sample photographs and material retained by a 1mm sieve from the well location (e.g. G01 and G03) and pipeline (e.g. G09 and G11)

G01 G03



G09 G11

Notes:
G01 – Very poorly sorted, fine sand. Fines (22.3%), sand (68.5%) and gravel (9.2%).
G03 – Very poorly sorted, very fine sand. Fines (26.2%), sand (66.4%) and gravel (7.4%).
G09 – Poorly sorted, very fine sand. Fines (22.8%), sand (76%) and gravel (1.2%).
G11 – Poorly sorted, very fine sand. Fines (20.8%), sand (78.6%) and gravel (0.6%).
Source: Fugro (2025).

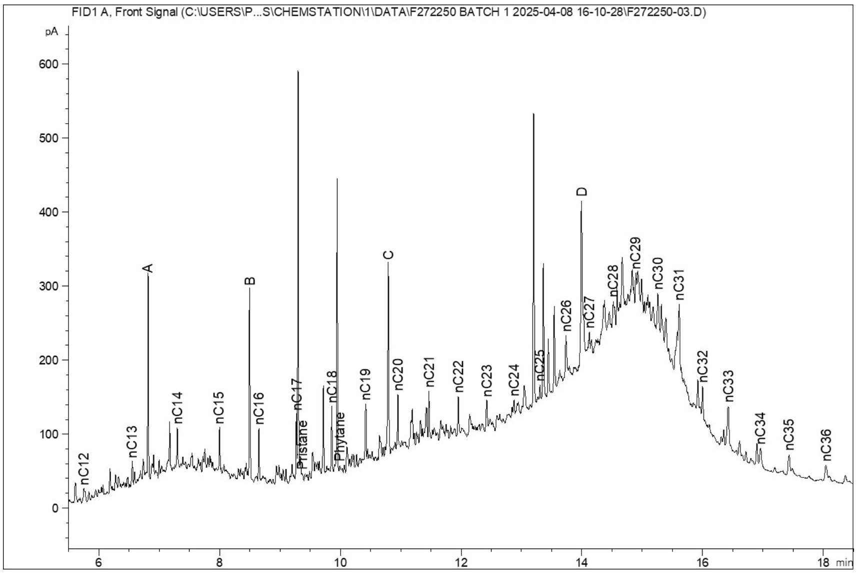
Contamination

Hydrocarbons

The 2021 sediment samples were analysed for total hydrocarbon content (THC), unresolved complex mixture (UCM), individual and total n-alkanes (nC_{12} to nC_{36}) and the subsequent carbon preference index (CPI) using gas chromatography-flame ionisation detection (GC-FID) (Fugro 2025). Aromatic hydrocarbons were analysed by gas chromatography - mass spectrometry (GC-MS).

The gas chromatographic profiles obtained from all sediments collected exhibited a hump of high molecular weight unresolved complex material (UCM) (Figure 3-5) which reflected background hydrocarbon contamination from terrestrial runoff, shipping and oil and gas exploitation. Stations G01, G02, G03, G04 and G06 also displayed evidence of a mixed input of an oil based mud (OBM) and a low toxicity oil based mud (LTOBM) (Figure 3-5). Stations G05, G07 and G08 displayed evidence of an input of an OBM. The GC-FID profiles obtained at stations G09, G10 and G11 were typical of the background NNS as were all profiles obtained in the 2011 survey.

Figure 3-5: Gas chromatographic profile for typical surface sediment (station G03)



Notes: Evidence of an OBM, displayed as a range of n-alkanes and associated UCM from ca. nC18 to nC26 was present. Evidence of a low toxicity oil based fluid (LTOBF), shown by a range of n-alkanes from approximately nC12 to nC16, with an associated UCM, was present. Source: Fugro (2025).

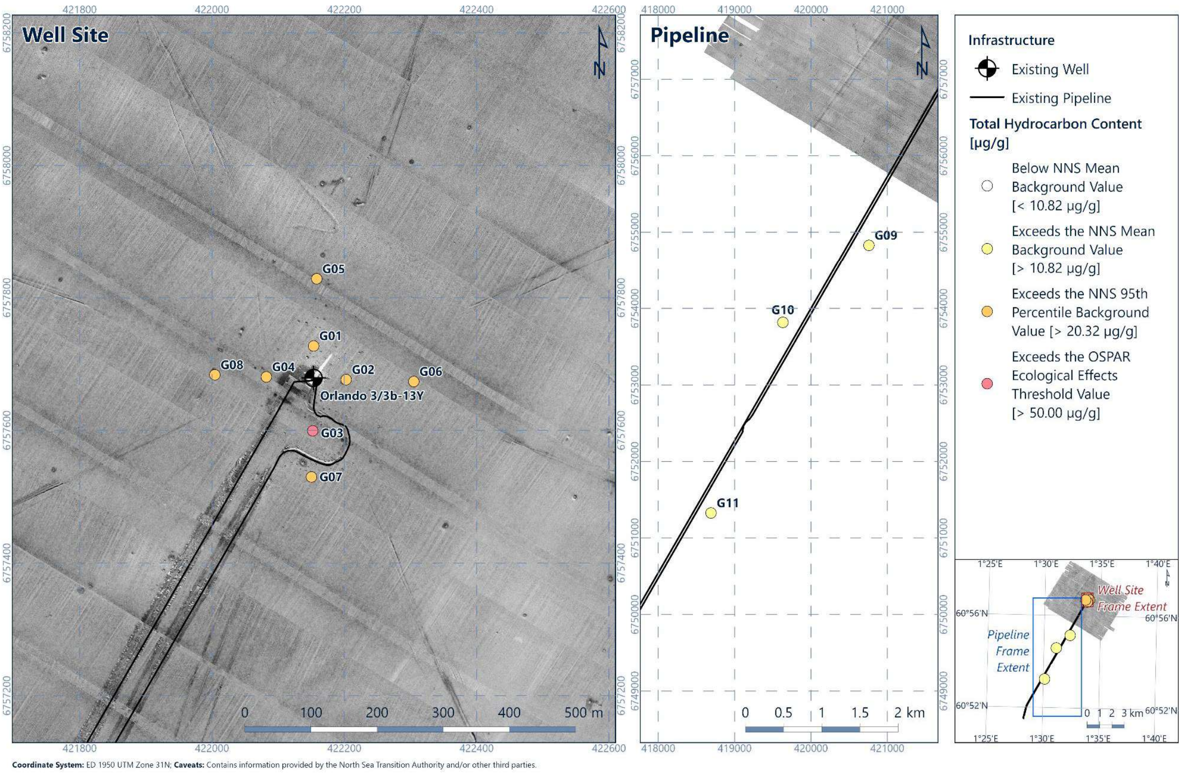
The single production well at Orlando was a re-entry and sidetrack of the previously suspended appraisal well (3/3b-13z), which was drilled in 2012 and would, therefore, have not involved the discharge of oil based muds. The sidetrack (3/3b-13y), drilled in 2018, consisted of three sections; 17½" and 12¼" inclined sections, and an 8½" open hole horizontal reservoir section, with all three sections drilled with low toxicity oil based mud (LTOBM). These muds were either retained on the rig or backloaded to shore, with a minor component discharged with the cuttings (0.681t (OPF Mass Balance calculation from EEMS submission)) following thermal treatment. The total mass of cuttings discharged was 897.4t, indicating an oil on cuttings volume of less than 0.1%, and the dry cuttings and related oil would have been rapidly and widely dispersed, with deposition of any cuttings to the seabed taking place over a wide area.

For comparison, Aquateam COWI (2014) summarise SINTEF dispersion modelling of discharged thermally treated OBM cuttings from the three lower hole sections of a representative well in the Ivar Aasen Field (Norwegian sector of the northern North Sea, water depth 113m, quantity of treated OBM cuttings released 1,149 tonnes, and discharge one metre below the sea surface) for summer and winter scenarios. The modelling indicated that a maximum concentration of cuttings in the water column of 1-5mg/l, and that the maximum thickness of the cuttings on the seabed occurred 250-300m from the discharging rig. In an area equivalent to 50 x 50 metres, the thickness of cuttings deposition was up to 1.8mm. The authors also noted that the environmental risk associated with the discharge of thermal treated LTOBM cuttings corresponds to that seen with discharges of water based mud (WBM) cuttings; representative pictures from the Orlando well area show no deposition of cuttings.

A PON1 notification[3] indicates a small chemical release of Versaclean LTOBM (0.39kg) during the drilling of the appraisal well in 2012. Assuming that the release was of whole mud rather than just the base fluid, it would likely have sunk to the seabed due to the density of the mud weighting agents and would have dispersed over time. The past discharge of drill cuttings contaminated with OBM resulted in well documented acute and chronic effects at the seabed (e.g. Olsgard & Gray 1995, Daan & Mulder 1996), with secondary toxicity as a consequence of organic enrichment (from hydrogen sulphide produced by bacteria under anaerobic conditions) probably the most important effect of the current suite of OBMs. The small volume of oil, and time since discharge (nearly 13 years), are such that whilst the spill may be detected in the 2025 analysis of sediment hydrocarbons (e.g. UCM described above and THC below) and metals (e.g. barium, see below), it is highly unlikely that significant environmental effects resulted from the spill (as evidenced by the 2025 macrofaunal analysis described in Section 3.4).

The mean total hydrocarbon content (THC) values at the well site stations (32.1µg/g) and the pipeline stations (14.1 µg/g) were higher than the wider area (NNS mean background 10.8 µg/g) (Table 3.3). The highest THC value was observed at station G03 (73µg/g), exceeding the OSPAR ecological effects threshold (EET) (50 µg/g). This corroborates the mixed drilling fluid input observed at this station (Figure 3-5). Figure 3-6 shows that THC values decreased with distance from the well in a southerly direction and that the THC values were higher at the well site stations compared to the pipeline stations, suggesting an impact from drilling operations at the well.

Figure 3-6: Total hydrocarbon content (µg/g dry weight) at the well site and pipeline



[3] https://itportal.energysecurity.gov.uk/irs/publications/pon1/2012/legacy-notification/6352

The total 2 to 6 ring polycyclic aromatic hydrocarbon (PAH) concentrations were low across the well site stations and pipeline stations (Table 3.3). Total 2 to 6 ring PAH concentrations were slightly higher at the well site stations compared to the pipeline stations. The mean total 2 to 6 ring PAH concentration at the well site stations was higher than the 2011 site survey; however, the mean total 2 to 6 ring PAH concentration at the pipeline stations was comparable to the 2011 pipeline survey. Values were lower than the NNS mean background (0.320 µg/g, UKOOA 2001) and the NNS background 95th percentile value (0.855µg/g, UKOOA 2001) at all stations (Fugro 2025).

Table 3.3: Hydrocarbon concentrations, µg/g dry weight

Station	% fines	THC	n-Alkanes (nC_{12-36})	UCM	CPI Ratio			Pr	Ph	Total PAH (2-6 Ring)
					nC_{12-20}	nC_{21-36}	nC_{12-36}			
Well site stations 2021										
G01	22.3	22.7	0.89	17.9	0.84	1.26	1.11	0.0187	0.0116	0.129
G02	28.0	23.5	0.77	19.1	0.89	1.29	1.13	0.0140	0.0061	0.176
G03	26.2	73.0	1.16	61.0	0.81	1.52	1.13	0.0197	0.064	0.166
G04	29.6	36.9	0.96	31.0	0.83	1.46	1.24	0.0155	0.0059	0.166
G05	26.3	23.5	0.81	18.4	0.89	1.37	1.11	0.0145	0.0072	0.106
G06	26.7	28.6	1.03	23.1	0.83	1.40	1.13	0.0175	0.0102	0.163
G07	30.4	24.0	0.73	19.5	0.81	1.32	1.12	0.0130	0.0089	0.131
G08	29.0	24.7	0.59	20.8	0.93	1.48	1.37	0.0101	0.0027	0.155
Mean	**27.3**	**32.1**	**0.87**	**26.4**	**0.85**	**1.39**	**1.17**	**0.0154**	**0.0074**	**0.149**
Pipeline stations 2021										
G09	22.8	15.1	0.50	12.2	0.82	1.55	1.47	0.0088	0.0042	0.128
G10	22.1	13.3	0.34	11.1	0.87	1.53	1.47	0.0055	0.0016	0.134
G11	20.8	13.8	0.35	11.5	0.71	1.57	1.45	0.0074	0.0027	0.099
Mean	**21.9**	**14.1**	**0.40**	**11.6**	**0.80**	**1.55**	**1.46**	**0.0072**	**0.0028**	**0.120**
Well site stations 2011 (Fugro 2012a)										
Mean	**26.1**	**9.0**	**0.40**	**7.6**	**0.92**	**1.34**	**1.30**	**0.006**	**0.002**	**0.097**
Pipeline stations 2011 (Fugro 2012a)										
Mean	**30**	**11.5**	**0.50**	**9.7**	**0.93**	**1.25**	**1.22**	**0.006**	**0.002**	**0.126**
Northern North Sea (UKOOA 2001)										
Mean	**8.7**	**10.8**	**0.40**	**-**	**-**	**-**	**1.62**	**-**	**-**	**0.320**
95th %		**20.3**	**0.83**	**-**	**-**	**-**	**2.11**	**-**	**-**	**0.855**

Notes: THC = total hydrocarbon content, UCM = unresolved complex mixture; CPI = carbon preference index; Pr = pristane; Ph = phytane. Source: Fugro (2025).

When normalised to 2.5% total organic carbon (TOC), background assessment concentration (BAC) values were exceeded for the following aromatic hydrocarbons: naphthalene at stations G03 and G09, phenanthrene at station G09, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene and benzo(a)pyrene at stations G09 and G10, indeno(1,2,3-cd)pyrene at eight stations, and benzo(ghi)perylene at nine stations. Examination of naphthalenes, phenanthrenes/anthracenes and dibenzothiophenes (NPD) content and the parent/alkyl distributions within the PAH data suggested a predominance of inputs from pyrolytic rather than petrogenic sources (Fugro 2025).

Metals

Sediments collected within the survey area were analysed for heavy and trace metals. The sediment samples underwent an aqua regia digest followed by multi-element analysis by inductively coupled plasma-mass spectrometry (ICP-MS) or by inductively coupled plasma-optical emission spectrometry (ICP-OES). When high quantities of barites from drilling muds are present in samples, the extraction efficiency for barium is considerably reduced. A more stringent methodology (Hartley 1996) to determine total barium concentrations has therefore been applied: total barium by alkali fusion. Barite is also highly unreactive; therefore, the total barium levels provide relevant information on the quantity/spatial extent of drilling mud present in the sediment (Fugro 2025).

The normalisation of heavy metals against aluminium content is typically undertaken to account for natural variations derived from differences in sediment characteristics. The data presented in Table 3.4 has not been normalised to 5% aluminium content using pivot values and co-factors as detailed by OSPAR (2015) as the aluminium content was below the pivot point detailed in OSPAR (2015) (Fugro 2025).

The OSPAR Coordinated Environmental Monitoring Programme (CEMP) listed metal concentrations include arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc (OSPAR 2014). The CEMP provides assessment criteria for contaminants in sediments in the form of background concentration (BC), background assessment concentration (BAC) and effects range low (ERL) threshold values. Adverse effects on organisms are rarely observed when concentrations are present below the ERL value (OSPAR 2009a). Concentrations of the CEMP listed metals were below their respective ERL values at all stations, where available (Table 3.4).

Table 3.4: Total heavy and trace metal concentrations, µg/g dry weight

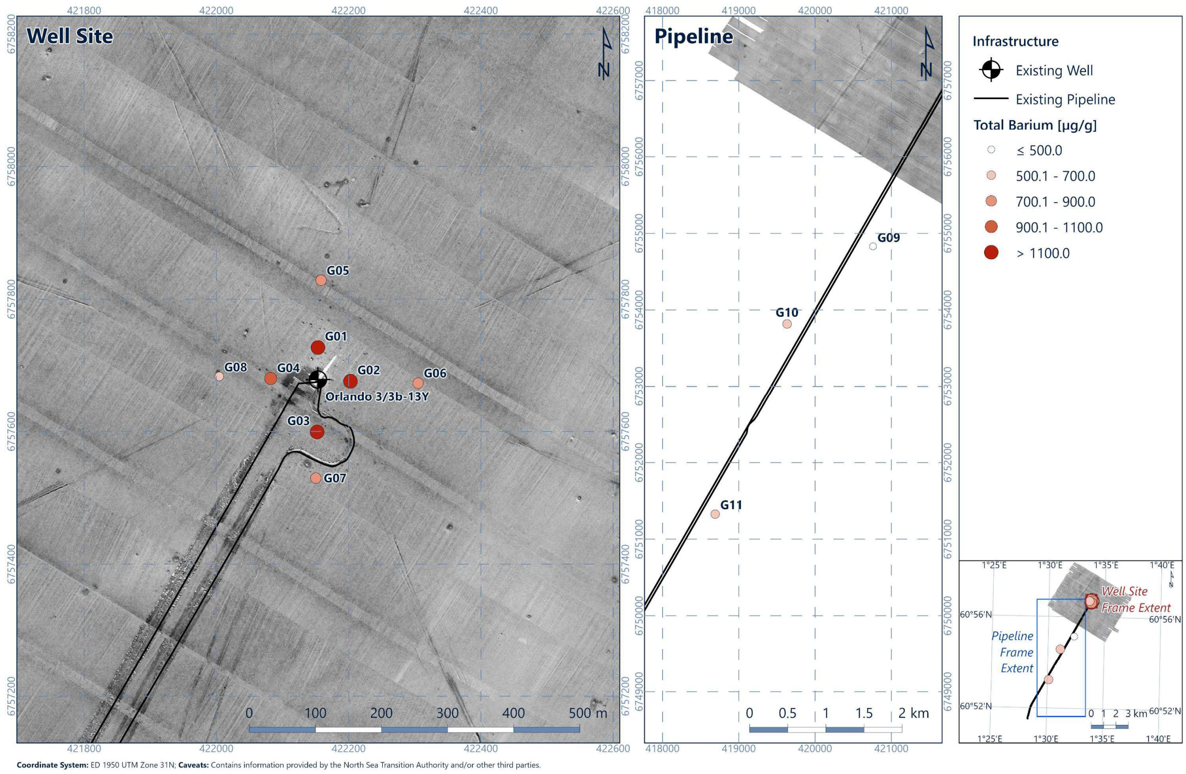
Station	Al	As	Ba	TBa	Cd	Cr	Cu	Fe	Pb	Hg	Ni	V	Zn
Well site stations 2021													
G01	6140	3.66	1490	1970	<0.1	18.2	4.9	7390	5.1	0.04	7.9	19.9	17.9
G02	5310	2.70	1370	1910	<0.1	20.9	6.8	8290	5.7	0.03	9.8	15.4	20.5
G03	6360	2.50	2100	2820	<0.1	16.1	3.6	7170	6.0	0.04	8.0	16.7	18.7
G04	5390	2.50	866	1100	<0.1	14.1	3.2	6610	5.1	<0.03	7.0	14.7	15.5
G05	5590	2.09	478	773	<0.1	14.0	3.1	6490	4.6	<0.03	6.5	16.2	14.0
G06	5430	2.73	536	790	<0.1	13.4	3.3	6620	4.7	<0.03	6.9	14.3	52.2
G07	5720	2.17	453	719	<0.1	14.3	3.4	6130	4.8	<0.03	6.9	15.2	14.7
G08	5900	2.18	459	678	<0.1	16.3	3.7	6700	6.7	<0.03	8.3	16.2	16.1
Mean	**5730**	**2.57**	**969**	**1340**	**<0.1**	**15.9**	**4.0**	**6920**	**5.3**	**-**	**7.7**	**16.1**	**21.2**
Pipeline stations 2021													
G09	4460	1.94	208	495	<0.1	11.5	2.4	5680	4.0	<0.03	5.7	12.5	11.8
G10	4500	2.02	323	615	<0.1	11.5	2.4	5400	3.9	<0.03	5.1	12.8	11.4
G11	4380	1.92	417	559	<0.1	10.8	2.5	5130	4.0	<0.03	5.6	11.8	11.9
Mean	**4450**	**1.96**	**316**	**556**	**<0.1**	**11.3**	**2.4**	**5400**	**4.0**	**-**	**5.5**	**12.4**	**11.7**

Station	Al	As	Ba	TBa	Cd	Cr	Cu	Fe	Pb	Hg	Ni	V	Zn
Northern North Sea (UKOOA 2001)													
Mean	-	-	232	-	0.2	7.1	2.4	4532	5.5	0.04	4.1	9.2	11.7
95th %	-	-	577	-	0.8	11.5	4.0	8040	11	0.10	7.0	19.7	17.1
CEMP Assessment Criteria (OSPAR 2014)													
ERL					1.2	81.0	34.0	-	47	0.15	-	-	150

Notes: Al (aluminium), As (arsenic), Ba (barium), Tba (total
Source: Fugro (2025).

Barium concentrations exceeded the NNS 95th percentile at stations G01 to G04, located within 100m of the Orlando 3/3b-13Y well. The higher barium concentrations were likely to be from the redistribution of cuttings materials (including drilling fluids) from drilling activities at the Orlando 3/3b-13Y well. These stations also displayed evidence of a mixed input of drilling fluids in the GC-FID profiles and had slightly higher concentrations of some metals (namely copper, nickel, lead and zinc) which are often associated with drill cuttings (Ansari *et al*. 2001). Figure 3-7 shows a decrease in sediment total barium concentrations with distance from the well. Station G03 displayed the highest total barium concentration (Table 3.4) and the highest THC value (Table 3.3), indicating the presence of drilling fluids.

Figure 3-7: Total Barium (µg/g dry weight) at the well site and pipeline



3.2 Water column, climate and hydrography

Significant wave heights in the vicinity of Orlando exceed 2.25m for 50% of the year, although there is considerable seasonal variation between sea states.

Tidal currents in the northern North Sea are generally weak, and readily influenced by other factors such as winds and density driven circulation, rather than the tides themselves. Maximum tidal rates in the region of the Block are 0.26 and 0.1m/s respectively for spring and neap tides. Wind direction is variable, but predominately from the south and southwest. Northerly winds occur most frequently during the spring and early summer, with a marked seasonal variation, with stronger winds prevailing during the autumn and winter.

Thermal stratification occurs in April/May; stratification breaks down with increasing frequency and severity of storms and cooling in the autumn.

3.3 Plankton

The phytoplankton community of the North Sea is dominated by the dinoflagellate genus Tripos along with diatoms, *Chaetoceros* and *Thalassiosira* spp. A phytoplankton bloom occurs in spring, followed by a smaller peak in the autumn. The zooplankton community is dominated by calanoid copepods, although other calanoid genera such as *Paracalanus* spp. and *Pseudocalanus* spp. are also abundant. There is also a high biomass of *Calanus* larval stages present in the region. Euphausiids, *Acartia* and decapod larvae are all important components of the zooplankton assemblage. A phytoplankton bloom occurs in spring, followed by a smaller peak in autumn. Zooplankton abundance follows a similar seasonality to phytoplankton, although peak abundances are later. The time-lag between a phytoplankton bloom and peak zooplankton abundance is dependent on both the species composition and oceanographic conditions.

3.4 Benthos

Regional overview

An ICES regional survey found that the benthic infaunal communities in waters north of the 100m depth contour were typified by finer sediments and the indicator species *Minuspio (=Prionospio) cirrifera, Aricidea catherinae, Exogone verugera* (polychaetes) and *Thyasira* spp. (Kunitzer *et al*. 1992). A second regional ICES survey classified the fauna of the northern and central North Sea area as a Myriochele with Paramphinome assemblage, found in muddy and fine sand, in water depths >50m, with the polychaetes *Paramphinome jeffreysii, Myriochele* spp., *Spiophanes* spp. and the brittlestar *Amphiura filiformis* abundant (Rachor *et al.* 2007, Reiss *et al.* 2010). The main epifaunal communities of relevance to the Orlando area included those in average water depths of 167m (112–205m), characterised by echinoids *Echinus* spp., the hermit crabs *Anapagurus laevis, Pagurus prideaux, P. bernhardus*, and the gastropod *Colus gracilis*, as well as an epifaunal assemblage in water depths of 145m (105-243) characterised by *Echinus* spp., *A. irregularis, H. tubicola*, the echinoderm *Luidia sarsi, A. laevis* and the mollusc *Scaphander lignarius* (Reiss & Rees 2007, Reiss et al. 2010).

Orlando benthic sampling

Infauna

The majority of taxa and individuals within the macrofaunal community sampled by the 2021 site survey were annelids, contributing five of the ten most abundant taxa across the survey area (Table 3.5) (Fugro 2025). Thyasirid bivalves contributed a further three taxa, mirroring the results from the 2011 site survey which was also dominated by polychaete worms and bivalves from the family Thyasiridae (Fugro 2011a). These taxa are typical of the region and are characteristic of the habitats likely to be found in the survey area (Fugro 2025).

Table 3.5: Most abundant taxa across the 2021 survey sites

Taxon	Faunal abundance (individuals per sample)										
	G01	G02	G03	G04	G05	G06	G07	G08	G09	G10	G11
Annelida											
Galathowenia oculata	39	38	30	29	68	61	23	79	55	74	50
Owenia	10	8	13	6	60	40	13	32	36	38	45
Paradoneis lyra	25	32	29	7	37	25	26	27	21	6	16
Paramphinome jeffreysii	22	38	25	11	18	38	20	31	12	22	10
Aricidea (Acmira) catherinae	9	11	13	1	26	16	24	8	26	9	14
Mollusca											
Adontorhina similis	41	47	59	30	47	59	61	42	22	23	28
Retusa umbilicata	22	13	16	11	24	24	23	22	23	18	20
Mendicula ferruginosa	31	11	16	10	18	31	25	21	11	25	4
Axinulus croulinensis	21	14	13	5	25	12	14	21	10	11	6
Other											
Phoronis	20	34	17	16	59	42	38	54	68	46	69

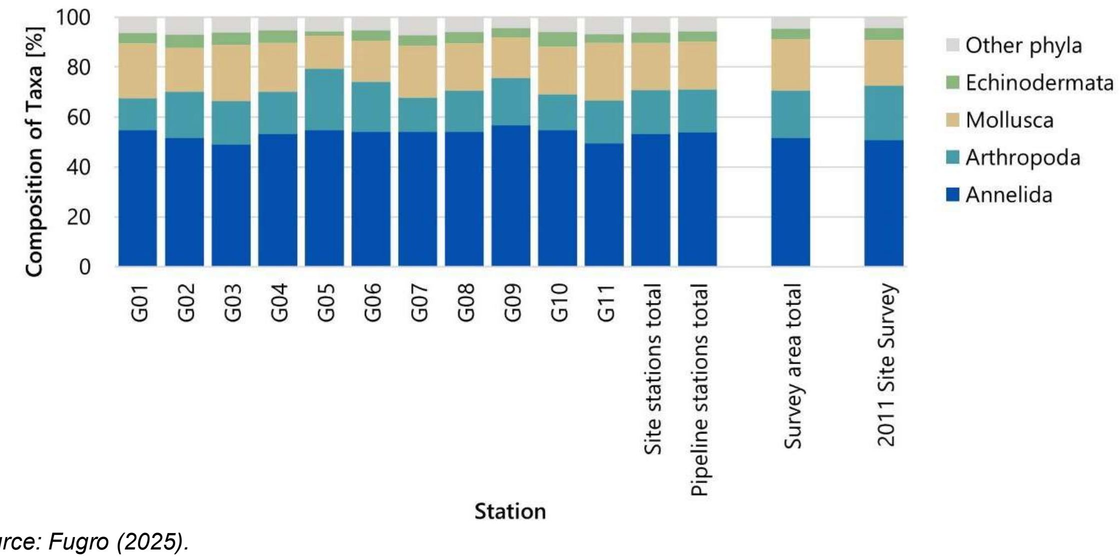
Source: Fugro (2025).

The composition of the community of the well site and pipeline area were very similar suggesting that there was not a spatial influence on the macrofaunal community throughout the survey area. This was also the case in the 2011 survey where stations were not found to group together by location within the survey area but rather displayed some grouping according to differences in the sediment. This trend was not found in the 2021 survey as all stations were described as 'very fine sand' or 'fine sand' (see Section 3.1), and results of cluster analysis (see below) did not show grouping according to mean sediment size (Fugro 2025).

The polychaete *Paramphinome jeffreysii* was the most abundant and dominant taxon as reported in the 2011 survey (Fugro 2011a). This taxon featured sixth most abundant in the 2021 survey, *with Galathowenia oculata* the most abundant taxon (Table 3.5). *P. jeffreysii* is known to be omnivorous, switching between predatory/scavenging and deposit feeding behaviour in response to changes in food supply (Jumars *et al*. 2015). *G. oculata* switches between filter feeding and surface deposit feeding (Fauchald & Jumars 1979) and is a known habitat builder which may be contributing to the slight rise in species number between the 2011 and the 2021 surveys. Although five of the top ten taxa had changed, the phyletic make up of these taxa had remained the same (Figure 3-8), indicating that there had not been a 'shift', as defined in Collie *et al*. (2004), in macrofaunal community between the 2011 and 2021 surveys, but rather a fluctuation in the abundance of species as conditions became less favourable for the dominant species other common species began to thrive (Frid *et al*. 2009).

Cluster analysis differentiated two clusters, and one ungrouped station (G04) based on the macrofauna data; however, all stations were at least 60.1 % similar to one another. This indicated a moderate to high level of similarity of macrofaunal community throughout the survey area and it was likely one homogenous community with localised fluctuations. There were no correlations between the macrofauna and the composition of sediments (percentage of fines, sands and gravels); however, from the photographic data it was observed that there were infrequent patches of coarser material present sporadically around the survey area with was otherwise dominated by 'fine sand'. These small changes in sediment may exert a sphere of influence on the macrofaunal community contributing to the small scale differences in the less abundant, specialised taxa. For example, the amphipod *Scopelocheirus hopei* was present only at station G04. *S. hopei* is known to be a scavenger and in particular to feed on discarded echinoderm casts (Lowry & Stoddart 1989, cited by Fugro 2025); as numbers of echinoderms were slightly raised at station G04 compared with other stations, this may be providing a food source and explain the presence of this taxon in the data. Despite station G04 not grouping with the rest of the stations, it was still likely to represent a variation of the same soft sediment community observed across the survey area (Fugro 2025).

Figure 3-8: Phyletic composition of infaunal taxa from the 2021 survey



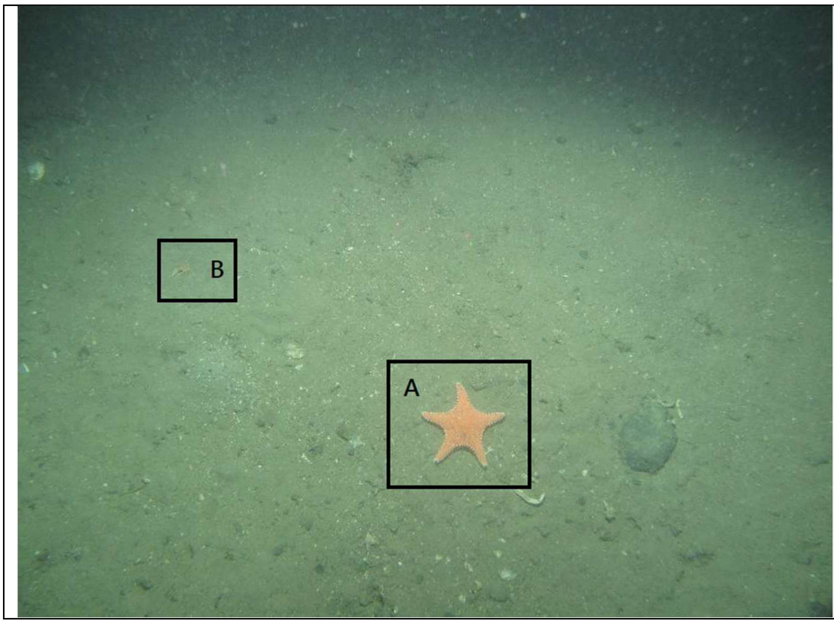
Source: Fugro (2025).

The results of the correlation analysis (Fugro 2025) did not present any correlations between the number of taxa or individuals in relation to physical characteristic of the sediments nor to sediment chemistry. This was to be expected as there were low levels of total organic carbon (TOC) and total organic matter (TOM) present throughout the survey area and levels of heavy metals were broadly comparable to their respective NNS mean background concentrations. The majority of stations were typical of background sediment in the NNS with the exception of stations closest to the well, which showed some evidence of drilling fluids from drilling activities at the well, but no negative effects on the macrofauna were found at these stations (Fugro 2025).

Epifauna

Epifauna associated with muddy sands within the 2021 survey area was generally sparse. The most regularly observed mobile epifauna included hermit crabs (Paguroidea), squat lobsters (*Munida* sp.), starfish (Asteroidea including *Asterias rubens*), brittlestars (Ophiuridae) and whelks (Buccinidae) (Figure 3-9). Where increased proportions of hard substrate were present (e.g. cobbles, boulders, shell fragments, tubes of *Sabellaria spinulosa*), sessile epifauna was observed, particularly anemones (Actiniaria), encrusting and erect sponges (Porifera), tube worms including *Filograna/Salmacina* clusters, fan worms (Sabellidae) and keel worms (Serpulidae). Faunal turf (Bryozoa including *Reteporella* sp.), and Hydrozoa was also common on hard substrates (Figure 3-9). Recorded epifaunal communities were typical of sediments within the NNS and were similar to the epifauna recorded in the 2011 survey (Fugro 2021a). Images from a 2024 ROV inspection survey of the well and pipeline provide further details of the epifaunal species present in the Orlando area (Figure 3-10).

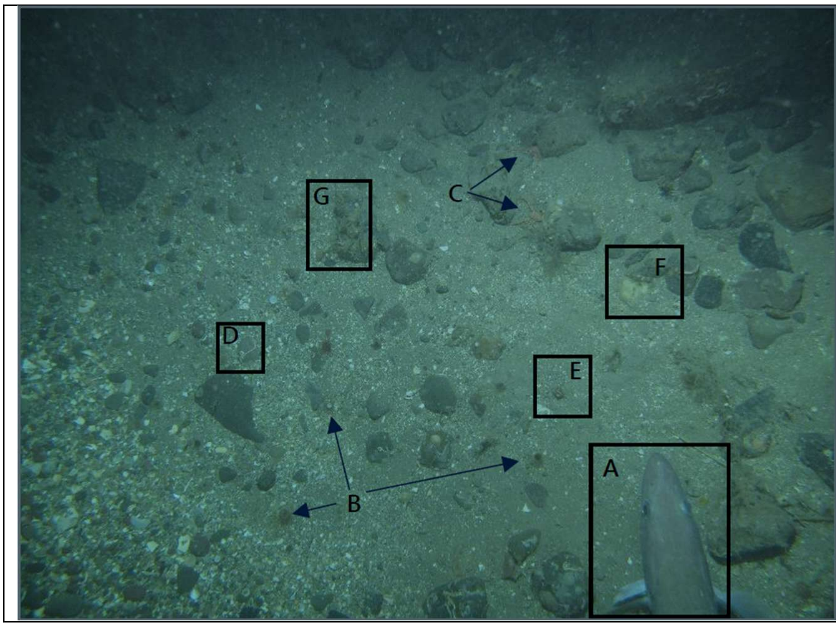
Figure 3-9: Examples of epifauna from 2021 survey transects



Transect V02

Sediment type:
Muddy sand/sandy mud with shell fragments and cobbles

Fauna:
A – Starfish (*Hippasteria phrygiana*)
B – Hermit crab (Paguridae)



Transect V01

Sediment type:
Muddy sand/sandy with pebbles, cobbles and boulders.

Fauna:
A – Ling (*Molva molva*)
B – Burrowing anemone (Ceriantharia)
C – Squat lobster (*Munida* sp.)
D – Calcareous worm tubes (Serpulidae)
E – Crab (Brachyura)
F – Encrusting sponge (Porifera)
G – Faunal turf (Hydrozoa/Bryozoa)

Source: Fugro (2025).

Benthic habitats

From the review of the photographic data during the habitat assessment report, the main sediment type observed across the survey area was slightly gravelly muddy sand/gravelly muddy sand (Folk 1954) with varying proportions of shell fragments. Areas of transects V01, V02, V06 and V09 recorded mixed sediments which corresponded to areas of high reflectivity from the SSS data (Fugro 2021b). Utilising this data, the original habitat report (Fugro 2021b) recorded two habitat types 'Deep circalittoral sand' (A5.27) and 'Deep circalittoral mixed sediment' (A5.45).

However, in considering macrofaunal and sediment distribution data, Fugro (2025) refined the EUNIS (2019) biotope 'Deep circalittoral sand' (A5.27) identified in the habitat assessment (Fugro 2021b), to the EUNIS (2022) biotope 'Faunal communities in Atlantic circalittoral sand' (MD521). This biotope describes offshore (deep) circalittoral habitats with fine sands or non-cohesive muddy sands. Very little data is available on these habitats; however, they are likely to be more stable than their shallower counterparts and characterised by a diverse range of polychaetes, amphipods, bivalves and echinoderms (EEA 2022). The EUNIS (2019) biotope 'Deep circalittoral mixed sediment' (A5.45) was also refined to the EUNIS (2022) biotope 'Faunal communities of Atlantic offshore circalittoral mixed sediment' (MD421). This biotope describes well mixed muddy gravelly sands or very poorly sorted mosaics of shell, cobbles and pebbles embedded in or lying upon mud, sand or gravel, supporting a wide range of infaunal polychaetes, bivalves, echinoderms and burrowing anemones (EEA 2022). These biotopes were observed in a mosaic across the survey area, with observed areas of higher reflectivity being indicative of mixed sediments (Fugro 2025).

The 2024 inspection survey noted that protection materials (rock deposits) were present along much of the pipeline route, and shorter sections of the umbilical route, between the Orlando well and the NCP. The fauna present on these areas of hard substrate associated with pipeline protection materials included numerous sea squirt (ascidians), hydroids, anemone (*Bolocera tuediae*), and polychaete worm (likely the peacock worm *Sabella pavonina*) (Figure 3-11).

Figure 3-10: Selected seabed images and fauna interpretation from the 2024 inspection survey

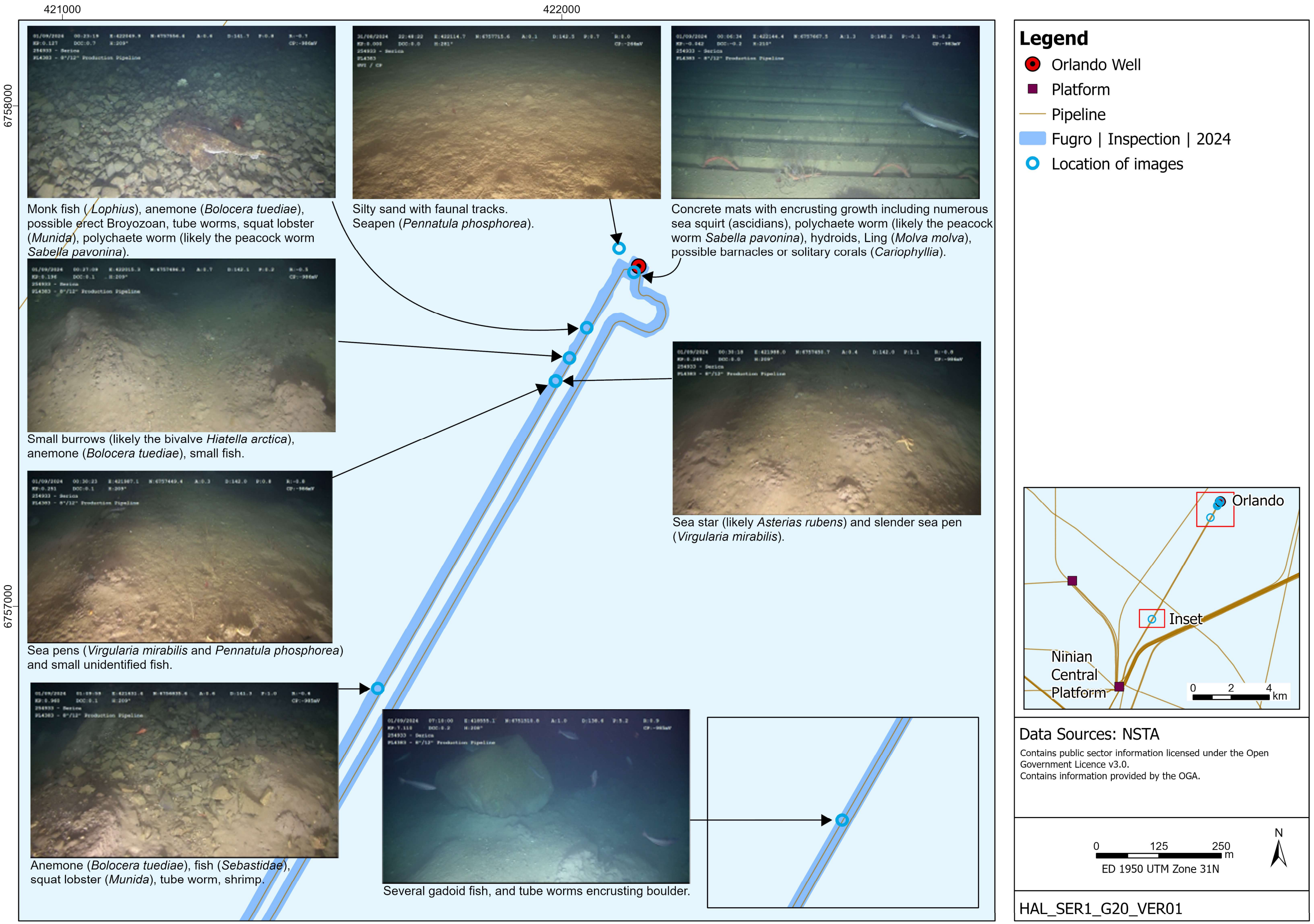
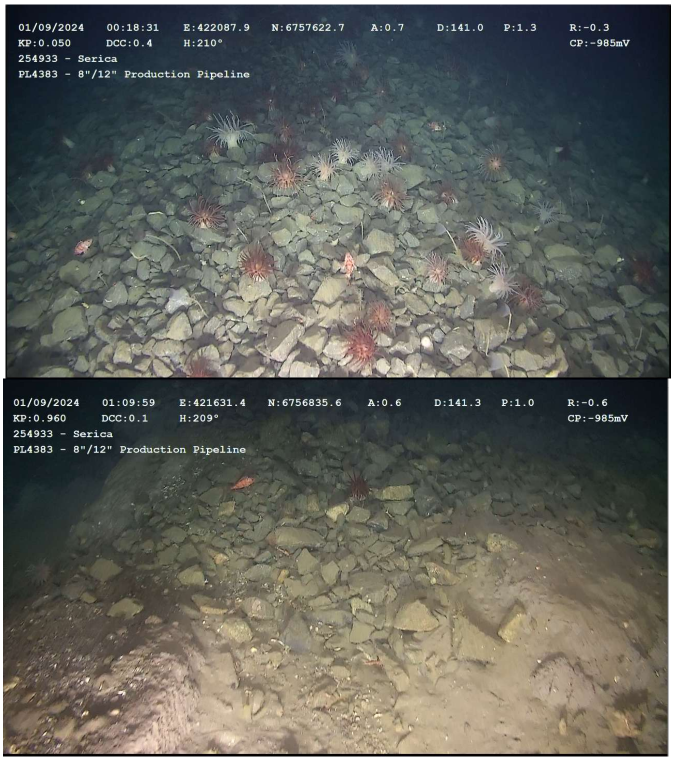


Figure 3-11: Representative pictures of fauna present on Orlando protective material



Rock protection material. Conspicuous fauna includes numerous anemone (*Bolocera tuediae*), several fish (Sebastidae), polychaete worm (likely the peacock worm *Sabella pavonina*), hydroids.

Start of rock remediation. Mounds of disturbed silty sand, coarse sand with scattered shell debris, small burrows. Conspicuous fauna include anemone (*Bolocera tuediae*), fish (Sebastidae), squat lobster (*Munida*), tube worm, shrimp.

3.5 Fish and Shellfish

The demersal fish community of the North Sea was investigated by Callaway *et al*. (2002) and Reiss *et al*. (2010), including sampling at sites in proximity to the Block. The demersal fish community was dominated by dab (*Limanda limanda*), long rough dab (*Hippoglossoides platessoides*) and the hagfish (*Myxine glutinosa*) with Norway pout (*Trisopterus esmarkii*), haddock (*Melanogrammus aeglefinus*), whiting (*Merlangius merlangus*), plaice (*Pleuronectes platessa*), grey gurnard (*Eutrigla gurnardus*) and lemon sole (*Microstomus kitt*) also present. Pelagic species found in the area include herring (*Clupea harengus*), mackerel (*Scomber scombrus*) and sprat (*Sprattus sprattus*). Many of these species, abundant in the deeper waters of the North Sea, are valuable commercially although there is relatively limited fishing activity in the Orlando area throughout the year (see Section 3.9).

The long-term North Sea International Bottom Trawl Survey (NS-IBTS) provides monitoring data for stock assessments and information on the distribution and relative abundance of fish in the area. In the North Sea, the surveys are performed in Q1 and Q3 and the data from the trawls are stored on the ICES DATRAS (Database of Trawl Surveys) site[4]. The Orlando infrastructure lies within ICES rectangle 50F1 with recent data (2020-2023) from DATRAS for sample stations within this rectangle indicating that a range of demersal fish species were likely to be present, including pollock (*Pollachius virens*), cod (*Gadus morhua*) and haddock often dominating catches, with whiting, blue whiting (*Micromesistius poutassou*), Norway pout, tusk (*Brosme brosme*), ling (*Molva molva*), hake (*Merluccius merluccius*), greater argentine (*Argentina silus*), horse mackerel (*Trachurus trachurus*) and anglerfish (*Lophius piscatorius, Lophius*

[4] https://www.ices.dk/data/data-portals/Pages/DATRAS.aspx

budegassa) also caught in smaller numbers. Pelagic species caught included herring and mackerel. Shellfish species sampled from 50F1 included Norway king crab *(Lithodes maja)*, Loligo squid, shortfin *(Illex coindetii*) and long-finned *(Loligo forbesii)* squid.

ICES rectangle 50F1 overlaps with reported spawning and nursery grounds of several commercially important fish species (Table 3.6), and these are also shown in Figure 3-12 and Figure 3-13. Of the six species with spawning grounds in the area, five are priority marine features (PMF) in Scottish waters: saithe, cod, Norway pout, sandeel, and whiting.

Table 3.6: Spawning and nursery areas for fish and shellfish

Species	Spawning	Spawning period	Peak spawning	Nursery
Haddock	✓[1,3]	February-May[1]	-	✓[1]
Whiting†	✓[1,4]	February-June[1,2]	-	Low intensity[2]
Saithe	✓[1]	January-April[1]	-	High intensity[1]
Norway pout†	✓[1]	January-April[1]*	-	✓[1]
Sandeel†	✓[2]	November-February[2]	-	Low intensity[2]
Mackerel†	-	-	-	Low intensity[2]
Cod†*	✓[1,2,5]	January-April[1,2]	February-March[2]	-
Blue whiting†	-	-	-	High intensity[2]
Spurdog†*	-	-	-	Low intensity[2]
Herring	-	-	-	Low intensity[2]
Ling†	-	-	-	Low intensity[2]
Hake	-	-	-	Low intensity[2]
Anglerfish	-	-	-	Low intensity[2]

*Note: *Higher concentrations of Norway pout eggs recorded in 50F1, †Priority marine features (PMF) in Scottish waters * OSPAR Threatened and/or Declining Species (Fish). Source: [1]Coull et al. (1998), [2]Ellis et al. (2012), [3]González-Irusta et al. (2016a), [4]González-Irusta et al. (2017), [5]González-Irusta et al. (2016b), Tyler-Walters et al. (2016)*

Figure 3-12: Fish spawning grounds

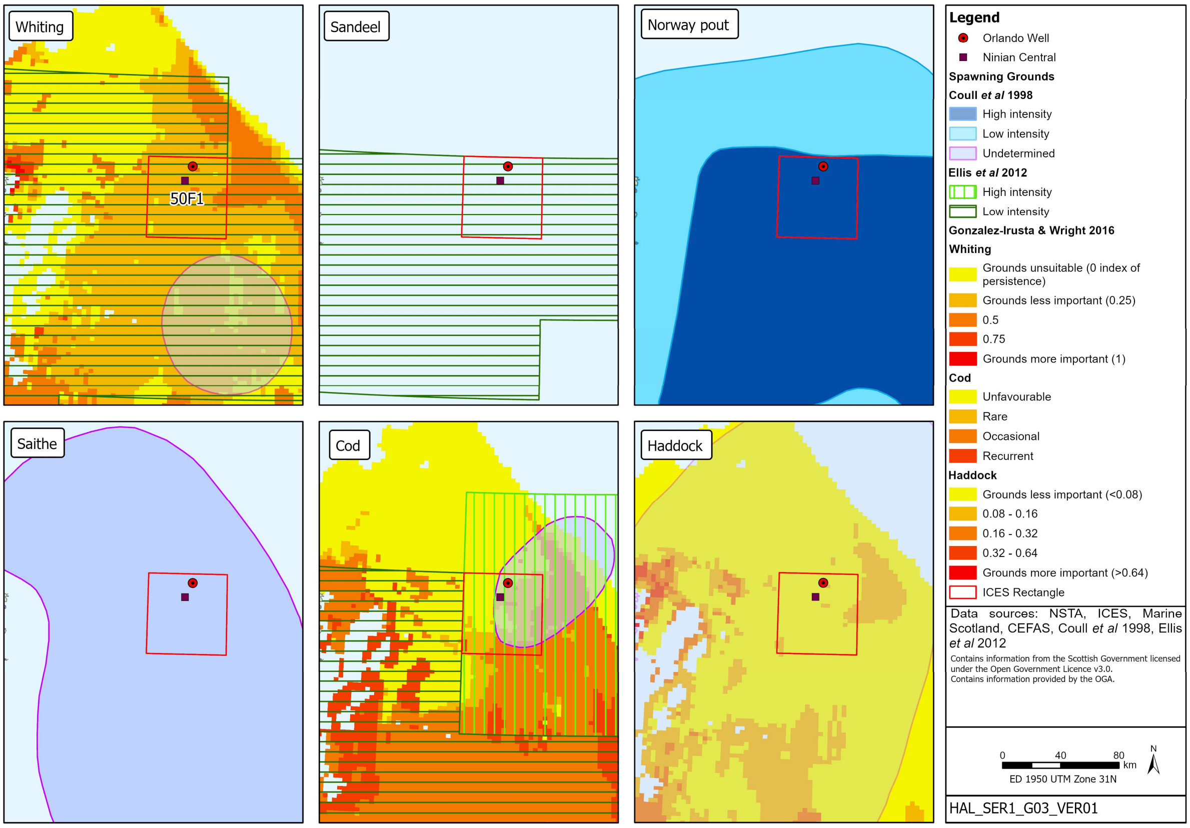
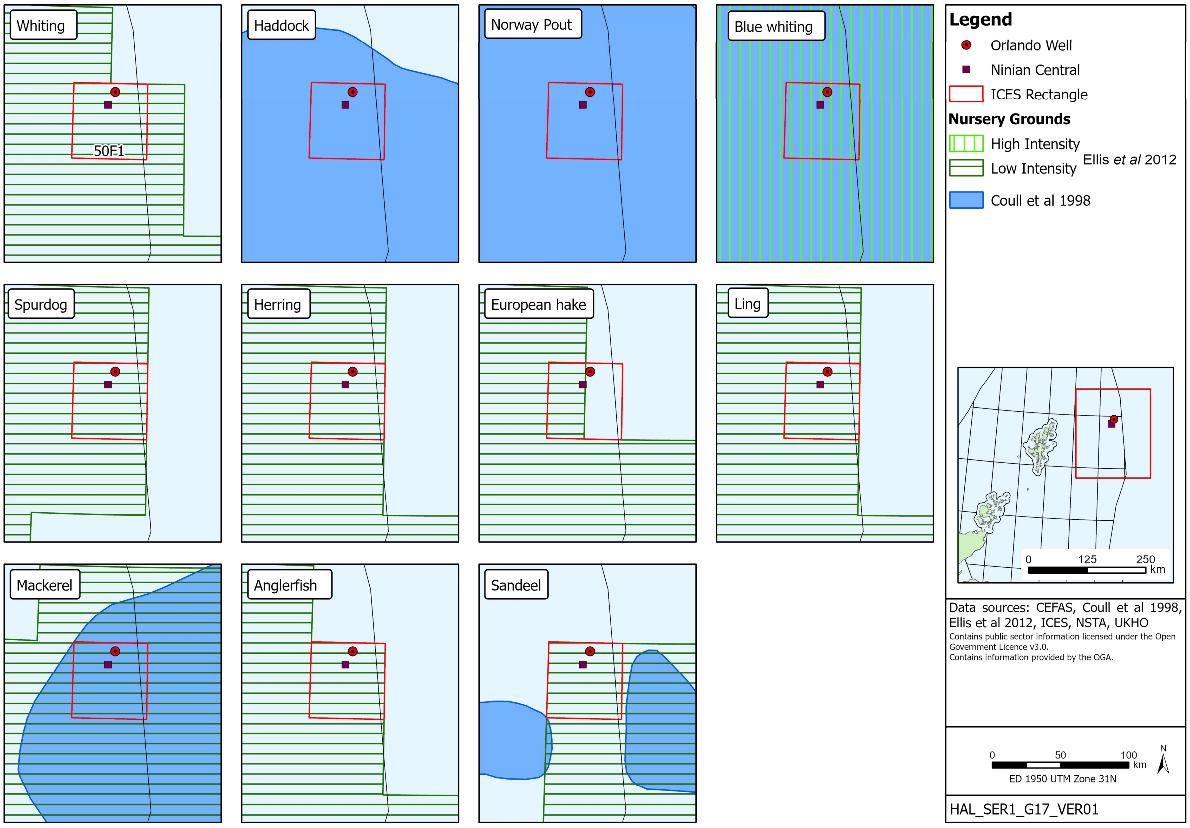


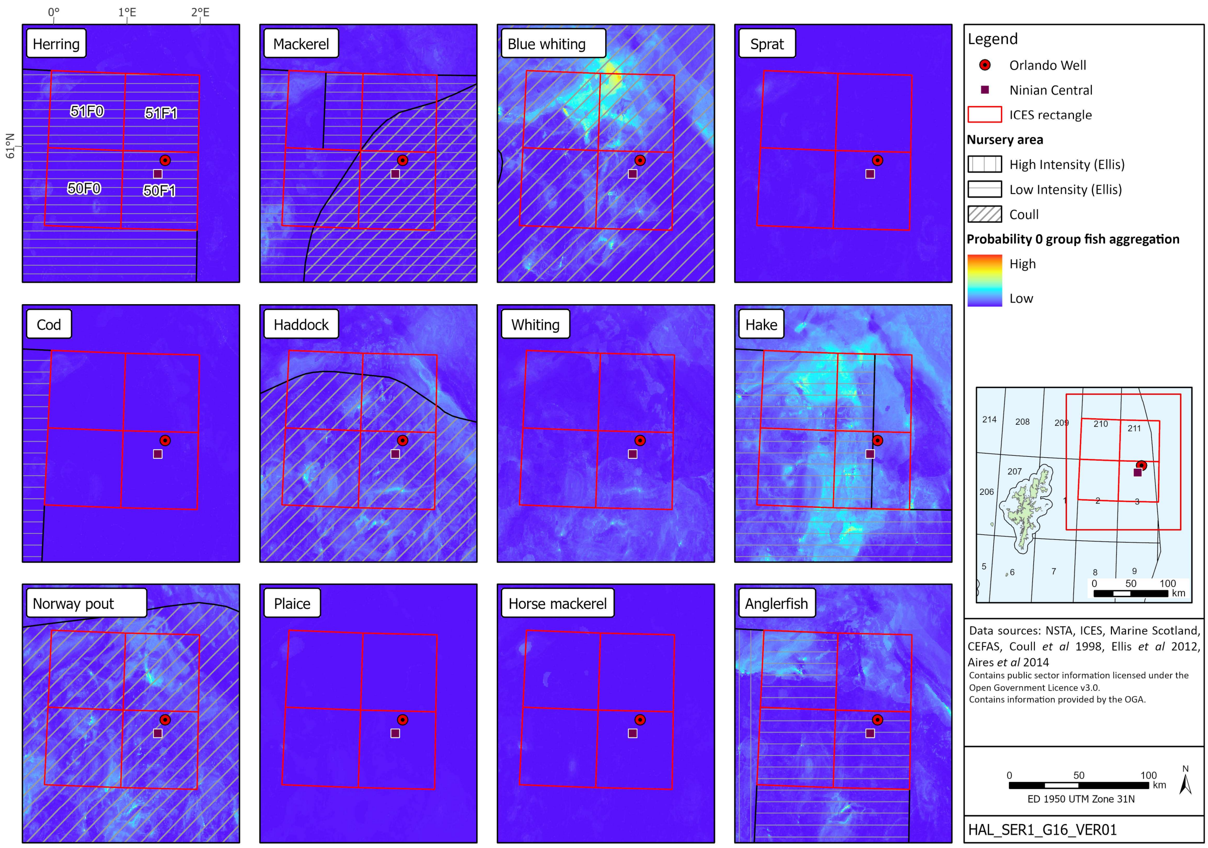
Figure 3-13: Fish nursery grounds



A study conducted by Aires *et al.* (2014) produced maps of modelled predicted probability of aggregations of 0-group fish (fish within the first year of their lives). The authors noted that insufficient data on 0-group fish were available to perform species distribution modelling on saithe and ling and these two species were not covered. Similarly, outputs for hake and anglerfish represent presences and absences of 0-group fish as insufficient data were available to apply the species distribution modelling approach to aggregations of 0-group fish for these two species.

From Figure 3-14, there is evidence of low to moderate probability of aggregations of juvenile blue whiting, haddock, hake, Norway pout and anglerfish in the wider Orlando area (noting the qualification above with respect to hake and anglerfish and that the data for these species indicates probability of presence of 0-group fish rather than aggregations).

Figure 3-14: Aggregations of 0-group fish and wider nursery areas



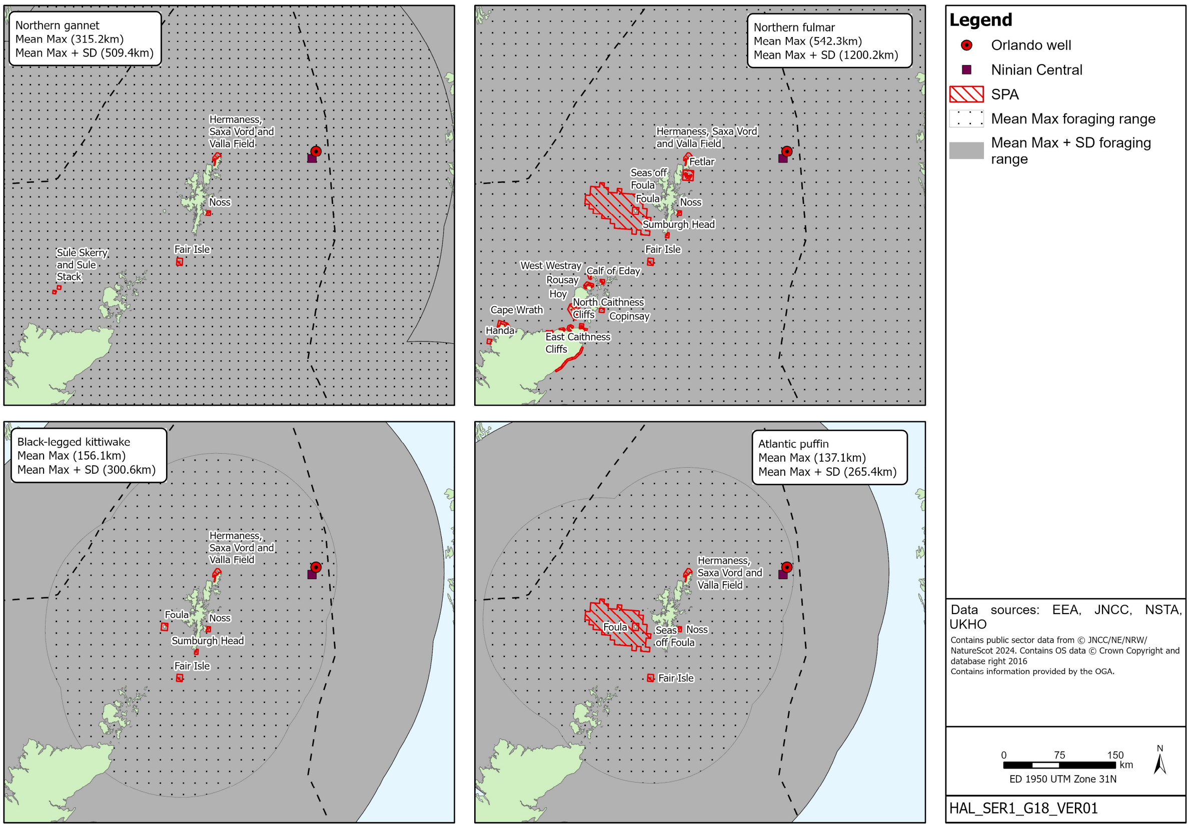
Review of video footage from the 2024 ROV inspection survey of the Orlando infrastructure identified saithe, blue ling, anglerfish and *Sebastides* sp., in the immediate area of the P1 well and along the pipeline route. The 2021 seabed survey reported that cod, Norway pout, gurnard (Triglidae), ling and flatfish (Pleuronectiformes) were infrequently observed within the survey area (Fugro 2025).

3.6 Birds

The Orlando area may be considered to be of low importance for seabirds in the context of the North Sea as a whole. This is related to the distance from breeding colonies and the availability of prey. At >120km to the nearest UK coastline, the Orlando area is beyond the reported mean maximum foraging range for the majority of UK-breeding seabird species (e.g. Thaxter et al 2012, Woodward *et al*. 2019, 2024); those species for which the area is within their foraging range from relevant Special Protection Areas are described in Figure 3.14. The species present in the area varies seasonally but may include northern fulmar (*Fulmarus glacialis*), northern gannet (*Morus bassanus*), black-legged kittiwake (*Rissa tridactyla*) and puffin (*Fratercula arctica*), several of which are widespread for much of the year. Modelled distributions of seabirds based on European Seabirds at Sea data (Kober *et al*. 2010) suggest that northern fulmar are likely to be the most abundant species in the general area during breeding season, primarily associated with fishing vessels (although the discard ban since 2019 may have reduced the importance of this association in the region).

For those seabird species for which the Orlando area is within their foraging range, Table 3.5 provides counts from the most recent seabird census (Seabirds Count, Burnell *et al.* 2023) of each species for the relevant SPAs highlighted in Figure 3-15 and the percentage change since the previous census, Seabirds 2000. In general, northern gannet counts at relevant SPAs have increased considerably, while black-legged kittiwake and Atlantic puffin numbers have decreased. Northern fulmar counts are more mixed with some SPAs showing considerable increases in numbers since Seabird 2000, while at others numbers have decreased. These changes do not take account of the impact of the H5N1 strain of Highly Pathogenic Avian Influenza (HPAI) which has affected UK wild bird populations since first recorded in great skuas in summer 2021 (Tremlett *et al*. 2024). The RSPB HPAI Seabird Surveys Project reports that with respect to relevant priority species (northern gannet and black-legged kittiwake in Table 3.7), since Seabirds Count there has been a *ca*. 3 to 37% decrease in gannet counts (both Apparently Occupied Sites (AOS) and Nests (AON)) at a number of relevant sites. Whilst black-legged kittiwake counts were more variable with increases at some sites on Shetland, there were also significant decreases of between 21 and 69% at others (Tremlett *et al*. 2024).

Figure 3-15: Seabird species and relevant Special Protection Areas* from which the Orlando area is within mean maximum foraging range



*Note: *SPAs where the seabird species is a qualifying feature of the site.*

Table 3.7: Counts and percentage change* in seabird qualifying features of relevant SPAs within mean maximum foraging range of Orlando area

SPA	Northern gannet (AOS/AON)		Northern fulmar (AOS)		Black-legged Kittiwake (AON)		Atlantic puffin (AOB)	
Hermaness, Saxa Vord and Valla Field	29,562	(89%)	13,208	(17%)	177	(-77%)	13,773	(-43%)
Fetlar	-	-	9,177	(-12%)	-	-	-	-
Noss	13,765	(59%)	5,092	(-40%)	179	(-93%)	1,174	(-42%)
Sumburgh Head	-	-	5,950	(70%)	966	(10%)	-	-
Foula	-	-	10,253	(-51%)	425	(-78%)	4,234	(-81%)
Seas off Foula	N/A	-	N/A	-	N/A	-	N/A	-
Fair Isle	4,971	(165%)	32,491	(59%)	448	(-95%)	6,666	(-56%)
Calf of Eday	-	-	2,324	(-64%)	-	-	-	-
Copinsay	-	-	1,618	(-21%)	-	-	-	-
Hoy	-	-	20,541	(-39%)	-	-	-	-
Rousay	-	-	2,192	(160%)	-	-	-	-
West Westray	-	-	1,214	(-74%)	-	-	-	-
North Caithness Cliffs	-	-	15,370	(-3%)	-	-	-	-
East Caithness Cliffs	-	-	13,964	(-3%)	-	-	-	-
Cape Wrath	-	-	1,477	(-52%)	-	-	-	-
Handa	-	-	723	(-81%)	-	-	-	-
Sule Skerry and Sule Stack	9,065	(94%)	-	-	-	-	-	-

*Note: *Percentage change between Seabird 2000 and Seabirds Count (2023). For northern gannet, percentage change values indicate change from the 2003-05 Gannet Census to 2013-14 Gannet Census and Seabirds Count. Seas off Foula SPA is not a breeding colony and therefore not counted. Apparently Occupied Nest (AON), Apparently Occupied Site (AOS), Apparently Occupied Burrow (AOB).*
Source: Burnell et al. (2023), https://data.jncc.gov.uk/data/63f0ea40-485d-46dd-b967-150df90a7b2b/seabirds-count-dataset-master-spa-summary-table.xlsx

Birds present vary seasonally, and being far offshore, those present are likely to be (predominately) those transiting through the area during migration, and during post-breeding dispersion from colonies. Seabird oil spill sensitivity is low in Block 3/03 for those months with data, with the exception of September (medium) (Table 3.8, Figure 3-16). Where no data coverage is available, JNCC guidance was used, to reduce the extent of coverage gaps (these are shown in red and highlighted yellow, below). The surrounding blocks also record low sensitivity, with some months with no coverage and the JNCC method applied.

Table 3.8: Seabird oil sensitivity in and around the Orlando area

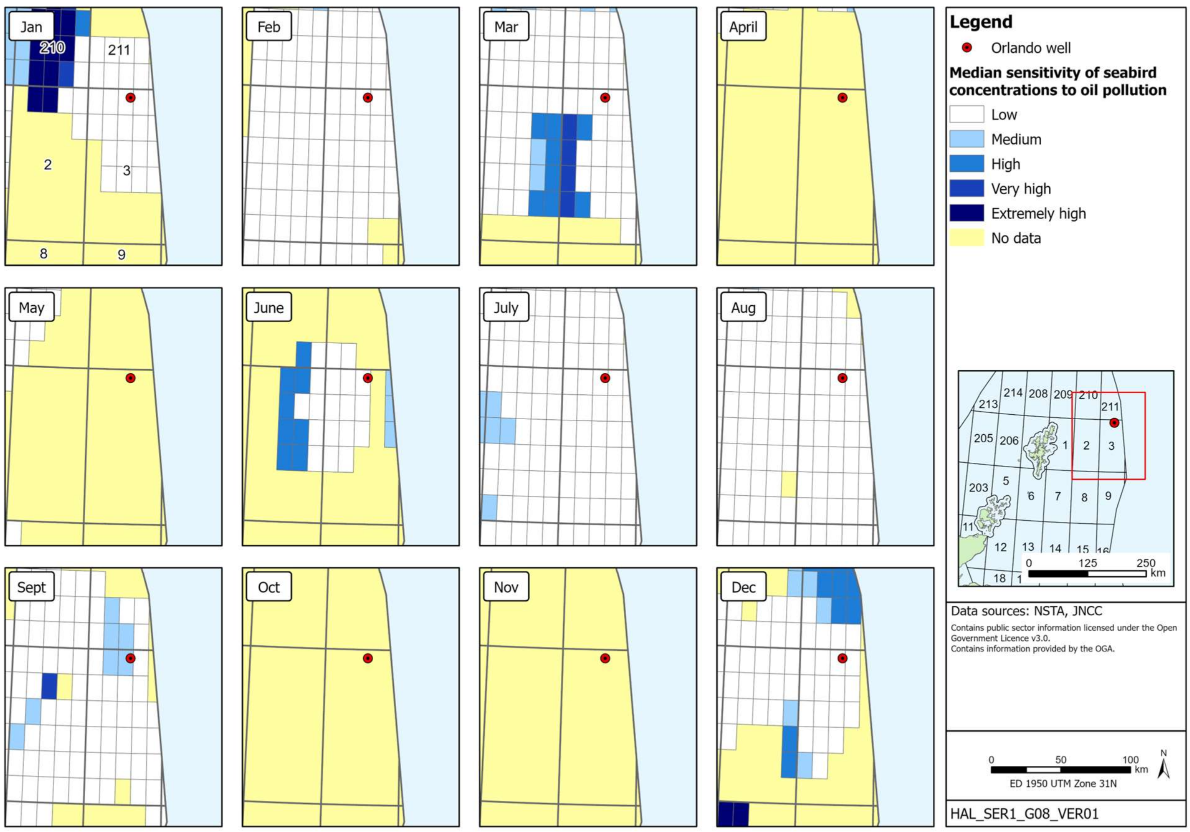
Block	J	F	M	A	M	J	J	A	S	O	N	D
211/27	5	5	5	5*	5*	5	5	5	4	4*	5*	5
211/28	5	5	5	5*	N	5*	5	5	4	4*	5*	5
211/29	5	5	5	5*	N	5*	5	5	5	5*	5*	5
3/02	5	5	5	5*	5*	5	5	5	4	4*	5*	5
3/03	5	5	5	5*	5*	5	5	5	4	4*	5*	5
3/04	5	5	5	5*	N	5*	5	5	5	5*	5*	5
3/07	5	5	5	5*	5*	5	5	5	5	5*	5*	5
3/08	5	5	5	5*	5*	5	5	5	5	5*	5*	5
3/09	5	5	5	5*	N	5*	5	5	5	5*	5*	5

Notes: Colour coding as follows:

1=extremely high	2=very high	3=high	4=medium	5=low	N=no data/JNCC (2017)*

Source: JNCC (2017)

Figure 3-16: Seabird oil sensitivity in and around the Orlando area



3.7 Marine Mammals

Block 3/03 lies within survey stratum NS-F of the SCANS-IV survey (previously U from SCANS III). For SCANS-IV, harbour porpoise (*Phocoena phocoena,* an Annex II species) was the most abundant species recorded in the survey stratum (0.4393 per km^2), followed by white-beaked dolphin (*Lagenorhynchus albirostris*, 0.3056 per km^2), and a low density of minke whale (*Balaenoptera acutorostrata*, 0.0271 per km^2 (Gilles *et al*. 2023). Harbour porpoise are present year-round, although sightings peak in this area in July and August. All the cetacean species recorded are also listed as Scottish Priority Marine Features (PMF) and European Protected Species (EPS). Figure 3-17 provides data on the distribution of the main cetacean species within the area from the large scale SCANS III (2016) and SCANS IV (2022) surveys. The SCANS III data provides an estimate of the density of each species in the area and is not directly comparable to the SCANS IV data which represents the distribution of sightings, the modelled density data has not yet been published.

Model-based assessments of the at-sea distribution of grey (*Halichoerus grypus*) and harbour (*Phoca vitulina*) seals (both Annex II species) around the UK and Ireland have been derived from satellite tagging data and haul-out count data, including several dozen seals tagged at colonies on the east coast of Scotland and Orkney (Jones *et al*. 2015, Jones & Russell 2016, Russell *et al.* 2017, Carter *et al*. 2020, 2022). Results show that grey seals use offshore areas (up to 100km from the coast) connected to their haul-out sites by prominent corridors, while harbour seals primarily stay within 50km of the coastline (Jones *et al*. 2015); both species are listed as PMFs. The Orlando area is distant from seal breeding colonies and haul-out sites; very low densities of both grey and harbour seal are likely in the area (Figure 3-18).

Figure 3-17: Estimated densities (SCANS III) and distribution of sightings (SCANS IV) of cetacean species in the Orlando area

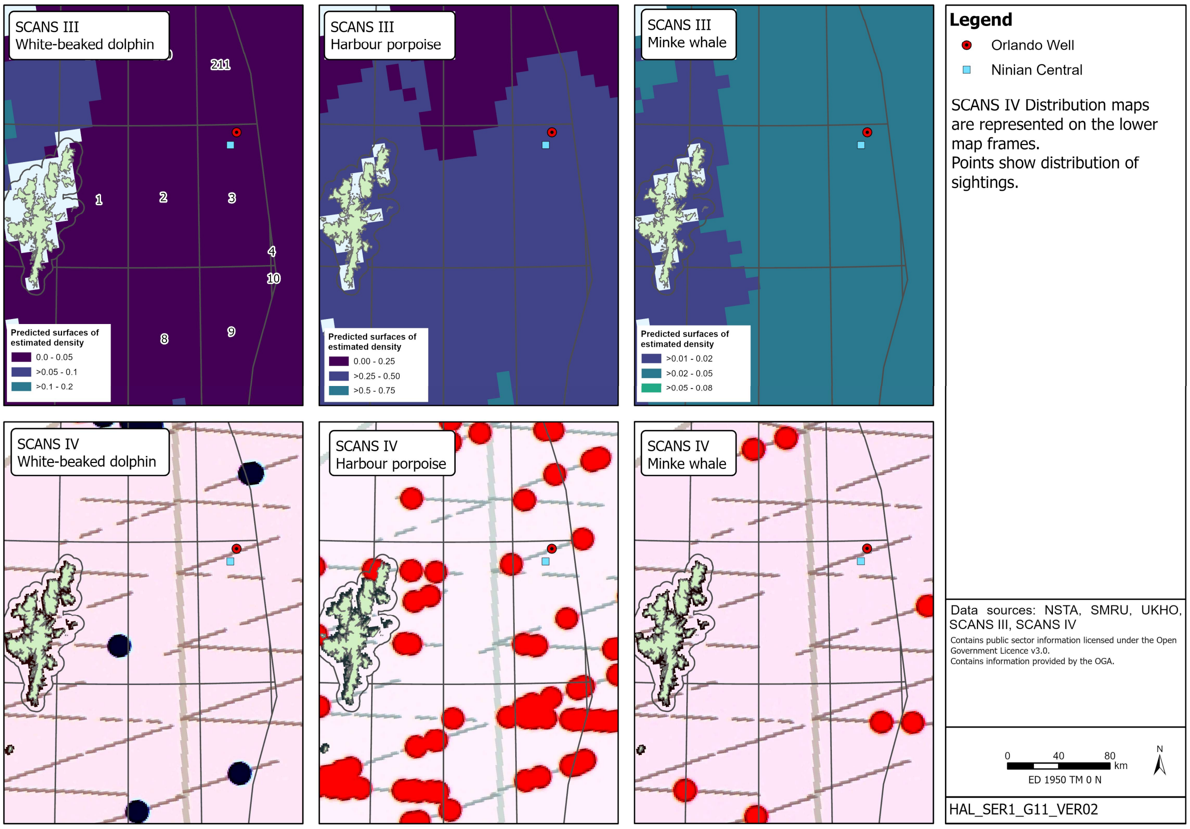
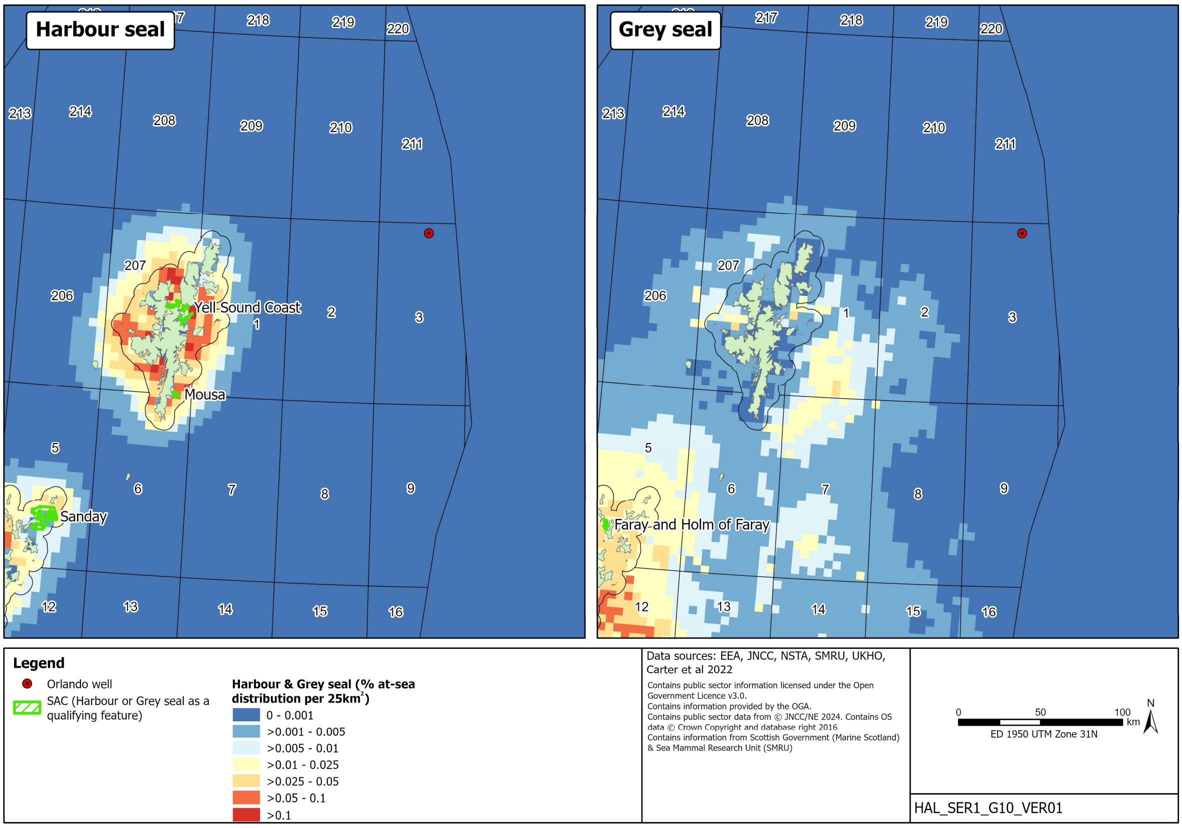


Figure 3-18: Seal distribution in the Orlando area



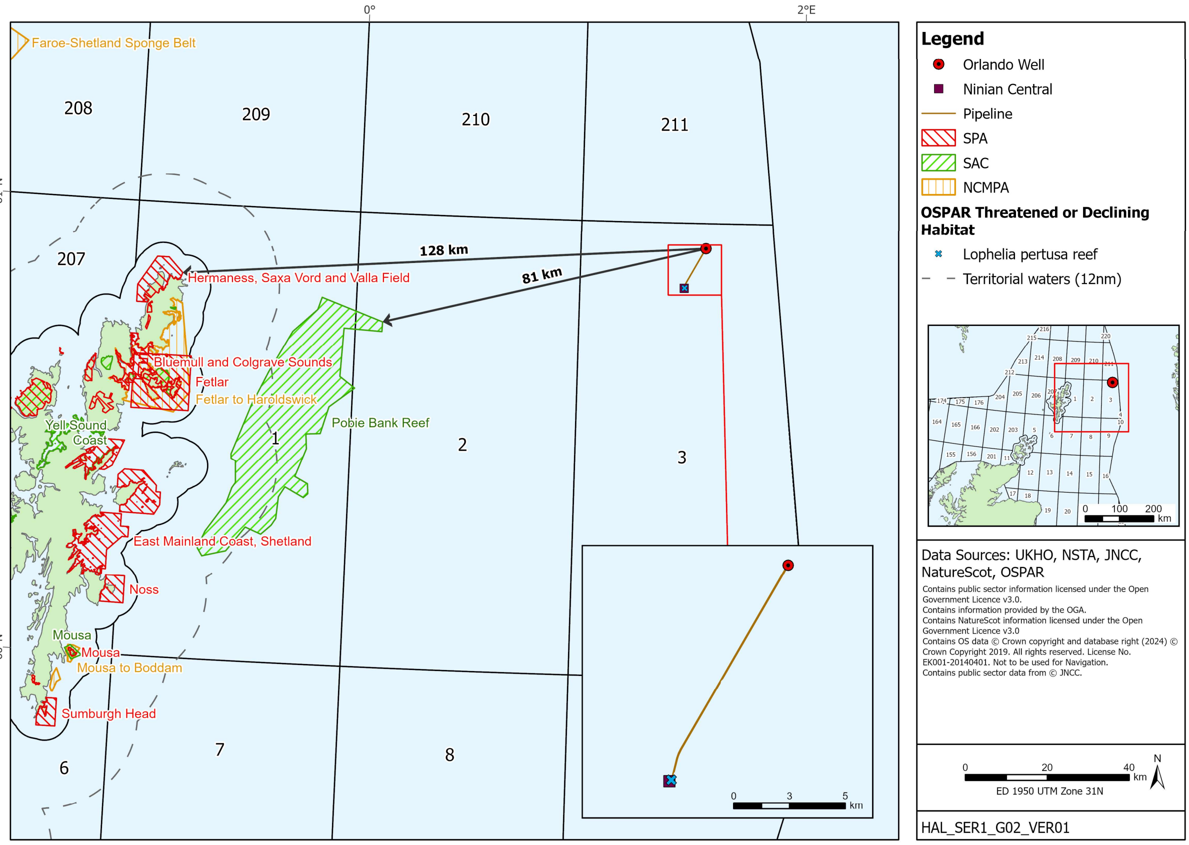
3.8 Conservation Sites, Habitats and Species

There are a number of designated coastal, inshore and marine conservation sites, the closest of these to the Orlando location is the Pobie Bank Reef Special Area of Conservation (SAC)[5], located *ca*. 81km to the west (Figure 3-19). This is an area of stony and bedrock reef, providing a habitat to an extensive community of encrusting and robust sponges and bryozoans.

All other designated sites, those present along the coast of Shetland and offshore sites, e.g. North-East Faroe-Shetland Channel Nature Conservation Marine Protected Area (NCMPA)[6], the Faroe-Shetland Sponge Belt NCMPA[7] and the Central Fladen NCMPA[8] are >100km distant.

[5] https://jncc.gov.uk/our-work/pobie-bank-reef-mpa/
[6] https://jncc.gov.uk/our-work/north-east-faroe-shetland-channel-mpa/
[7] https://jncc.gov.uk/our-work/faroe-shetland-sponge-belt-mpa/
[8] https://jncc.gov.uk/our-work/central-fladen-mpa/

Figure 3-19: Conservation sites in the region



Some Priority Marine Features (PMFs) were observed in survey data, including anglerfish and ling, however, these are widely distributed in the central and northern North Sea. Similarly, some broadscale habitats are likely to be present, such as offshore subtidal sands and gravels, which similarly have a wide distribution in the North Sea.

The presence of the OSPAR listed threatened and/or declining habitat 'Sea pens and burrowing megafauna communities' (also a PMF - Seapens and burrowing megafauna in circalittoral fine mud) was considered by the 2021 survey habitat assessment, due to observations of the sea pens *P. phosphorea* and *Virgularia* sp., along with faunal burrows, including the characteristic burrows of the Norway lobster (*Nephrops norvegicus*) during the previous 2011 Orlando survey. A detailed SACFOR assessment was not undertaken at that time, as the 2011 survey preceded the publication of the JNCC guidance (JNCC 2014). The 2021 photographic data were analysed using the SACFOR methodology, with *N. norvegicus* burrows recorded as being at least 'frequent' and other burrows as being at least 'occasional' along sections of all transects using the SACFOR scale (JNCC 2014). The presence of burrowing megafauna is the essential defining characteristic of the feature, whereas sea pens do not have to be present (JNCC 2014). Where burrows were recorded as 'frequent' or 'common' (from sections of between 8 – 146m in length from all of the video transects, with the exception of V03 and V07), the OSPAR designated 'Sea pen and burrowing megafauna communities' habitat is likely to be present.

The 2011 and 2021 surveys considered whether coarse sediment in the Orlando area constituted Annex I reef, however, consideration of the nature of the substrate suggested it lacked the elevation or extent necessary or was of low quality, and lacked the abundance and diversity of fauna to suggest it constituted stony reef.

The latest OSPAR Threatened and/or Declining Habitats dataset[9] indicated the presence of *Lophelia pertusa* reef associated with the NCP (Figure 3.19). *L. pertusa* has been positively identified on a number of platforms in the northern North Sea (Gass & Roberts 2006), including the Ninian Northern platform (CNRI 2017), 6km to the north west of NCP; *L pertusa* was not identified as present on the 2024 inspection survey video footage of the Orlando subsea infrastructure (noting that this did not include infrastructure within the NCP 500m zone). Similarly, a review of footage from a 2025 inspection survey of the Orlando subsea infrastructure within the NCP 500m zone did not identify the presence of *L. pertusa* reef.

3.9 Other Users of the Offshore Environment

Offshore Energy

The area is within a wider mature oil and gas province, with considerable infrastructure in adjacent Blocks and the wider area. Figure 3-20 indicates that much of the oil and gas infrastructure is in the process of being decommissioned.

There is no renewable energy associated infrastructure within the Orlando area, the closest lease area being >200km to the west.

From the Innovation and Targeted Oil and Gas (INTOG) leasing round, thirteen projects (out of 19) have been offered initial agreements (exclusivity agreements), which would now enable them to proceed towards gaining consent for offshore wind development work; the closest of these to the Orlando location is 323km away.

Commercial Fisheries

ICES rectangles are used for fisheries data recording and management, and Orlando lies within ICES rectangle 50F1. Table 3.9 lists the weight and first sale value of fish and shellfish landings by UK and foreign vessels into UK ports and UK vessels into foreign ports from this rectangle over the period 2022-2024. Demersal species was the highest total weight and value of landings from the Orlando area, in 2022, followed by pelagic and shellfish species (Figure 3-21 and Figure 3-22). However, pelagic catches have varied significantly between the years, with the sector representing the highest total weight and value of landings in both 2023 and 2024. The UK sea fisheries statistics report (MMO 2024) noted that pelagic landings in 2023 had increased for the Scottish fleet due to an increase in quota for key pelagic species including mackerel and blue whiting.

[9] https://emodnet.ec.europa.eu/en/ospar-threatened-andor-declining-habitats-spatial-dataset

Figure 3-20: Offshore energy infrastructure in the area

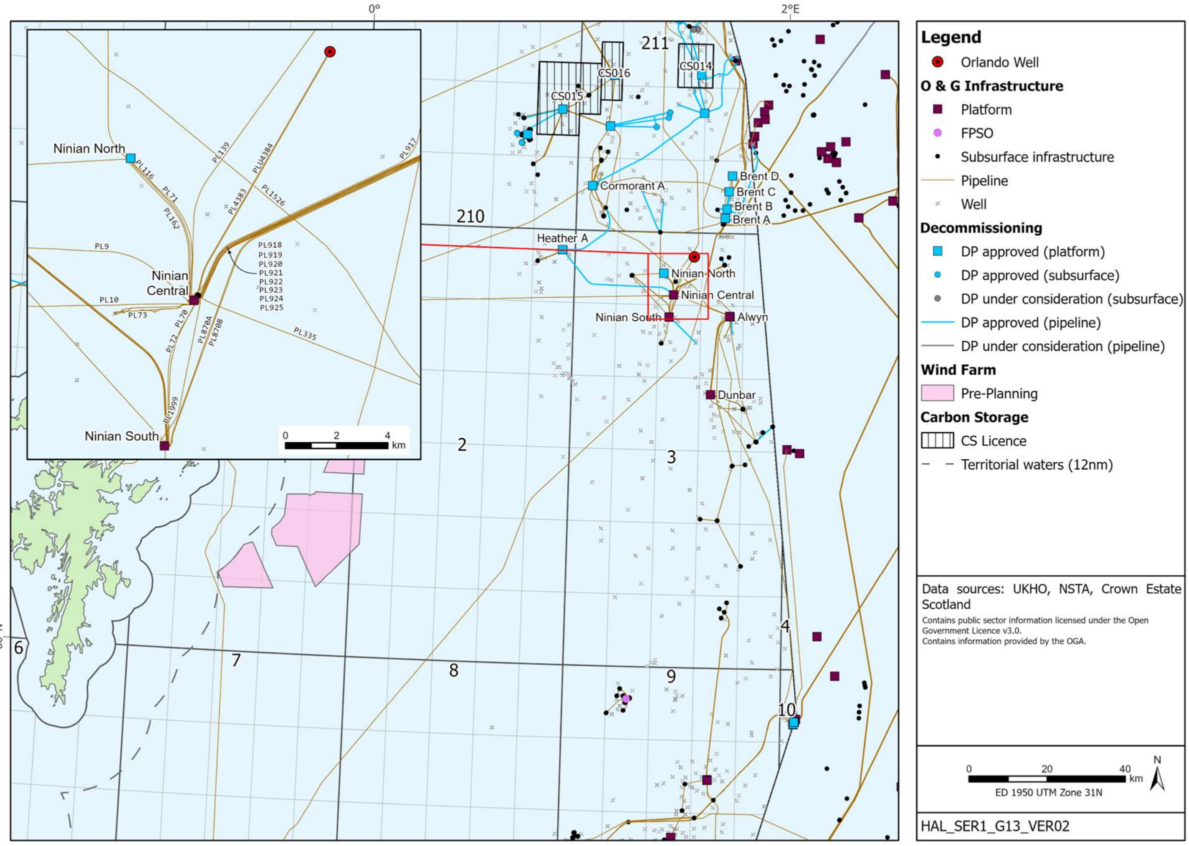


Table 3.9: Weight and value of landings from ICES rectangle 50F1, 2022-2024

Species group	2022		2023		2024	
	Live weight (tonnes)	Value (£)	Live weight (tonnes)	Value (£)	Live weight (tonnes)	Value (£)
Demersal	1,489	2,686,209	2,073	3,664,653	2,114	3,951,602
Pelagic	198	98,906	4,415	4,761,116	21,707	28,813,488
Shellfish	3	9,077	10	44,590	4	16,992
TOTAL (50F1)	1,690	2,794,193	6,499	8,470,359	23,825	32,782,082
UK TOTAL	484,585	687,722,582	548,657	802,120,945	594,481	882,253,660
% of UK TOTAL	**0.3**	**0.4**	**1**	**1**	**4**	**3.7**

Note: Marine Scotland data includes landings by UK vessels into UK and abroad and landings into UK by foreign vessels. Therefore, UK total covers the same metrics. Figures rounded to nearest tonne/£.
Source: Marine Directorate Data

Figure 3-21: Fish landings by weight from the Orlando area

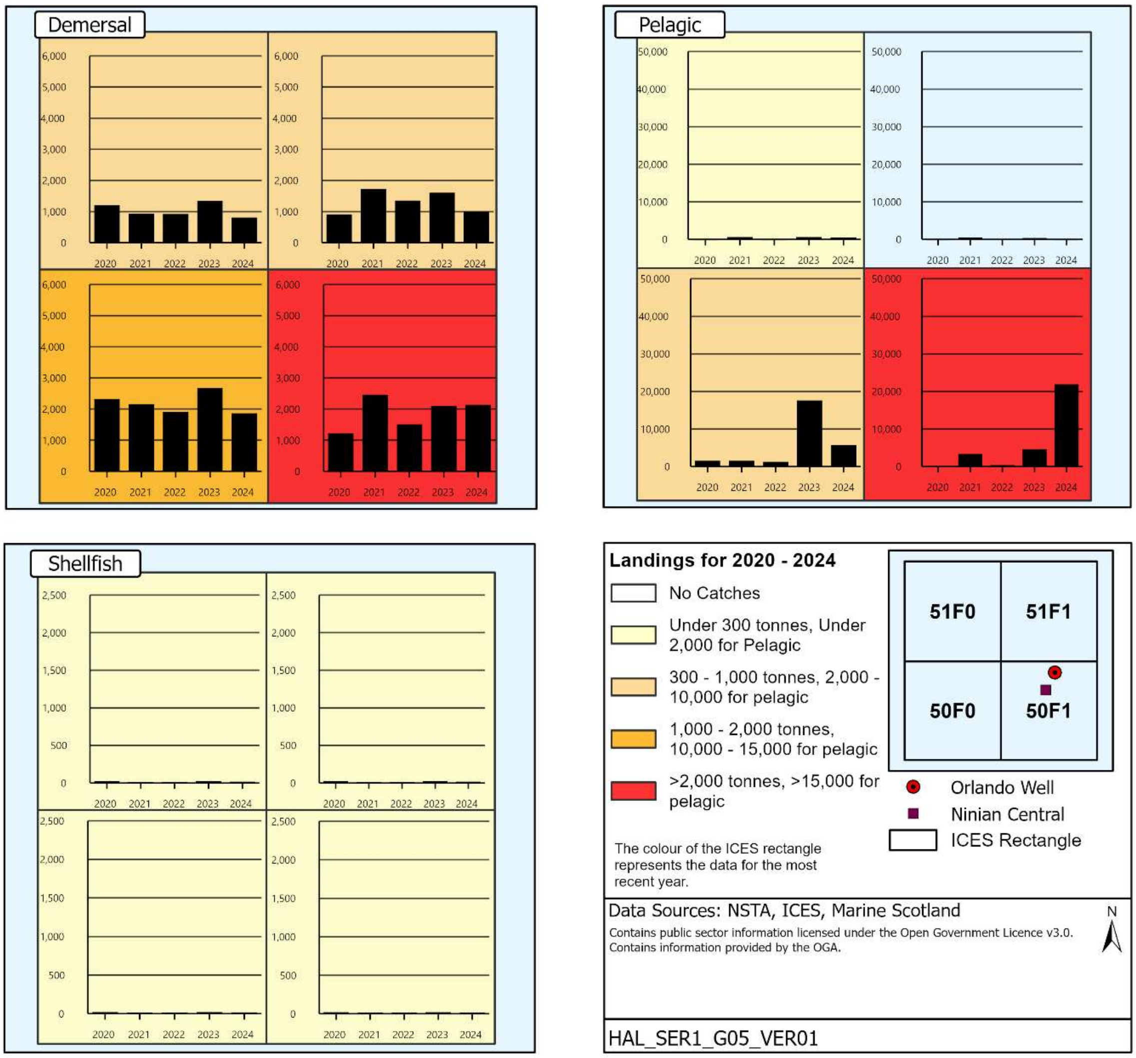


Figure 3-22: Fish landings by value from the Orlando area

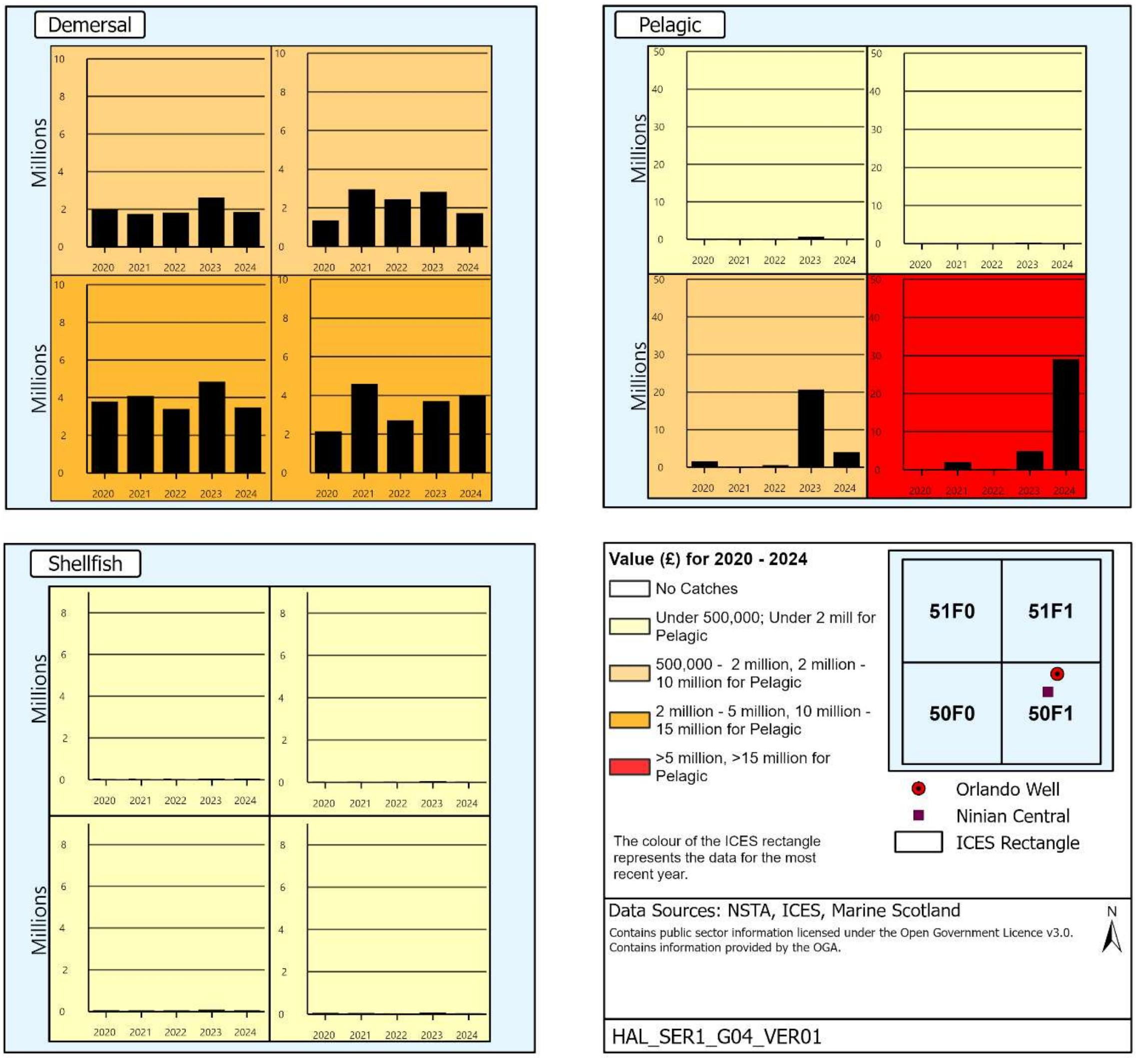


Figure 3-23 and Figure 3-24 provide context for the weight and value of landings from 50F1 in 2024 with respect to the wider northern North Sea area, with areas to the south and west supporting greater landings.

Figure 3-23: Fish landings by weight from the northern North Sea

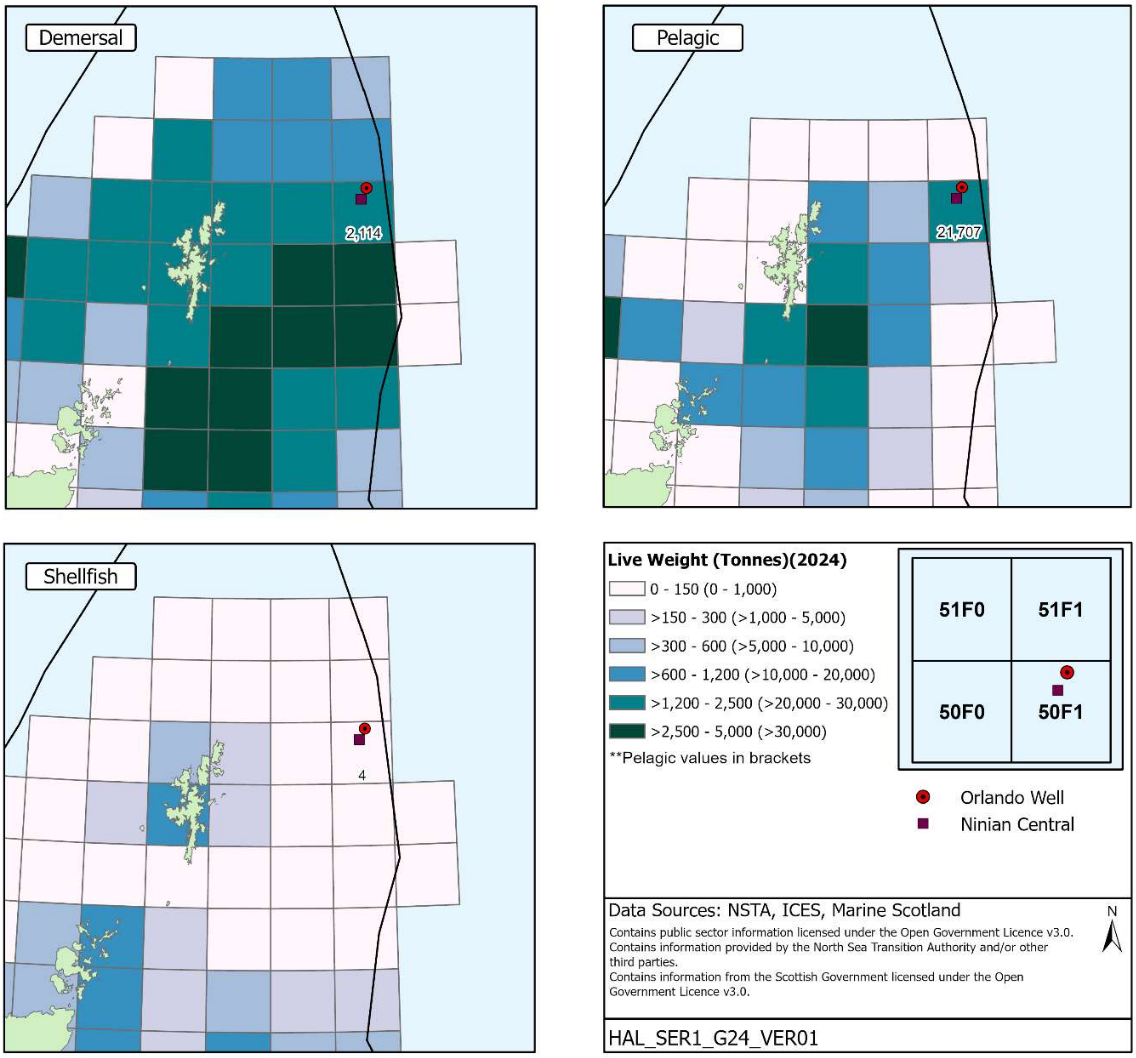
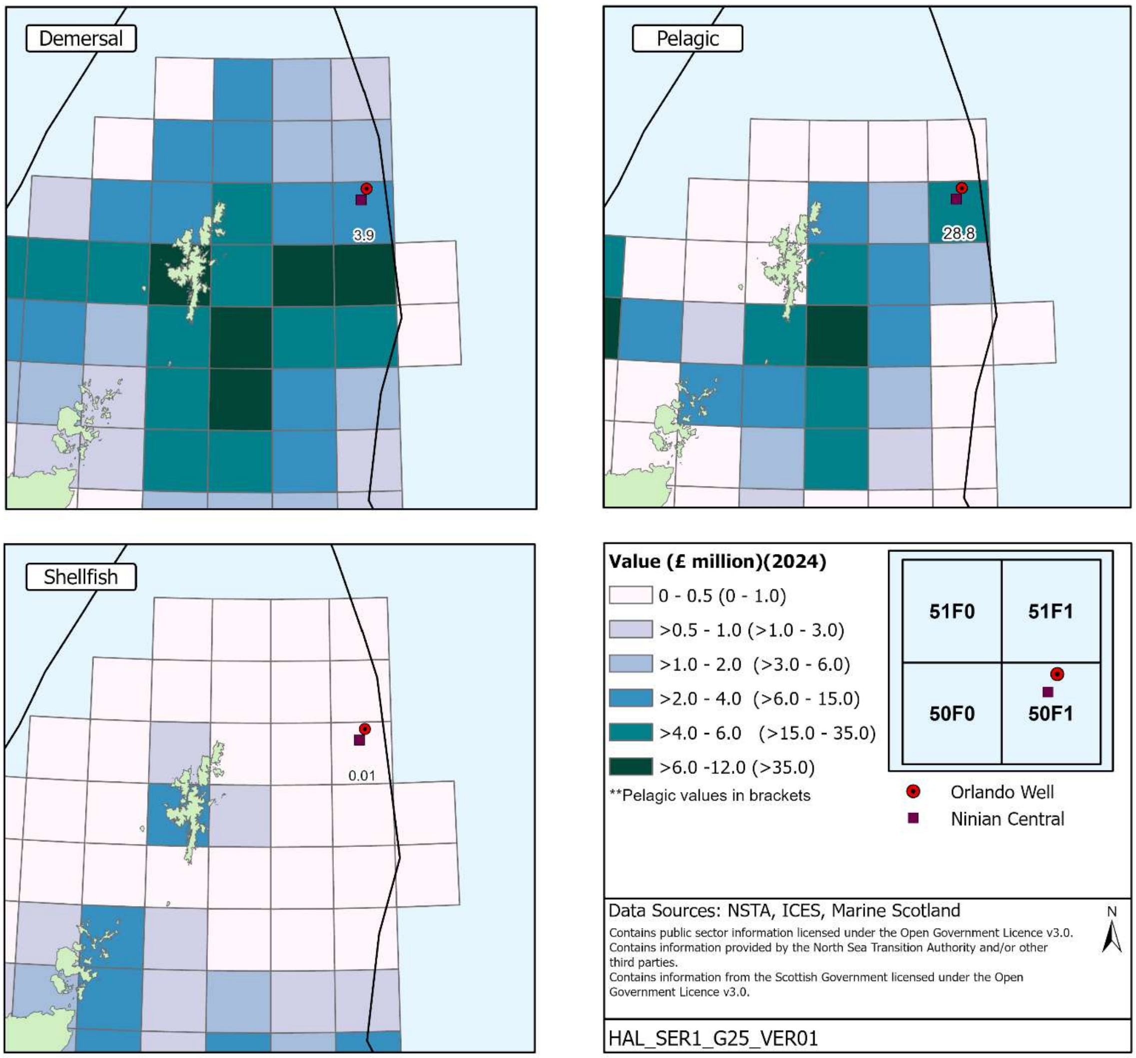


Figure 3-24: Fish landings by value from the northern North Sea



The main fishing effort is from mobile gears, particularly otter bottom trawl. Species dominating the demersal catches include whiting, hake, saithe and cod, while herring and mackerel, dominate pelagic catches and *Nephrops* represents the largest landing of shellfish.

Logbooks submitted by fishermen allow an examination of the gears operated and seasonal patterns in fishing effort (Table 3.10). There is relatively limited fishing activity in 50F1, with less than 400 days a year recorded in 50F1 for two of the last three years. Highest activity typically in late spring and through summer.

Table 3.10: Number of days fished per month (all gears, UK >10m vessels) in ICES rectangle 50F1, 2022-2024

Year	J	F	M	A	M	J	J	A	S	O	N	D	Total	UK total	% of UK total
ICES rectangle 50F1															
2022	28	16	44	28	42	14	24	16	10	10	24	18	**273**	**95,516**	**0.2**
2023	13	17	25	20	53	37	37	39	28	58	18	20	**366**	**96,131**	**0.3**
2024	15	31	20	55	74	13	53	47	51	43	32	14	**448**	**92,322**	**0.5**

Note: Monthly fishing effort by UK vessels >10m; 'days fished' includes time travelling within rectangles; D = disclosive data, green = 0-15 days fished, yellow = 16-30, orange = 31-45, red = 46>.
Source: Marine Directorate Data

The Fisheries Sensitivity Mapping and Displacement Modelling (FiSMaDiM) project (Muench *et al.* 2024), funded by The Crown Estate's Offshore Wind Evidence + Change (OWEC) programme has developed fisheries sensitivity maps. Based on Vessel Monitoring Systems (VMS) data augmented with data from Automated Identification Systems (AIS), these capture fishing effort for UK and non-UK vessels operating in the UK EEZ for the years 2012-2021 and the potential for impacts on the fisheries from offshore wind farms (based on the economic importance of wind farm areas for the fishing industry).

Figure 3-25 indicates that demersal trawling in the Orlando area is of relatively low to moderate sensitivity to displacement. Figure 3-26 shows fishing route density information based on AIS data which indicates a localised area of moderate to high density to the south west of the Orlando well which may accord with an area fished by Scottish vessels identified by SFF during scoping.

Figure 3-25: Mean fisheries sensitivity in the Orlando area, demersal trawl (2012-2021)

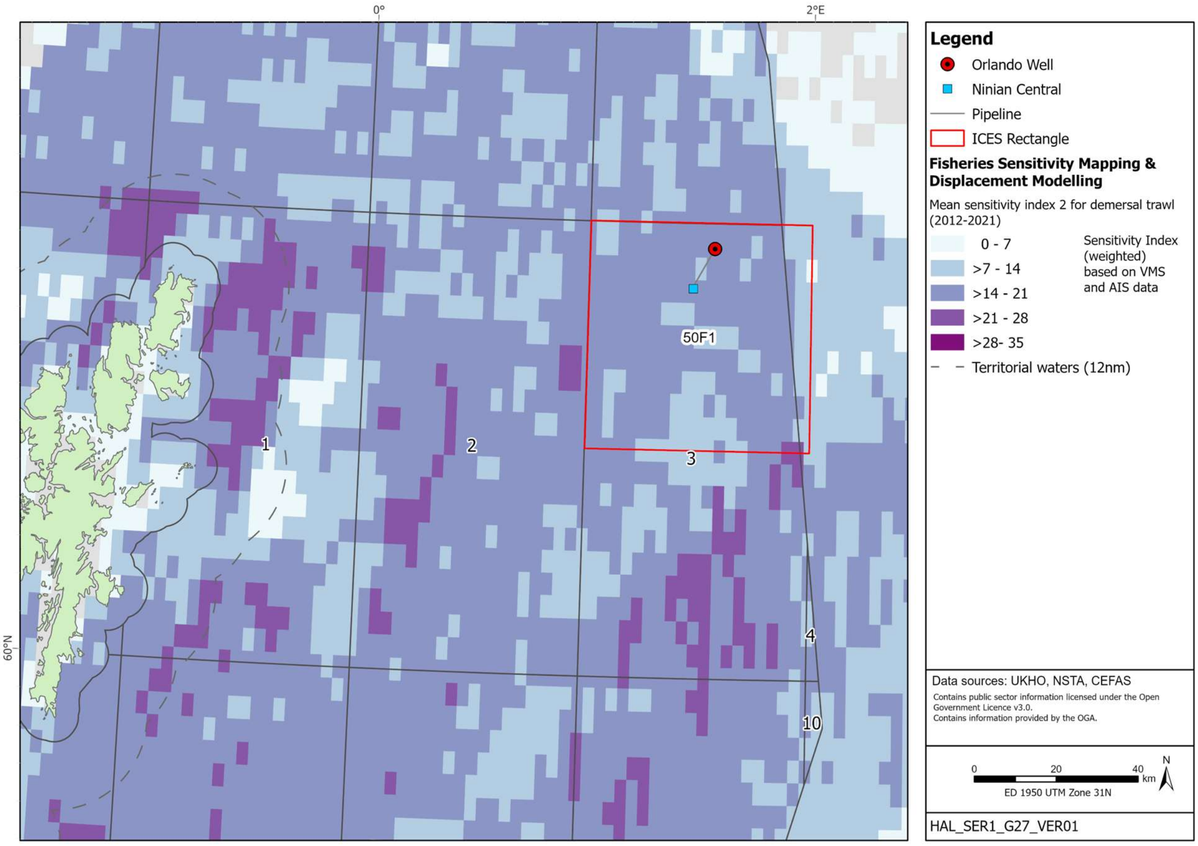
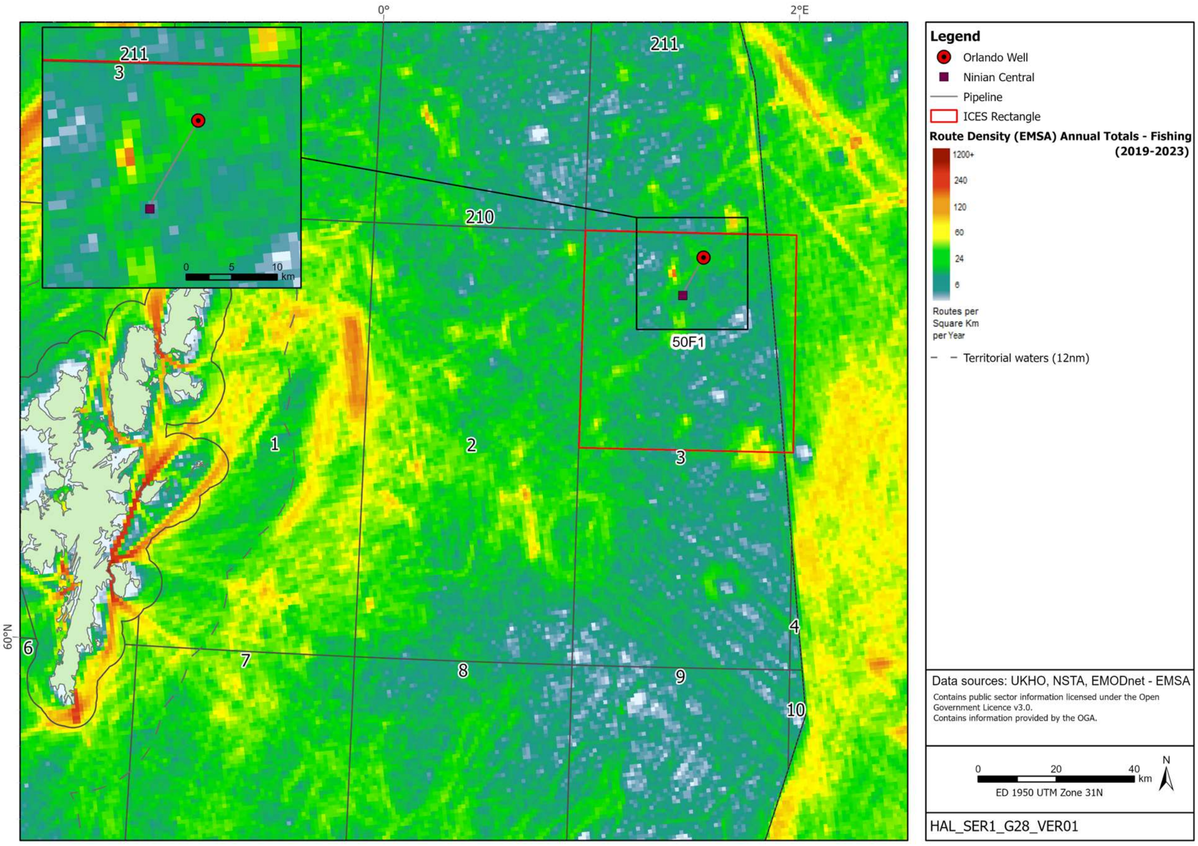


Figure 3-26: Fishing route density annual totals in the Orlando area (2019-2023)



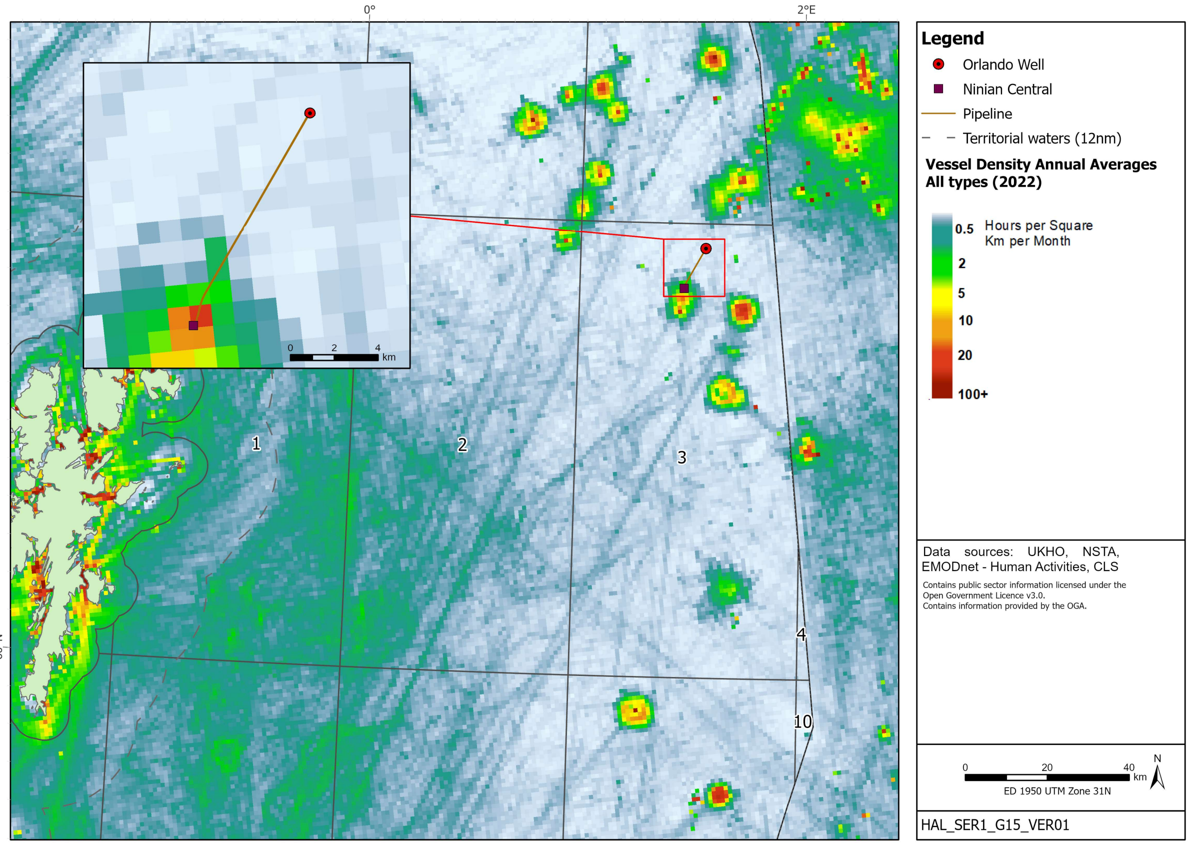
Other Users

The shipping density information provided as part of the 29th Licensing Round, indicates Block 3/03 is categorised as having a moderate shipping density, most likely from traffic associated with servicing oil and gas installations. Vessel density over the Orlando area is focussed on the NCP (Figure 3-27).

There are no dredging areas, or marine disposal sites in the vicinity and no telecommunication cables cross the Orlando area the closest cable is in the Norwegian sector (Martin Linge power cable) at 55km from Orlando and 49km from NCP.

There are no designated protected wrecks in the area, with the closest wrecks being *ca*. 9km from Orlando (Blagdon, possibly) and an unknown wreck *ca*. 5km from the NCP.

Figure 3-27: Vessel density annual averages (2022) in the Orlando area



4.0 Environmental Impact Scoping

4.1 Introduction

Activities associated with the decommissioning of Orlando have the potential to affect the environment in a number of ways, including physical and other disturbance, emissions and other discharges, waste generation and accidental events. This section describes the process used to identify and screen the relative significance of the potential environmental issues associated with the proposed decommissioning activities.

4.2 Issue Identification and Screening of Potential Effect

Serica held an Environmental Impact Identification (ENVID) workshop to identify activity/environment interactions, and raise awareness within the decommissioning team of the baseline environment and potential sources of environmental effects from decommissioning activities. At the workshop, the decommissioning activities were systematically considered for their potential interactions with the environment and in the context of legislative and policy requirements. These were identified using a range of data sources including:

- Regional and site specific environmental data, including from previous surveys of the Orlando area, and engineering documents
- Typical semi-submersible drilling rig specifications (for well plug and abandonment)
- Typical vessel specifications (e.g. for subsea infrastructure decommissioning and support)
- Experience of analogous projects in the North Sea and elsewhere, including in areas of conservation importance
- Reviews and assessments of the environmental effects of offshore oil and gas operations
- Peer reviewed scientific papers on the effects of specific interactions and habitat processes
- Other publicly available "grey" literature
- Offshore Energy Strategic Environmental Assessment Environmental Reports and underpinning studies (e.g. BEIS 2022)
- Conservation site designations, potential designations and related supporting site information
- Applicable legislation, guidance and policies
- Consultee and stakeholder engagement and feedback (see Section 1.6)

Following the ENVID, and based on the current level of activity definition and stakeholder feedback, the environmental assessment took both qualitative and quantitative approaches to the identification of the likely magnitude of effects, as appropriate. Defined severity criteria were used to assist in describing the magnitude of environmental effect from the decommissioning activities. These also allowed for the consideration of the likelihood, scale and frequency of potential effects (see Table 4.1) and the results are shown in Table 4.2.

Table 4.1: Criteria for the identification of potential environmental effects from Orlando decommissioning

Effect	Consequences
None Foreseen	No detectable effects
Positive	Activity may contribute to recovery of habitats Positive benefits to local, regional or national economy
Negligible	Change is within scope of existing variability but potentially detectable.
Moderate	Change in ecosystem leading to short term damage with likelihood for recovery within 2 years to an offshore area less than 100 hectares or less than 2 hectares of a benthic fish spawning ground Possible but unlikely effect on human health Possible transboundary effects Possible contribution to cumulative effects Issue of limited public concern May cause nuisance Possible short term minor loss to private users or public finance
Major	Change in ecosystem leading to medium term (2+ year) damage with recovery likely within 2 - 10 years to an offshore area 100 hectares or more or 2 hectares of a benthic fish spawning ground or coastal habitat, or to internationally or nationally protected populations, habitats or sites Transboundary effects expected Moderate contribution to cumulative effects Issue of public concern Possible effect on human health Possible medium term loss to private users or public finance
Severe	Change in ecosystem leading to long term (10+ year) damage with poor potential for recovery to an offshore area 100 hectares or more or 2 hectares of a benthic fish spawning ground or coastal habitat, or to internationally or nationally protected populations, habitats or sites Major transboundary effects expected Major contribution to cumulative effects Issue of acute public concern Likely effect on human health Long term, substantial loss to private users or public finance

Frequency with which Activity or Event Might Occur	Likelihood
Unlikely to occur	**Unlikely**
Once during decommissioning activity	**Low**
Once a year	**Medium**
Once a month or regular short term events	**High**
Continuous or regular planned activity	**Very High**

	Likelihood				
Consequences	Very High	High	Medium	Low	Unlikely
Severe					
Major					
Moderate					
Negligible					
Positive					
None foreseen					

- Issues requiring detailed consideration in the EA
- Positive or minor or negligible issues
- No effects expected

Notes:
1. The criteria to the left include consideration of issues of known public concern
2. In addition to screening on the basis of these criteria, issues/interactions raised during stakeholder consultation will be treated as requiring detailed consideration. These issues/interactions will be indicated in Table 4.2 by C (raised in stakeholder consultation).

Table 4.2: Screening matrix

Potential for significant
Minor issue

Activity/Source of Potential Impact	Summary Consideration														
	Land, soil, water, air, climate			Biological, with particular attention to species and habitats protected under Directive 92/43/EEC and Directive 2009/147/EC						Material assets, other users, onshore				Population and human health	Transboundary issues
	Climate/air quality	Water Quality	Seabed and sediments	Benthic Fauna	Plankton	Fish and Shellfish	Marine Mammals	Birds	Species / habitats of conservation interest[4]	Fisheries	Shipping	Other users	Landfill/onshore resources		
Vessels (applicable to rig, subsea scope and post-decommissioning monitoring)															
Power generation (rig and all vessels)	Potential for significant														Minor issue
Rig tow in/out	Minor issue											Minor issue			
Rig positioning and anchoring			Potential for significant	Potential for significant					Potential for significant						
Physical presence of rig/vessels										Minor issue	Minor issue	Minor issue			
Machinery space, deck, sewage & other discharges		Minor issue													
Underwater noise						Minor issue	Minor issue	Minor issue							
Airborne noise								Minor issue							
Surface lighting								Minor issue							
Well plug and abandonment															
Discharge of well P&A chemicals		Minor issue	Minor issue	Minor issue	Minor issue										
Fugitive emissions from fuel and chemical storage	Minor issue														
Other solid and liquid wastes to shore													Minor issue	Minor issue	

Key
Potential for significant
Minor issue

Activity/Source of Potential Impact	Summary Consideration														
	Land, soil, water, air, climate			Biological, with particular attention to species and habitats protected under Directive 92/43/EEC and Directive 2009/147/EC						Material assets, other users, onshore				Population and human health	Transboundary issues
	Climate/air quality	Water Quality	Seabed and sediments	Benthic Fauna	Plankton	Fish and Shellfish	Marine Mammals	Birds	Species / habitats of conservation interest[4]	Fisheries	Shipping	Other users	Landfill/onshore resources		
Subsea activities															
Disconnection and lowering/burial of pipeline/umbilical ends			Significant	Significant	Minor	Minor			Significant	Significant	Minor				
Remediation of cut ends			Significant	Significant	Minor	Minor			Significant	Significant	Minor				
Removal of seabed infrastructure (e.g. xmas tree, spools, SSIV, riser bases)			Significant	Significant	Minor	Minor			Significant	Significant	Minor				
Removal of exposed protective material			Significant	Significant	Minor	Minor			Significant						
Pipeline flushing and cleaning		Minor			Minor	Minor									
Chemical/residual hydrocarbon discharge		Minor			Minor	Minor									
Presence and degradation of material left *in situ*			Minor	Minor	Minor	Minor			Minor	Minor	Minor	Minor			
Onshore[2]															
Offloading decommissioned material (e.g. seabed infrastructure)													Minor	Minor	
Emissions from material recycle/replacement	Minor													Minor	
Onshore waste treatment and disposal	Minor												Minor	Minor	
Road transport of materials/waste	Minor													Minor	

Potential for significant
Minor issue

Activity/Source of Potential Impact	Summary Consideration														
	Land, soil, water, air, climate			Biological, with particular attention to species and habitats protected under Directive 92/43/EEC and Directive 2009/147/EC						Material assets, other users, onshore					
	Climate/air quality	Water Quality	Seabed and sediments	Benthic Fauna	Plankton	Fish and Shellfish	Marine Mammals	Birds	Species / habitats of conservation interest[4]	Fisheries	Shipping	Other users	Landfill/onshore resources	Population and human health	Transboundary issues
Treatment of NORM/LSA scale[3]															
Removal of marine growth (onshore)															
Use of non-UK based receiving yard															
Accidental events[2]															
Vessel collision															
Accidental spill from rig/vessel (diesel)															
Chemical spill (well P&A)															
Dropped objects															

Notes: [1]includes offshore renewables, oil and gas, military activities, subsea cables, recreational yachting etc. [2]Current guidance (BEIS 2018) states there is no requirement to assess impacts associated with wastes taken and processed onshore (as this is associated with onshore and not marine) or accidental impacts; emissions associated with material recycle/replacement has been included as this is a requirement. Onshore and accidental are included here for context but not included for further assessment (Section 5). The quantity of material being returned to shore will be small (i.e. well material and subsea infrastructure) and the recycling aspirations for this material, and estimated quantity of material being disposed of, are as described in the DPs. Serica will compile a full waste inventory of all materials returned to shore and ensure appropriate waste segregation and treatment is undertaken. Assessment of accidental events, along with a major environmental incident assessment, in line with regulatory requirements applicable at the time, will be included in the term permits (i.e. MATs and SATs) applied for the well and subsea decommissioning activities. [3]NORM/LSA scale not expected as no history of this from the fields. This has been included here as contingency. [4]Species/habitats of conservation interest have been included here as the Orlando infrastructure is over 80km from a designated conservation site.

5.0 Consideration of Environmental Effects

5.1 Effects considered minor

A number of potential sources of effect from Table 4.2 above have been considered minor and these have not been assessed further. A consideration of these, supporting the conclusion to screen these out from further assessment, is shown in Table 5.1 below.

Table 5.1: Environmental effects considered minor

Potential source of effect	Summary consideration
Vessels (applicable to rig, subsea scope and post-decommissioning monitoring)	
Drilling rig tow in/out	Drill rig movements will create temporary, short term and small scale increment to physical presence whilst transiting the North Sea. Notification to mariners, operations are within an area of existing oil and gas associated shipping movements, small increment to existing traffic. Significant effects not likely.
Physical presence	Rig and vessel physical presence during well P&A and subsea scope will create temporary and short term increment to other vessels in the area. Rig location will be within existing 500m safety zone, however, anchors will likely reach outside of this. Operations are within an area of existing oil and gas associated shipping movements and decommissioning will represent a small increment to existing traffic. A consent to locate application will be submitted, and all appropriate notifications to mariners will be made (this will include the locations of anchors/section of mooring lines outside of the 500m safety zone). Significant effects not likely.
Machinery space, deck, sewage and other discharges	Discharges will contribute to local water quality changes and associated interactions with water column biota. However, discharges will be small. In view of location, current/wave action and dilution of discharges, significant effects are not likely.
Underwater noise	The primary contributor to underwater noise from the activities will be rig and vessel activity. The primary receptor of noise impacts are marine mammals. It is noted that the Orlando area does not overlap and is not close to any designated or proposed marine protected areas for marine mammals, and is not an area identified as of particular importance to marine mammals. The density of grey and harbour seals in the area is expected to be very low. The increased vessel activity associated with decommissioning will add to the overall ambient noise in the wider Orlando area; however, noise characteristics are such that injury will not occur to marine mammals, fish or birds. The noise sources will be temporary and minimised by a phased approach to decommissioning such that vessel time in the field is minimised. Sound from vessels may result in some temporary influence on the behaviour of individual marine mammals within the vicinity of the operations, however, such effects will be short-term, localised, and in the context of existing levels of shipping activity in the region. Consequently, significant negative effects at the population level are not anticipated.
Airborne noise	Small increment to current levels, local, and short term. Significant effects are not likely.
Surface lighting	Incremental surface lighting from rig and associated vessels will be temporary and of short duration, and will not significantly add to existing lighting levels in the area. Significant effects are not likely.
Well plug and abandonment	
Well P&A chemical discharges	Small quantity and variety of chemicals to be used and discharged, predominately cement, the majority of which will remain downhole. Chemicals selected for best environmental performance where technically feasible to do so. A risk assessment will be carried out and the use and discharge of chemicals approved prior to use offshore. Discharges will contribute to local water quality changes and associated

Potential source of effect	Summary consideration
	interactions with water column and benthic biota. Impacts will be short term and localised. Significant effects not likely.
Fugitive emissions from fuel and chemical storage	Emissions include those from cement tanks, diesel storage and cooling/refrigeration systems and have the potential to make minor contribution to air quality effects. Such emissions are minor in the context of those from combustion of fuel for power generation and in view of the location and prevailing meteorological conditions, these emissions are not considered to be a significant source of air pollutants. Significant effects not likely.
Other solid and liquid wastes to shore	Materials returned to shore contribute to well-regulated onshore activities such as materials processing and landfill. Significant effects are not likely.
Subsea activities	
Pipeline flushing and cleaning - chemical/ residual hydrocarbon discharges	The pipeline and associated infrastructure (spools, dynamic riser and SSIV) will be cleaned and flushed with fluids either going down the well (preferred option) or back to the NCP prior to decommissioning. **Residual hydrocarbons and wax** Flushing downhole will result in the majority of the hydrocarbons being displaced down the well and not being discharged to the marine environment. However, as there are no testing facilities on the well, to ascertain the remaining residual hydrocarbon at completion of the three line flushes, an estimate of the oil in the water has been made. All surface laid infrastructure (hereafter referred to as associated infrastructure, e.g. spools, SSIV and riser) are to be recovered, with the Orlando production pipeline to be decommissioned *in situ* (option identified by Orlando CA). At disconnect, the pipeline ends will be left open to sea and this will initially result in a small discharge from these; due to hydrostatic pressures, the majority of the contents will remain in the pipeline/pipework and discharge, over time, as these degrade. This degradation (see below), will eventually result in a discharge of the full pipeline contents. After disconnect, the SSIV and risers will be recovered to shore, however the schedule for this (and the time between disconnect and final recovery) is still to be determined, as such a worst-case assumption of the discharge of all residual liquid hydrocarbon volumes present in all associated infrastructure/pipework has been risk assessed. The total volume is 281m^3, and the estimated quantities of oil, based on 200mg/l, 150mg/l and 100mg/l that this discharge would represent are: • Total volume = 281m^3, based on a OIW content of 200mg/l, this equates to an oil discharge of 0.06 tonnes (rounded) (56kg) • Total volume = 281m^3, based on a OIW content of 150mg/l, this equates to an oil discharge of 0.04 tonnes (rounded) (42kg) • Total volume = 281m^3, based on a OIW content of 100mg/l, this equates to an oil discharge of 0.03 tonnes (rounded) (28kg) The actual OIW content is expected to be lower due to the lines having been flushed multiple times (base case 3 x line flushes). However, assuming a maximum OIW concentration of 200mg/l is present, is a worst case. All practicable steps will have been taken to clean the Orlando production pipeline as far as possible and discharges during disconnection cannot be avoided. However, by pre-cleaning the lines, the discharges of reservoir hydrocarbons have been minimised.

Potential source of effect	Summary consideration
	There is no testing facilities available with the downhole flush, to ascertain the OIW contents, therefore, at a worst case of 200mg/l, and assuming the full discharge of the pipeline (and associated pipework) volumes, this equates to a discharge of oil (0.06 tonnes (rounded), 56kg), which will occur over a long period of time. A wax study undertaken by Serica estimated that, based on historical production, the wax appearance temperature (WAT) and wax dissolution temperature (WDT), and that wax inhibitor has been used throughout the operational life of the field, to, if not prevent, certainly reduce, the build up of wax, the Orlando pipeline is expected to have a small (approximately 1mm thick) layer of wax deposited, equating to 0.8m³ wax volume, across all the Orlando infrastructure, which is 0.3% of the pipeline volume. From present until decommissioning production flowrates and temperatures are expected to decline, based on the continuous production scenario. With the declining temperatures further wax deposition would be expected within the flowline, however, modelling estimated the maximum would equate to approximately 2.5m³ (wax deposits) in the 11km flowline (0.9% of the total pipeline volume), with a total deposit mass of approximately 1,400kg. Modelling estimates the uninsulated SSIV and riser section to show thicker layers of wax, estimated up to 20mm. Following cleaning and flushing, it is fully expected that the wax remaining within the SSIV and riser will remain within these structures (adhering to the infrastructure) as the temperatures would not reach, or rise above, the WDT. As the SSIV structure and riser are to be removed during decommissioning, wax residue in these is not expected to enter the marine environment. Similarly, the temperature of the pipeline once disconnected and decommissioned, will be such that any wax deposition present will remain as a solid and adhered to the internal side of the pipeline and not expected to enter the marine environment. As the density of wax is less than seawater, if deposited wax were to enter the marine environment, it is unlikely to deposit onto the seabed (no impact on seabed sediments, benthos or demersal spawning species), but instead rise through the water column to the sea surface. Paraffin waxes are considered to be chemically and biologically inert, thus having a perceived low ecotoxicity (Gomes *et al.* 2020). However, the release of some paraffin constituents, such as n-hexane, which may then be absorbed by organisms may have biological effects (as reviewed by Gomes *et al*. 2020). The acute and chronic effects of different densities (5, 20, and 80 mg.l) and sizes of paraffin particles (from 100 to 1200 µm) on the epibenthic polychaete *Hediste diversicolor* and mussels (*Mytilus* sp.) were recently assessed (Gomes *et al.* 2020, Nunes *et al*. 2020). Overall, the toxic effects of paraffin particles were measurable but not life-threatening, and were dependent on particle size. Taking into account the particle densities used (worst-case scenario) and the level of the biological effects measured, it was concluded unlikely that these materials had the potential to exert concerning toxic effects in marine organisms. Therefore, as the pipeline degrades, the duration of displacement (tens, hundreds of years), small quantity of wax present and its relatively low toxicity are such that any environmental impact is considered negligible. **Hydraulic fluid** Contents of the umbilical includes operational chemicals and hydraulic fluid; the base case for these will be that chemical cores will be flushed through into the pipeline via the tree and dropdown spool, with hydraulic fluid discharged to sea when cores are cut. The hydraulic cores are not being flushed as, in order to facilitate pipeline flushing, well control is required, i.e. subsea control system valve functioning (via hydraulics) is required for the tree and SSIV. Additionally, it is not practicable to displace the

Potential source of effect	Summary consideration
	hydraulic fluid into the pipeline for flushing since the hydraulic system is a closed system (separate to the pipeline) and diver intervention would be required to manually override valves and displace hydraulic core volumes into the pipeline. Taking into account the cores within the dynamic and static umbilicals, plus the connecting hoses, the total volume of the hydraulic lines is 6.823m^3, and total weight of Oceanic HW443 R is estimated as 7300.9kg; note, Oceanic HW443 R is neat within the cores, with no other chemical/carrier fluid present. Two assessments have been undertaken, one where each individual hydraulic line has been risk assessed and the second assessment assessed the full volume and full discharge quantity. As this discharge would occur subsea, an Osborne Adams (T1/T2) assessment has been carried out; where, if T1 (time taken to discharge sufficient chemical to exceed PEC/PNEC = 1 in the 500 m column water) is > than T2 (time taken to completely refresh that column of water) then this indicates no significant effect, with the converse of this (T2>T1) indicating a significant effect. From the chemical risk assessment, all individual lines resulted in T1>T2, indicating no significant effect from this discharge. While the combined discharge of the total volume and weight of Oceanic HW443 R, if this discharge occurred over 1 hour duration, did result in a significant effect, if the duration of discharge was just longer than an hour (1 hr versus 1.04 hrs) this resulted in no significant effect. Discharge occurring over 1 hour was used a worst case, however, in all likelihood, a full discharge of the line would be expected to take longer than this, based on hydrostatic pressures, insomuch that while an initial discharge would occur, the remaining contents would remain within the lines and only discharge over time, as the lines degraded. Oceanic HW443 R does have a substitution warning (for the dye component), however, the discharge to sea of the chemical within the Orlando lines will be a known, finite discharge; once the contents of the lines have been discharged, there will be no further discharge of the chemical. In addition, the risk assessment has indicated there would not be a significant effect on the marine environment from this discharge.
Presence and degradation of material left *in situ*	The production pipeline is buried for its entire length, either under backfilled seabed sediment or rock cover to a minimum depth of 0.6m, and degradation will occur over a long period of time. Generally, carbon steel pipelines degrade at very low rates once cathodic protection has expired, at between 0.05-0.1mm/year when exposed directly to seawater or 0.01-0.02mm/year when buried (OGUK 2013), such that corrosion and collapse of the Orlando pipeline would likely take centuries. As the pipeline degrades, material covering the line will sink into the spaces created; the line outside diameter is only 12" and the resulting profile after degradation will not be too dissimilar to the existing profile, or natural seabed topography, and degradation of the sections under rock may not result in any change to seabed topography. Fishing effort in the area is low to moderate, both from UK and non-UK vessels, these vessels currently fish throughout the area over the pipeline and umbilical routes, with the exception of the 500m safety zones around the well location and within the NCP 500m safety zone. Whilst seabed disturbance associated with fishing activity was evident from the 2024 inspection video data, along and across the pipeline/umbilical routes, there have been no fishing related incidents associated with the Orlando pipeline system over the duration of field life (*ca*. 7 years). With an absence of free-spanning or pipeline exposure occurring through the life of the field, the only potential snagging hazard will be the pipeline and umbilical cut ends. However, these will be suitably remediated using rock to be overtrawlable and therefore will not represent a snagging hazard. Significant effects are not likely.

5.2 Potential effects to be considered further

A small number of environmental interactions were identified with the potential to result in significant effects. The major sources of potentially significant effect have been grouped against those activities identified as likely to, directly or indirectly, affect one or more relevant environmental factors (and interactions between these). These have been listed below (Table 5.2) and are described and assessed in detail in Section 6.

Table 5.2: Environmental effects considered further (Section 6)

Issue	Potential Source of Effect (activity area)	Section
Seabed disturbance	• Disturbance of seabed from rig mooring system, (well P&A, semi-submersible anchors) • Removal of subsea infrastructure and removal of protective material (subsea activities) • Trenching/backfilling or rock cover of cut ends (subsea activities)	6.1
Atmospheric emissions	• Rig power generation and vessel operation (well P&A, subsea activities)	6.2
Transboundary issues	• Hydrocarbon, diesel and other (e.g. chemical) spills (well P&A)	6.3
Cumulative effects	• Possibility of interactions with other developments in the North Sea or proposed activities/developments in the wider area (including other decommissioning activities)	6.4

6.0 Potential Environmental Impacts

For each source of effect identified as being potentially significant (Table 5.2), a description of the potential impacts is given below, along with a consideration of the significance of any potential effect.

In addition to regulator acceptance of Decommissioning Programmes being required, decommissioning activities are regulated, and will be subject to, individual consenting mechanisms which the EA will support (e.g. under the *Offshore Chemical Regulations 2002*). Serica will maintain awareness of any additional provisions which come into force during decommissioning planning and implementation.

6.1 Effects of Seabed Disturbance during Decommissioning

Potential impacts

Physical disturbance to the seabed will be associated with a number of decommissioning activities, primarily:

- Anchoring of the semi-submersible for well plug and abandonment
- The cutting and removal of risers, tie-in spools and jumpers, and remediation of cut ends with rock placement
- Removal of the SSIV and riser bases
- The removal of exposed protective materials (mattress and grout bags)

Rig anchoring

Anchors will be used for the semi-submersible rig used to plug and abandon the Orlando well. Although final rig selection is still to be made, it is assumed it will have a twelve point mooring system, typically comprising an anchor and chain/cable element. This is a worst case scenario for the purposes of assessment as previous rig anchoring at the Orlando well location has involved an eight anchor rig. Analysis of anchor scars associated with the placement of this rig have been used to inform the calculation of associated seabed disturbance (see note for Table 6.1). The anchor type and arrangement pattern will be subject to a detailed mooring study and the estimated seabed disturbance from rig use is shown in Table 6.1. Other vessels involved in decommissioning activities will be kept on station using dynamic positioning.

Removal of subsea infrastructure, protective material and remediation of cut ends

The removal of the spools/risers/jumpers, SSIV, riser bases, protective material and remediation of pipeline and umbilical cut ends, will cause some seabed disturbance, the majority of which will be within the physical footprint of the original development and the effects of which will be temporary. The disconnection, temporary lay down and removal of the Orlando dynamic riser and dynamic riser umbilical has the potential to disturb the NCP drill cuttings pile. A multibeam echosounder (MBES) and push core sampling survey conducted in summer 2025 characterised the extent and characteristics of the NCP cuttings pile. The closest sample points used to characterise the physical extent of the NCP cuttings pile are approximately 37m from the touchdown point of the Orlando umbilical riser and approximately 41m from the touchdown point of the production riser catenary (Figure 6-1). Both risers hang in the water column well clear of the cuttings pile as they approach NCP. The highest total hydrocarbon concentrations (THC) were found in those parts of the cuttings pile closest to the NCP structure (noting that THC concentrations from sample points in the vicinity of the riser bases were above the OSPAR (2009b) threshold of 50 mg/kg (Figure 6-2). Disconnection, laydown and recovery timelines and laydown location(s) for the catenary risers will be discussed between CNRI and OPRED during work preparation phase utilising BAT/BEP studies and awareness of the proximity of the drill cuttings to the risers to inform the discussions, laydown and removal methodology, and applications for the necessary permitting.

Figure 6-1: MBES data of Orlando infrastructure with the nearest push core sampling locations marked (CP16 and CP20)

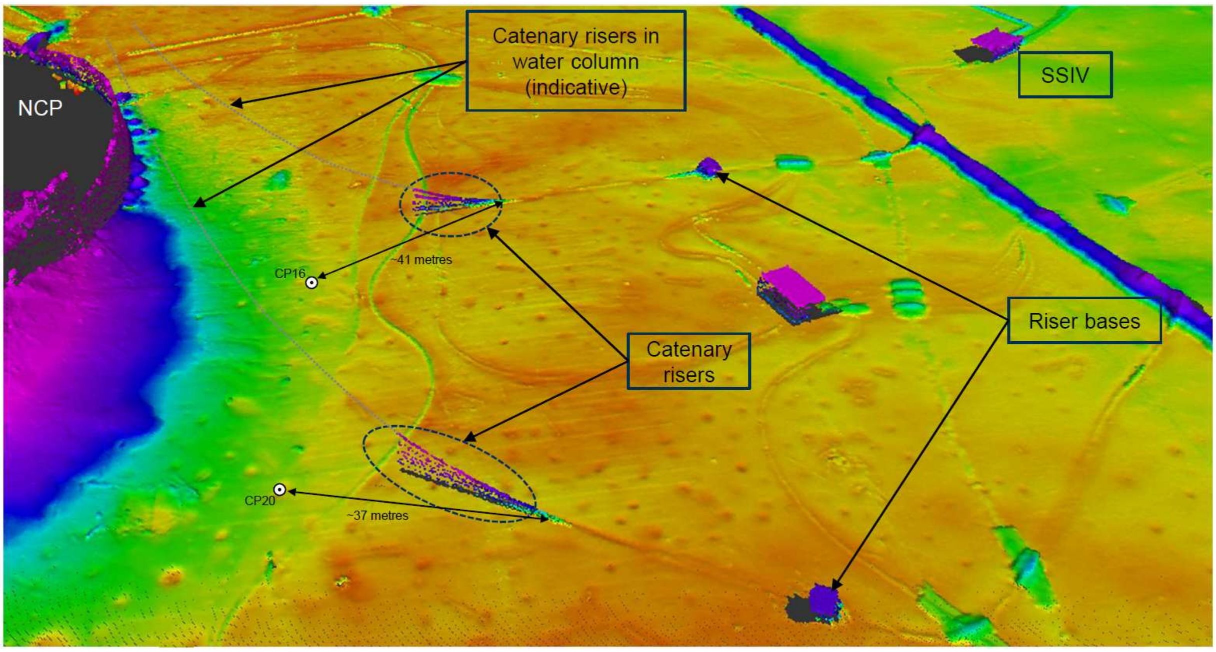
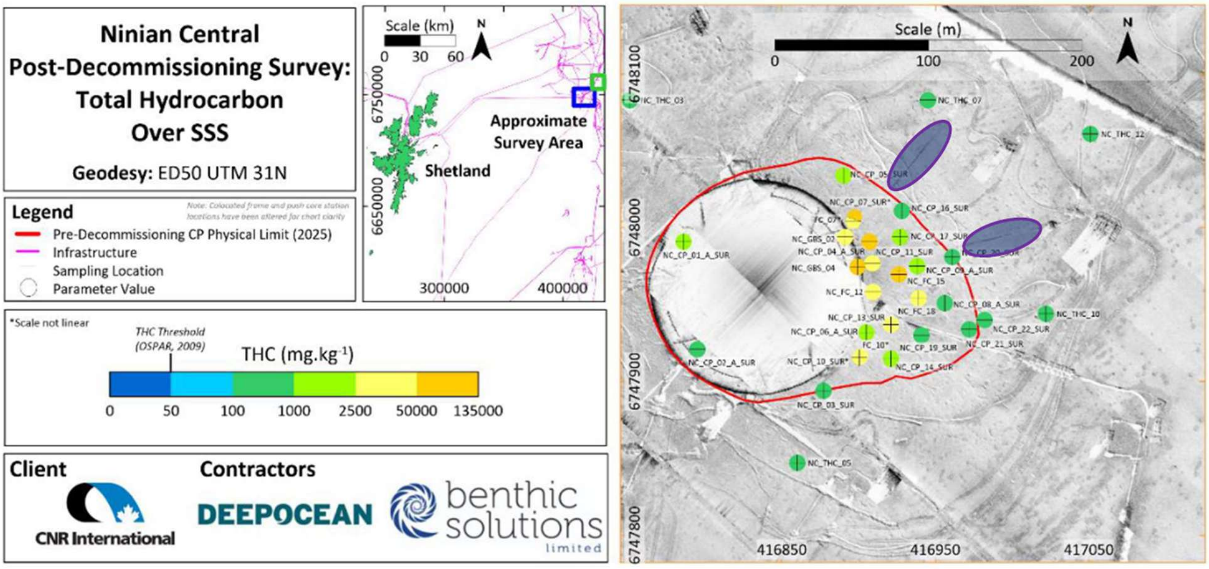


Figure 6-2: Total hydrocarbon concentrations from push core samples in the vicinity of NCP



Note: Side scan sonar (SSS). Purple lozenges represent the Orlando catenary risers in Figure 6.1.

Where rock occurs at crossing locations, this will be left in place for both the pipeline and umbilical. It is assumed that all mattresses and grout bags which are not covered by rock will be removed (see Section 2.1). The area of seabed disturbance generated by these activities is estimated in Table 6.1

The pipeline/umbilical cut ends may be remediated to a minimum depth of cover of 0.6m using rock placement (worst case). For the purposes of assessment, it has been assumed that rock remediation will be required along a 20m length of pipeline/umbilical at each cut end (assumes 100% contingency) and a width of 7.5m in order to achieve a suitable rock profile (1 in 3 slope). The assumed height of the rock at each cut end is 1.25m resulting in an estimated volume of rock of 375m^3 which equates to approximately 940 tonnes of rock (assuming average specific gravity for rock of 2.5). Disturbance generated by the rock placement will be highly localised, however, the rock will represent the introduction of hard substrate and will be permanent.

The particle size analysis undertaken as part of the 2021 Orlando survey (e.g. Fugro 2025) suggests that the seabed sediments at the sampling locations are poor to very poorly sorted fine to very fine sands, though some samples did have a slightly higher proportion of coarse material, and seabed photography also indicated the presence of cobbles and boulders, some of which are large, and which was also reflected in areas of higher reflectivity in the geophysical data. In areas of predominately sand sediments, the introduction of hard substrate (deposits of protective material including rock), might facilitate biological colonisation, including by non-indigenous species, by allowing species with short lived larvae to spread to areas, using these “stepping stones” where previously they were effectively excluded. A concern of introducing hard substrate to a seabed area where currently there is none, is that this could result in a change of seabed habitat type, adversely affecting species with habitat preferences. However, due to the existing natural hard substrate present in the area, and that the rock remediation will be an extension of rock already present at trench transitions, introducing new hard substrate in the limited quantities estimated, is not expected to result in a change of seabed habitat type. It can be expected that the rock protection will be colonised by epifaunal assemblages of various densities and compositions, as has been seen with the hard material used in the initial development of the fields, the addition of *ca*. 940 tonnes of rock is minor, and represents an increment of 2.5% on the levels of rock that will be left *in situ.*

Following removal of the subsea infrastructure, and informed by the post-decommissioning survey, any items of debris located on the seabed will be removed using an ROV and grab. The removal of such items will represent a minor increment to seabed disturbance generated during decommissioning.

Table 6.1: Estimated seabed disturbance from Orlando decommissioning

Item	Activity	Estimated disturbance of sediment m^2 (km^2)	
		Temporary	Permanent
	Well plug and abandonment activities		
1	Semi-submersible rig anchors and anchor chains[1]	28,683 (0.029)	-
2	Recovery of Orlando P1 well tree[2]	40 (0)	-
	Subsea decommissioning activities		
3	Recovery of spool pieces and jumpers[3]	Included within figure for 4 below	-
4	Recovery of protective material[4]	4,929 (0.005)	-

Item	Activity	Estimated disturbance of sediment m^2 (km^2)	
		Temporary	Permanent
5	Recovery of SSIV, riser bases, dynamic riser, umbilical riser and associated protective material[5]	2,870 (0.0029)	-
6	Remediation of cut ends (pipeline and umbilical)[6]	-	600 (0.0006)
	Total	**36,522 (0.0365)**	**600 (0.0006)**

Notes: [1]Information on the length of anchor chains comes from analysis of anchor scars left at the Orlando well site which were highlighted by the 2021 site survey (Fugro 2021a). From this analysis (and assuming lateral movement of 3m which review of extensive ROV footage of anchor chain disturbance (Hartley Anderson, personal communication), suggests is reasonable), previous anchoring of an eight anchored vessel resulted in seabed disturbance estimated at 19,122m^2/0.019km^2. The average anchor scar length was estimated at 797m and this was used to estimate seabed disturbance associated with a worst case twelve anchored vessel (figure in Table 6.1), again using a lateral movement of 3m; [2]assumes those dimensions presented in Table 2.1, and a 1m surrounding area of disturbance, [3]spools and jumpers are covered by protective material and their removal would not cause additional disturbance to that caused by the removal of the protective material; [4]assumes relevant mattress dimensions presented in Table 2.1, and a 1m surrounding area of disturbance, [5]assumes relevant dimensions presented in Table 2.1, and a 1m surrounding area of disturbance, [6]assumes rock remediation (worst case) of a 20m length of pipeline/umbilical at each cut end and a width of 7.5m in order to achieve a suitable rock profile (1 in 3 slope).

Seabed disturbance will result in direct physical effects on benthic communities which may include mortality as a result of physical trauma, smothering by excavated and re-suspended sediments. Disturbance during decommissioning activities would be limited to the benthic fauna present where anchors and anchor chains contact the seabed, fauna colonising the hard surfaces of the protective material to be lifted, and the biota present on and immediately around the subsea structures. The response of benthic macrofauna to physical disturbance has been well characterised, with increases in abundance of small opportunistic fauna and decreases in larger more specialised fauna (e.g. Eagle & Rees 1973, Newell *et al*. 1998, van Dalfsen *et al*. 2000, Dernie *et al*. 2003). The duration of effects on benthic community structure are related to individual species' biology and to successional development of community structure. The majority of seabed species recorded from the northern North Sea are known or believed to have short lifespans (a few years or less) and relatively high reproductive rates, indicating the potential for rapid population recovery, typically between 1 to 5 years (Jennings & Kaiser 1998), such that any effect will be temporary.

The infauna of the Orlando area is characterised by a range of small, short lived species, which have a widespread distribution and are characteristic of the fine to very fine sandy sediments, while seabed imagery and grab samples from the surveys, showed the larger visible fauna to be relatively sparse. Species of conservation interest have been identified from previous surveys; sea pens *Pennatula phosphorea* and *Virgularia* sp, mounds and burrows, and the presence of the OSPAR listed threatened and/or declining habitat "sea pens and burrowing megafauna communities", was considered likely to occur within the survey area. Analysis of 2021 survey photographic data (see Section 3.8), indicated that burrows (the presence of burrowing megafauna being the essential defining characteristic of the feature (JNCC 2014)), were recorded as 'frequent' or 'common' from all video transects, with the exception of V03 and V07 (noting the majority of video transects at the well end of the pipeline were not immediately adjacent to the Orlando infrastructure). The presence of individual sea pens was also noted in a number of images from the 2024 inspection survey of the pipeline route and well area (Figure 3.10), associated with areas of silty sand. As mentioned above, given rock remediation (to mitigate any potential snagging hazards to other marine users from pipeline cut ends) will be an extension of rock already present at trench transitions, introducing new hard substrate in the limited quantities estimated, is not expected to result in a change of seabed habitat type and is therefore unlikely to impact this potential OSPAR listed threatened and/or declining habitat.

Mortality of pennatulid sea pens (*Virgularia* spp. and *Pennatula phosphorea*), both recorded from survey in the area (Sections 3.4 and 3.8), may be high following physical disturbance, but crustaceans are probably able to restore burrow entrances following limited physical disturbance of the sediment surface (a few cm). *P. phosphorea* spawns annually and its fecundity is high (Edwards & Moore 2008), information on the reproduction of *Virgularia* spp. is sparse but based on its wide distribution and abundance is considered likely to be similarly fecund. Gates & Jones (2012) suggest that re-establishment of pennatulids is likely to take in excess of five years due to their slow growth rate (based on the Arctic species *Halipteris willemoesi*). As noted above, with the exception of the rig anchor and mooring lines, the disturbance associated with decommissioning will largely be isolated to the area of the original development.

Relevant information on the recovery of benthic habitats to smothering mainly comes from studies of dredge disposal areas (see Newell *et al*. 1998). Recovery following disposal occurs through a mixture of vertical migration of buried fauna, together with sideways migration into the area from the edges, and settlement of new larvae from the plankton. Defaunated sediments will be rapidly recolonised; Harvey *et al*. (1998) suggest that it may take more than two years for a community to return to a closer resemblance of its original state (although if long lived species were present this could be much longer). In contrast to habitats in energetic shallow waters, a stable sand and gravel habitat in deeper water is believed to take years to recover (see Newell *et al*. 1998, Foden *et al*. 2009).

Operational controls and mitigation

Applications will be made to deposit rock to cover the pipeline/umbilical ends, with the rock quantity to be minimised and placed as accurately as possible from the vessel. No specific additional mitigation was considered necessary beyond application of established operational controls.

Conclusion

The majority of seabed disturbance associated with decommissioning of the pipeline, umbilical and related infrastructure and protection materials will be within (and considerably less than) the development footprints of the Orlando Field, will be temporary and will not result in changes in sediment characteristics; the introduction of rock to remediate pipeline and umbilical cut ends is considered permanent, however this is being undertaken for safety reasons, to ensure no exposed cut ends remain. Previous surveys, including the recent pre-decommissioning survey indicate that the existing areas of rock cover, subsea infrastructure and associated protective material and existing natural hard features (cobbles, boulders) have been colonised by a range of epifaunal species. The potential introduction of hard substrate, on the scale estimated for decommissioning is minor in the context of that already present.

Anchor and catenary scars will be formed by the semi-submersible rig anchoring, and are estimated to be the largest source of seabed disturbance to result from the decommissioning of the field. These impacts are, however, not expected to result in changes in sediment characteristics, significant compaction or faunal effects; the physical aspects of anchoring, the anchor scars, will be more persistent, but the biological effects on fauna that relate to this are not.

The estimated area of total physical disturbance from decommissioning activities is relatively small (37,122m^2, 0.0371km^2), the majority of which is considered temporary, with an estimated 600m^2 (0.0006km^2) of permanent change in seabed habitat resulting from the application of rock. The area affected is negligible in the wider context of the northern North Sea.

In view of the potential effects described and recovery potential of the seabed, significant effects from physical disturbance are not considered likely.

6.2 Effects of Energy Use and Atmospheric Emissions

Potential Impacts

Evidence for human influenced climate change is now unequivocal (IPPC 2018). Over the last century anthropogenic sources of greenhouses gases (GHGs) have amplified the natural greenhouse effect and are estimated to have caused approximately 1.09°C of global surface warming above pre-industrial levels (likely range of 0.95°C to 1.2°C), with there being a greater than 50% likelihood that this will reach 1.5°C in the near term (IPCC 2021).

Predicted effects include *inter alia* an increase in global temperate (Kirtman *et al.* 2013, Collins *et al.* 2013), rising sea-levels (Lowe *et al.* 2009, Church *et al.* 2013, Horsburgh *et al.* 2020), changes in ocean circulation (Collins *et al.* 2013) and potentially more frequent extreme weather events (Wolf *et al.* 2020), and other effects including ocean acidification generated by enhanced atmospheric acid gas loading, deposition and exchange (see Humphreys *et al.* 2020, Findlay *et al.* 2022, 2025). These in turn are, and will, have effects on a number of receptor groups including seabirds (Burton *et al.* 2023, Hakkinen *et al.* 2022, Searle *et al.* 2022) and marine mammals (Martin *et al.* 2023), which include range shifts and, amongst other impacts, climate-mediated changes in prey species. These effects, amongst others, are most recently summarised in the Intergovernmental Panel on Climate Change (IPCC) 6th assessment report (IPCC 2021, also see IPCC 2018), are the rationale on which global carbon dioxide reduction measures such as the Paris Accord and the UK Government commitment to achieving net zero GHG emissions on 1990 levels, by 2050, are based.

In addition to effects associated with atmospheric greenhouse gases, emissions also have the potential to have negative effects on air quality. Poor air quality can result in effects on human health, the wider environment and infrastructure. Reduction in local air quality through inputs of contaminants such as oxides of nitrogen (NO_X), volatile organic compounds (VOCs) and particulates (e.g. PM_{10}, $PM_{2.5}$), may contribute to the formation of local tropospheric ozone and photochemical smog, which in turn can result in human health effects (see Bradley *et al*. 2019, Carnell *et al.* 2019, COMEAP 2018).

The principal GHG of concern is CO_2 as it constitutes both the largest component of global combustion emissions (generally ~80% of total GHG emissions) and has a long atmospheric residence time such that emissions made today continue to contribute to radiative forcing for some time[10]. Emissions of relevant gas species and their associated Global Warming Potential (GWP) have been estimated for the activities associated with the decommissioning of the Orlando facilities. This has involved the use of standard Environmental and Emissions Monitoring System (EEMS) conversion factors (DECC 2008) and the most recent GWP metrics (Myhre *et al.* 2013, Table 6.2). The result is a value in tonnes of CO_2 equivalent (CO_2 eq.) based on the radiative forcing effect of each GHG species relative to CO_2 and the atmospheric

[10] Figures vary widely from between 5-200 years (Houghton *et al.* 2001) to ~1,000 years (Archer 2005)

residence time of each gas. The GWP factor therefore changes depending on the "time horizon" considered (see IPCC 2001, 2007, Myhre *et al.* 2013, and Shine 2009 for a synthesis and critical review). GWP factors for CO have previously been calculated as 1.9 at 100 years, and that for NO_x is considered highly uncertain (Forster *et al.* 2007), and these are therefore not calculated.

For the purposes of this assessment, a 100 year time-horizon has been used, in line with its adoption by the United Nations Framework Convention on Climate Change and use in the Kyoto protocol (Myhre *et al.* 2013), and nationally for the calculation of carbon dioxide equivalent emissions (Shine 2009).

Table 6.2: Emissions factors

Gas	CO_2	N_2O	CH_4	CO	NOx	SO_2	NMVOCs
Diesel (engine)	3.2	0.00022	0.00018	0.0157	0.0594	0.004	0.002
Aviation fuel (helicopter)	3.15	0.00012	0.00035	0.00953	0.012	0.0009	0.00306
GWP at 100 years	1	273[1]	29.8[2]	-	-	-	-

Notes: [1]±130, [2]±11, Sources: DECC (2008), Forster et al. (2021)

Atmospheric emissions were identified in Section 5 as being a potential source of effect from activities associated with the decommissioning programme. Sources of emissions include:

- Drilling rig power generation, supporting vessels and helicopter traffic
- Combustion emissions from vessels involved in the subsea decommissioning campaign
- The recycling of materials returned to shore and the loss of materials left *in situ* for future use, and the possible related lost opportunity to displace primary materials from certain material supply chains

Decommissioning emissions

The well abandonment programme is the primary source of emissions (5,234tCO_2eq) and together with the decommissioning of the Orlando pipeline/umbilical (2,479tCO_2eq), results in an estimated total emissions from decommissioning the facilities of 7,713tCO_2eq. (Table 6.3). The emissions calculations are based on a range of assumptions relating to vessel type, timings and fuel use, which are outlined in Section 2.6 (Table 2.3).

Table 6.3: Estimated emissions (tonnes) associated with Orlando decommissioning activities[1]

Operation	CO_2	N_2O	CH_4	SO_2	CO	NOx	VOC	CO_2eq.
Well plug and abandonment								
Rig site survey	270	0.02	0.02	0.17	1.32	5.01	0.17	276
Rig[2]	1,472	0.10	0.08	0.92	7.22	27.32	0.92	2,351
ERRV	448	0.03	0.03	0.28	2.19	8.32	0.28	457
Anchor handling	1,485	0.10	0.08	0.93	7.28	27.56	0.93	1,515
Supply vessel	564	0.04	0.03	0.35	2.77	10.48	0.35	576
Helicopter	58	0.00	0.01	0.02	0.18	0.22	0.06	59
Subsea infrastructure removal and remediation								
Pipeline flushing	363	0.02	0.02	0.45	1.77	6.69	0.23	370

Operation	CO_2	N_2O	CH_4	SO_2	CO	NOx	VOC	CO_2eq.
Cutting and removal of spool pieces, jumpers and protective material, pipeline / umbilical end removal	1,030	0.07	0.06	1.28	5.02	18.99	0.64	1,051
Rock remediation of cut ends	451	0.03	0.03	0.56	2.20	8.32	0.28	460
Recovery of SSIV, riser bases, risers, and associated protective material	290	0.02	0.02	0.36	1.41	5.35	0.18	296
Post-decommissioning surveys	296	0.02	0.02	0.37	1.44	5.46	0.18	302
							Total	7,713

Notes: [1]includes contingency; [2]includes mob/demob, and all time in the field including anchoring and well P&A activities.

Emissions associated with material recycling

A high level breakdown of the material to be recovered as part of Orlando decommissioning are indicated in Table 6.4; also see Section 2. To provide a more complete indication of the emissions associated with decommissioning Orlando, emissions relating to the fate of the materials have also been estimated (note that re-use options have not been identified for the infrastructure, see Section 2). Emissions are primarily from steel associated with recovered pipeline and umbilical material (negligible as much relates to spools, risers and jumpers, and related infrastructure) and the recovered production Xmas tree and riser bases. The remaining materials include protective material recovered (e.g. mattresses), with some minor non-ferrous metal and plastic components (e.g. pipeline coatings).

Table 6.4: Estimated emissions relating to recycling of materials associated with Orlando

Activity	Steel	Copper	Plastics	Concrete	Emissions (tCO_2eq.)
Material recovered (t)					
Subsea installations (P1 wellhead tree including WHPS, 2 riser bases and 2 clump weights)	210.58	0	0.84	-	233.74
Subsea pipelines (spools and wellhead valve spool structure, risers, SSIV and controls equipment)	206.6	3.42	8.4	-	244.62
Mattresses	0	0	0	946.9	101.32
Material left *in situ* (t)					
Pipeline and umbilical	2,609.7	71.1	52.46	-	6896.82
Emissions estimated from production of equivalent material from primary source					1,060.15
Estimated emissions avoided from material recovery					581.79
Estimated lost opportunity from materials left *in situ*					3,864.74
Estimated net emissions					3,282.95

Notes: Emissions have been estimated based on the typical embodied carbon of primary materials and materials containing typical proportions of recycled components (tCO_2eq./t), with factors based on those from IoP (2000), Hammond & Jones (2011), Burrow et al. (2024).

Most materials to be recovered are recyclable (e.g. steel) and therefore have a strong end-of-life benefit through the displacement of virgin material in the wider materials supply chain (Hammond & Jones 2011, Weinzettel *et al*. 2009, Yellishetty *et al*. 2012), which also has wider implications than just emissions. The benefit of displacing primary materials has been taken to be the difference in emissions from producing an equivalent unit of recycled material compared to that of primary material. Conversely the leaving of some components *in situ* results in a loss of future use of that material, and the emissions associated with generating the equivalent materials from primary sources have been calculated, assuming that these would otherwise displace such primary material. However, the leaving of the material *in situ* negates additional vessel time in the field to recover and transport these to shore, emissions from which would be greater than the lost opportunity of recycling these materials.

Decommissioning emissions in context

To place the emissions from the proposed scope of work, including net emissions relating to materials (estimated total of 10,995tCO_2eq), in the context of total UK GHG emissions (385MtCO_2eq), these would represent an increment of 0.003% on those emitted provisionally estimated to have occurred from all UK sources in 2024. From available information from Offshore Energies UK, approximately 13.5MtCO_2eq was attributable to emissions from the production of oil and gas on the UKCS in 2023 (OEUK 2024). To place the emissions of this work scope in the context of these 2023 emissions these would represent an increment of 0.08%. In view of when the decommissioning activities are proposed to take place (*ca*. 2027-2030), it has been estimated that they would contribute to approximately 0.0006% of the relevant fifth carbon budget covering the period 2028-2032, which has a total budget of 1,725MtCO_2eq. These will represent the final emissions from the Orlando field, and have been minimised as far as possible (see the operational controls and mitigation below).

Operational Controls and Mitigation

As part of their standard programme management and planning, Serica look to minimise vessel time in the field as far as practicable and will make use of vessel and rig synergies where possible. The above estimates are based on representative vessels presently in operation, with timings and related emissions representing a probable worst-case, whereas Serica's contractor selection process allows for the selection of contractors with, for example, modern and fuel efficient vessels, where available, while satisfying the other selection criteria, such as maximising synergies with other programmes of work using rigs or vessels, taking place in the Orlando or wider northern North Sea area. Emissions are also reduced by following relevant industry best practices and minimising fuel consumption, where possible.

Emissions from material flows are minimised by using a waste hierarchy approach consistent with the Waste Framework Directive 2008/98/EC and relevant legislation; establishing where there is scope for equipment and material recycling, with disposal only taking place where no feasible alternative is available. The selected decommissioning options has minimised the need for material returns to shore for recycling or disposal. Additionally, as noted above, the emissions associated with alternative removal options would likely be the same or greater than that associated any energy and emissions saving from their recycling, and also involve additional impacts (see Section 6.1) which have the potential to make minor contributions to emissions, in the form of the disturbance of "blue carbon" in seabed sediments (e.g. see van de Velde *et al.* 2018, Graves *et al.* 2022, BEIS 2022).

It is considered that there is limited scope for additional mitigation measures to reduce the residual effect on atmospheric GHG loading, or any local effects on air quality. However, these latter effects are naturally mitigated through the area being relatively far offshore (~127km), the predominant air flow in the region and relatively short duration of activities.

Conclusion

The decommissioning activities will lead to emissions of gases which contribute both to localised and short-term increases in atmospheric pollutants, and to global atmospheric GHG concentrations. In the context of wider UK emissions these effects are considered to be negligible, and there will be a minor reduction in net emissions associated with the return of recyclable materials to shore which will have a future use and offset the extraction and transport of primary raw materials. Overall, effects are considered to be negligible and temporary.

6.3 Cumulative Effects

Current guidance (BEIS 2018) requires the assessment to consider the cumulative effects arising from decommissioning activities in the context of all other activities taking place in the area, where relevant to do so. Serica has given consideration to cumulative effects and has followed the guidance to *The Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020* (BEIS 2020) where it states *The assessment should also consider the impacts of other existing, consented or planned activities in the development area, and determine whether there are likely to be any significant in-combination or cumulative impacts*. Serica have also considered DTI (2003), which defined three categories of "additive" effects in the context of Strategic Environmental Assessment:

Incremental effects are considered within the assessment process as effects from licensing exploration and production (E&P) activities, which have the potential to act additively with those from other oil and gas activity, including:

- Forecast activity in newly licensed areas
- New exploration and production activities in existing licensed areas
- Existing production activities
- Forecast decommissioning activities
- Legacy effects of previous E&P activities, post-decommissioning (e.g. unrecovered debris)

Cumulative effects are considered in a broader context, to be potential effects of decommissioning activities which act additively or in combination with those of other human activities (past, present and future); given the existing uses of the sea in and around the Orlando area and the decommissioning activities, the cumulative effects have the potential to arise with other activities, notably:

- Fishing
- Shipping and navigation
- Other oil and gas decommissioning activities
- Oil and gas and other industrial related activity (e.g. exploration, appraisal, development, marine aggregate extraction)

Synergistic effects – synergy occurs where the joint effect of two or more processes is greater than the sum of individual effects – in this context, synergistic effects may result from physiological interactions (for example, through inhibition of immune response systems) or through the interaction of different physiological and ecological processes (for example through a combination of contaminant toxicity and habitat disturbance).

Effects which are considered to have the potential to act in an incremental, cumulative or synergistic manner are summarised below.

Physical disturbance	**Incremental**: disturbance will be incremental with that resulting from other well plug and abandonment, pipeline decommissioning activities; there are other decommissioning projects in the wider northern North Sea area. However, the majority of the spatial extent of disturbance for decommissioning Orlando is limited and widely separated from other decommissioning projects, with the only footprint overlap being around the facilities within the NCP 500m exclusion zone (e.g. SSIV, riser bases and risers), which is also under assessment for future decommissioning (e.g. Ninian Hub Subsea DP). The total area affected is a small proportion of benthic habitat area. **Cumulative**: fishing probably represents the principal sources of seabed disturbance in and around the wider Orlando area. **Synergistic**: none
Emissions	**Incremental**: no significant incremental effects, in view of scale of inputs (relatively few vessels on site, for relatively short durations at a time, limited vessel overlap) and very high available dispersion. **Cumulative**: greenhouse and acid gas emissions will be cumulative in a regional and global context, although the contribution associated with the decommissioning activities is minor. **Synergistic**: none

6.4 Transboundary Effects

The UK has ratified the Convention on Environmental Impact Assessment in a Transboundary Context (the Espoo Convention) and thus an assessment is required of the potential for the decommissioning activities to result in significant transboundary effects.

At its closest point, the Orlando facilities are *ca*. 20km from the UK/Norway median line, however the activities associated with the decommissioning of the fields (well P&A, disconnect of pipeline/umbilical, removal of spools/jumpers/risers, removal of SSIV, riser bases and protective material) are considered to offer a remote risk of transboundary effects. As part of the permitting and consenting process for the decommissioning activities, accidental events and a major environmental incident assessment will be carried out, which will take into consideration the potential for transboundary impacts.

6.5 Marine Planning

The Orlando infrastructure lies within an area covered by Scotland's National Marine Plan (The Scottish Government 2015), and the decommissioning activities have been assessed against the relevant general principles and oil and gas marine planning policies (Table 6.5).

Table 6.5: Assessment of Scotland Marine Plan Policies[1] and Orlando decommissioning

Policy and topic	Assessment
General Policies	
GEN1 – General planning – activities undertaken in a sustainable manner	The decommissioning activities will be undertaken in a manner consistent with the Marine Plan policies, in a sustainable manner that ensures any potential impacts associated with the activities are kept to a minimum.
GEN4 – Co-existence	The project considers other sea users in the decision making process (e.g. assessing other vessel usage of the area), vessels[2] associated with the activities on location for relatively short duration, notification given of rig move and siting on location (marking of anchors), liaising with fisheries bodies and material decommissioned in situ. Aim being to minimise as far as practicable any potential impact on other sea users.
GEN5 – Climate change	Potential opportunities to reduce emissions through minimising flights, supply visits and fuel use, engagement with workforce.
GEN6 – Historic environment	Orlando is not located near any designated wreck sites or sites of historic significance.
GEN9 – Natural heritage	Orlando is not located in or near any area with protected species or habitats. The likely presence of the OSPAR habitat Sea pen and burrowing megafauna communities and the potential for impact on priority marine features has been assessed.
GEN11 – Marine litter	All vessel associated with decommissioning activities will be equipped to meet MARPOL and related merchant shipping regulations for the prevention of pollution from ships.
GEN12 – Water quality	The decommissioning activities will not result in a deterioration of water quality; the infrastructure will have been cleaned and flushed in preparation of decommissioning and processes and procedures in place for chemical use and discharge, prevention of spills, with all proposed chemical use and discharge assessed through the Regulator permit process.
GEN13 – Noise	There is no explosives to be used during decommissioning activities, the only noise source being the rig and vessels on location for a relatively short period of time; all noise sources will be of a non-pulsed/continuous nature.
GEN14 – Air quality	Emissions will be from rig and vessel engine use (power generation), with emissions associated with the replacement of the materials removed also taken into consideration.
GEN18 - Engagement	Serica have engaged with interested stakeholders (e.g. Scottish Fisheries Federation) as well as having early engagement with OPRED and statutory consultees (e.g. JNCC).
GEN19 – Sound evidence	The environmental appraisal to support the DPs for Orlando has utilised recent site specific survey data, scientific data and previous experience and knowledge from similar work scopes.
GEN21 - Cumulative impacts	Carrying out the decommissioning activities are not expected to have a cumulative impact.
Oil and Gas Policies	
O&G1 – Maximise and prolong O&G exploration and production – activity should be carried out using the principles of BAT/BEP	Well and infrastructure decommissioning uses BAT/BEP principles as far as practicable, e.g. well plug and abandonment following industry practices and aims to reduce waste generated and cement used. Chemicals will be selected for best environmental profile, where technical requirements allow. Comparative assessment for pipeline system decommissioning, with a requirement to leave a clean seabed, and takes account of environmental impact of different options. Assessment of potential impacts associated with

Policy and topic	Assessment
	the decommissioning of the field have been screened and those identified as potentially significant, have been further assessed in this environmental appraisal.
O&G2 – where re-use of O&G infrastructure is not practicable, decommissioning must take place in line with standard practice and as allowed by international obligations	Serica will endeavour to identify re-use potential for Orlando infrastructure, where re-use is not practicable decommissioning activities will be conducted in line with regulations, industry guidelines and best practice.
O&G6 – Operators should have sufficient emergency response and contingency strategies in place that are compatible with the National Contingency Plan and the Offshore Safety Directive	Serica will have in place an appropriately approved emergency response plan for the plug and abandonment of the Orlando well, ahead of any offshore activities being undertaken, the contracted rig will have in place an approved NPI OPEP and Serica will also have an approved onshore plan for Tier 3 responses.

Notes: [1]General policies and Oil and Gas specific policies not applicable to Orlando are not included here [2] Reference to vessels for Orlando includes the rig
Sources: Scottish Government (2015).

7.0 Environmental Management

7.1 Environmental Management

Serica operates an Operations Management System (OMS), which provides a framework for systematic management of health, safety, environment and quality (HSEQ) across the organisation and its activities, including decommissioning, and is designed to ensure the delivery of safe, environmentally responsible and reliable operations, in accordance with defined policies, practices, procedures and standards.

The environmental management system (EMS) contained within the OMS covers aspects of environmental management, including, but not limited to, contractor selection, waste management, chemical management, pollution prevention and control and emissions management, and is designed to achieve Serica's corporate expectation to implement best practice above and beyond the requirements of the regulations. Serica's EMS was successfully reverified against the requirements of OSPAR 2003/5 in May 2023 and all activities undertaken as part of the installation of the decommissioning of the Orlando subsea infrastructure will be in accordance with and alignment to, the EMS.

8.0 Overall Conclusion

The Orlando field is to be decommissioned by Serica and included in the decommissioning activities is the plug and abandonment of the Orlando well and the recovery of surface laid pipeline/umbilical infrastructure and exposed protective material. The trenched and buried pipeline and umbilical will be decommissioned *in situ*, whilst the exposed cut ends will be remediated to reduce as far as possible the potential for future snagging.

Based on the findings of this EA, the majority of potential impacts were screened out as considered minor.

Of those screened in as potentially significant, it was found that:

- Decommissioning activities will result in some short term atmospheric emissions, however these were considered negligible in the context of overall UK emissions.
- The majority of seabed disturbance will be temporary, the activity generating the largest seabed disturbance footprint being the mooring system for the semi-submersible required for the plug and abandonment of the Orlando well; the only permanent seabed disturbance will be from the introduction of new rock to remediate pipeline/umbilical cut ends although the total area of this is relatively small.
- No specific, additional controls were considered necessary on activities beyond application of regulatory requirements, established Serica management system processes, operational controls and following industry guidelines where applicable.

From the additional assessment of these potential impacts, none were identified as resulting in significant effects.

9.0 References

Aires C, González-Irusta JM & Watret R (2014). Updating fisheries sensitivity maps in British waters. Scottish Marine and Freshwater Science Report Vol 5 No 10, 93pp.
Ansari TM, Marr IL & Coats AM (2001). Characterisation of mineralogical forms of barium and trace heavy metal impurities in commercial barytes by EPMA, XRD and ICPMS. *Journal of Environmental Monitoring* **3**: 133–138.
Aquateam COWI (2014). Characterising Thermal Treated OBM Drill Cuttings. Sampling, characterisation, environmental analysis and risk assessment of offshore discharges Aquateam COWI AS Report No: 14-02 for the Norwegian Oil and Gas Association, 87pp.
BEIS (2018). Decommissioning of offshore oil and gas installations and pipelines. Guidance notes produced by the Offshore Decommissioning Unit, Offshore Petroleum Regulator for Environment and Decommissioning, Department of Business, Energy and Industrial Strategy, 138pp.
BEIS (2020). The Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020 – A Guide, revision 01, 83pp.
Bradley N, Dobney A, Exley K, Stewart-Evans J, Aldridge S, Craswell A, Dimitroulopoulou S, Hodgson G, Izon-Cooper L, Mitchem L, Mitsakou C & Robertson S (2019). Review of interventions to improve outdoor air quality and public health. Public Health England, 262pp.
Burnell D, Perkins AJ, Newton SF, Bolton M, Tierney TD & Dunn TE (2023). A census of breeding seabirds in Britain and Ireland (2015–2021).
Burton NHK, Daunt F, Kober K, Humphreys EM & Frost TM (2023). Impacts of Climate Change on Seabirds and Waterbirds in the UK and Ireland. MCCIP Science Review 2023, 26pp.
Callaway R, Alsvåg J, de Boois I, Cotter J, Ford A, Hinz H, Jennings S, Kröncke I, Lancaster J, Piet G, Prince P & Ehrich S (2002). Diversity and community structure of epibenthic invertebrates and fish in the North Sea. *ICES Journal of Marine Science* **59**: 1199-1214.
Carnell E, Vieno M, Vardoulakis S, Beck R, Heaviside C, Tomlinson S, Dragosits U, Heal MR & Reis S (2019). Modelling public health improvements as a result of air pollution control policies in the UK over four decades—1970 to 2010. *Environmental Research Letters* **14**: 074001.
Carter MID, Boehme L, Cronin MA, Duck CD, Grecian WJ, Hastie GD, Jessopp M, Matthiopoulos J, McConnell BJ, Miller DL, Morris CD, Moss SEW, Thompson D, Thompson PM & Russell DJF (2022). Sympatric Seals, Satellite Tracking and Protected Areas: Habitat-Based Distribution Estimates for Conservation and Management. *Frontiers in Marine Science* **9**: 875869.
Carter MID, Boehme L, Duck CD, Grecian WJ, Hastie GD, McConnell BJ, Miller DL, Morris CD, Moss SEW, Thompson D, Thompson PM & Russell DJF (2020). Habitat-based predictions of at-sea distribution for grey and harbour seals in the British Isles. Sea Mammal Research Unit, University of St Andrews, Report to BEIS, OESEA-16-76/OESEA-17-78.
Church JA, Clark PU, Cazenave A, Gregory JM, Jevrejeva S, Levermann A, Merrifield MA, Milne GA, Nerem RS, Nunn PD, Payne AJ, Pfeffer WT, Stammer D & Unnikrishnan A (2013). Sea Level Change. In: Stocker TF, Qin D, Plattner G-K, Tignor M, Allen SK, Boschung J, Nauels A, Xia Y, Bex V & Midgley PM (Eds.) Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1137-1216.
Circular Ecology (2024). Inventory of Carbon & Energy, v4.0, December 2024.
CNRI (2017). Ninian Northern Platform late life and decommissioning project. Environmental Statement, 229pp.

Collie JS, Richardson K & Steele JH (2004) Regime shifts: can ecological theory illuminate the mechanisms? *Progress in Oceanography* **60**: 281–302.
COMEAP (2018). Associations of long term average concentrations of nitrogen dioxide with mortality. A report by the Committee on the Medical Effects of Air Pollutants, 152pp.
Coull KA, Johnstone R & Rogers SI (1998). Fisheries Sensitivity Maps in British Waters. Report to United Kingdom Offshore Operators Association, Aberdeen, 58pp. http://www.cefas.co.uk/Publications/fsmaps/sensi_maps.pdf
Daan R & Mulder M (1996). On the short-term and long-term impact of drilling activities in the Dutch sector of the North Sea. *ICES Journal of Marine Science* **53**: 1036-1044.
DECC (2008). EEMS Atmospheric Emissions Calculations. Issue 1.810a, Oil & Gas UK and the Department of Energy and Climate Change, 53pp.
Dernie KM, Kaiser MJ & RM Warwick (2003). Recovery rates of benthic communities following physical disturbance. *Journal of Animal Ecology* **72**: 1043-1056.
DTI (2003). Strategic Environmental Assessment Area North and West of Shetland and Orkney (SEA 4). Consultation Document. Report to the Department of Trade and Industry, UK.
Eagle RA & Rees EIS (1973). Indicator Species – A Case for Caution. *Marine Pollution Bulletin* **4**: 25.
Edwards DCB & Moore CG (2008). Reproduction in the sea pen *Pennatula phosphorea* (Anthozoa: Pennatulacea) from the west coast of Scotland. *Marine Biology* **155**: 303–314.
Ellis JR, Milligan SP, Readdy L, Taylor N & Brown MJ (2012). Spawning and nursery grounds of selected fish species in UK waters. Cefas Science Series: Technical Report 147: 60pp.
Fauchald K & Jumars PA (1979). The diet of worms: a study of polychaete feeding guilds. *Oceanographical Marine Biology Annual Review* **17**: 193-284.
Findlay HS, Artoli Y, Birchenough SNR, Hartman S, León P & Stiasny M (2022). Climate change impacts on ocean acidification relevant to the UK and Ireland. MCCIP Science Review 2022, 24pp.
Findlay HS, Artoli Y, Greenwood N, Hartman S, Flohr A, León P, Stiasny M & Cronin M (2025). Ocean acidification around the UK and Ireland. MCCIP Science Review 2025, 31pp.
Foden J, Rogers SI & Jones AP (2009). Recovery rates of UK seabed habitats after cessation of aggregate extraction. *Marine Ecology Progress Series* **390**: 15-28.
Forster PT, Storelvmo K, Armour W, Collins JL, Dufresne D, Frame DJ, Lunt T, Mauritsen MD, Palmer M, Watanabe M, Wild H & Zhang (2021). The Earth's Energy Budget, Climate Feedbacks, and Climate Sensitivity. In: Masson-Delmotte VP, Zhai A, Pirani SL, Connors C, Péan S, Berger N, Caud Y, Chen L, Goldfarb MI, Gomis M, Huang K, Leitzell E, Lonnoy JBR, Matthews TK, Maycock T, Waterfield O, Yelekçi R Yu and Zhou B (eds.). Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, 132p
Frid CL J, Garwood PR & Robinson LA (2009). Observing change in a North Sea benthic system: A 33 year time series. *Journal of Marine Systems* **77**: 227–236.
Fugro (2011a) Semi-submersible rig site survey proposed location Block 3/03, Orlando. Volume 3 of 3: Environmental Baseline Survey Results. Report by Fugro Survey Limited, Document Ref: 00605-1V3
Fugro (2021a). Rig Site Survey Orlando UKCS Block 3/3b, Volume 3 of 5 Geophysical Results Report. Document Ref: 210473V3.
Fugro (2021b). Rig Site Survey Orlando UKCS Block 3/3b, Volume 4 of 5 Habitat Assessment Report. Document Ref: 210473V4.

Fugro (2025). Orlando Site Survey 2021 Orlando UKCS Block 3/3b Environmental Monitoring Survey. Document Ref: F272250-REP-001.
Gass SE & Murray Roberts J (2006). The occurrence of the cold-water coral *Lophelia pertusa* (Scleractinia) on oil and gas platforms in the North Sea: Colony growth, recruitment and environmental controls on distribution. *Marine Pollution Bulletin* **52**: 549-559.
Gates AR & Jones DOB (2012). Recovery of benthic megafauna from anthropogenic disturbance at a hydrocarbon drilling well (380m depth in the Norwegian Sea). *PLoS One* **7**: e44114.
Gilles A, Authier M, Ramirez-Martinez NC, Araújo H, Blanchard A, Carlström J, Eira C, Dorémus G, Fernández- Maldonado C, Geelhoed SCV, Kyhn L, Laran S, Nachtsheim D, Panigada S, Pigeault R, Sequeira M, Sveegaard S, Taylor NL, Owen K, Saavedra C, Vázquez-Bonales JA, Unger B & Hammond PS (2023). Estimates of cetacean abundance in European Atlantic waters in summer 2022 from the SCANS-IV aerial and shipboard surveys. Final report published 29 September 2023. 64 pp.
Gomes AS, Castro BB & Nunes B (2020). First characterization of the ecotoxicity of paraffin particles: assessment of biochemical effects in the marine polychaete *Hediste diversicolor*. *Environmental Science and Pollution Research* **27**: 45742-45754
Gonzalez-Irusta & Wright PJ (2016a). Spawning grounds of haddock *(Melanogrammus aeglefinus)* in the North Sea and West of Scotland. *Fisheries Research* 18**3**: 180-191.
Gonzalez-Irusta & Wright PJ (2016b). Spawning grounds of Atlantic cod *(Gadus morhau)* in the North Sea. *ICES Journal of Marine Science*, **73**: 304-315.
Gonzalez-Irusta & Wright PJ (2017). Spawning grounds of whiting *(Merlangius merlangus)*. *Fisheries Research* 195: 141-151.
Graves CA, Benson L, Aldridge J, Austin WEN, Dal Molin F, Fonseca VG, Hicks N, Hynes C, Kröger S, Lamb PD, Mason C, Powell C, Smeaton C, Wexler SK, Woulds C & Parker R (2022). Sedimentary carbon on the continental shelf: Emerging capabilities and research priorities for Blue Carbon. *Frontiers in Marine Science* **9**: 926215.
Hakkinen H, Petrovan SO, Sutherland WJ, Dias MP, Ameca EI, Oppel S, Ramírez I, Lawson B, Lehikoinen A, Bowgen KM, Taylor NG & Pettorelli N (2022). Linking climate change vulnerability research and evidence on conservation action effectiveness to safeguard European seabird populations. *Journal of Applied Ecology* **59**: 1178-1186.
Hammond & Jones (2011). Inventory of Carbon & Energy (ICE) Version 2.0.
Hartley JP (1996). Environmental monitoring of offshore oil and gas drilling discharges—A caution on the use of barium as a tracer. *Marine Pollution Bulletin* **32**: 727–733.
Harvey M, Gauthier D & Munro J. (1998). Temporal changes in the composition and abundance of the macrobenthic invertebrate communities at dredged material disposal sites in the Anseà Beaufils, Baie des Chaleurs, Eastern Canada. *Marine Pollution Bulletin* **36**:41–55.
Horsburgh K, Rennie A & Palmer M (2020). Impacts of climate change on sea-level rise relevant to the coastal and marine environment around the UK. MCCIP Science Review 2020, 116–131.
Humphreys MP, Artioli Y, Bakker DCE, Hartman SE, León P, Wakelin S, Walsham P and Williamson P (2020). Air–sea CO_2 exchange and ocean acidification in UK seas and adjacent waters. MCCIP Science Review 2020, 54–75.
IoP (2000). Guidelines for the Calculation of Estimates of Energy use and Gaseous Emissions in the Decommissioning of offshore structures, The Institute of Petroleum, February 2000 ISBN 0 8593 255 3.
IPCC (2001). Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). In: JT Houghton, Y

Ding, DJ Griggs, M Noguer, PJ van der Linden and D Xiaosu (Eds.). Cambridge University Press, UK, 944pp.
IPCC (2007). Climate Change 2007: The Physical Science Basis. In: S Solomon, D Qin, M Manning, Z Chen, M Marquis, KB Averyt, M Tignor & HL Miller (Eds.) Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 996pp.
IPCC (2013). Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. TF Stocker, D Qin, G.-K. Plattner, M Tignor, SK Allen, J Boschung, A Nauels, Y Xia, V Bex and P.M. Midgley Eds. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. http://www.ipcc.ch/report/ar5/wg1/
IPCC (2018). Summary for Policymakers. In: Masson-Delmotte V, Zhai P, Pörtner HO, Roberts D, Skea J, Shukla PR, Pirani A, Moufouma-Okia W, Péan C, Pidcock R, Connors S, Matthews JBR, Chen Y, Zhou X, Gomis MI, Lonnoy E, Maycock TK, Tignor M, and Waterfield T (Eds.) Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. World Meteorological Organization, Geneva, Switzerland, 32 pp.
Jennings S & Kaiser MJ (1998). The Effects of Fishing on Marine Ecosystems. *Advances in Marine Biology* **34**: 201–352.
JNCC (2017). Using the Seabird Oil Sensitivity Index to inform contingency planning (updated guidance to reduce data coverage gaps) http://jncc.defra.gov.uk/PDF/Using%20the%20SOSI%20to%20inform%20contingency%20planning%202017.pdf
Joint Nature Conservation Committee (JNCC) (2014). JNCC clarifications on the habitat definitions of two habitat FOCI. Peterborough, UK, 14pp. https://data.jncc.gov.uk/data/91e7f80a-5693-4b8c-8901-11f16e663a12/3-AdviceDocument-MudHabitats-Seapen-definitions-v1.0.pdf
Jones EL & Russell DJF (2016). Updated grey seal (*Halichoerus grypus*) usage maps in the North Sea. Report to the Department of Energy and Climate Change (OESEA-15-65), Sea Mammal Research Unit, 15pp.
Jones EL, McConnell BJ, Smout S, Hammond PS, Duck CD, Morris CD, Thompson D, Russel DJF, Vincent C, Cronin M, Sharples RJ & Matthiopoulos J (2015). Patterns of space use in sympatric marine colonial predators reveal scales of spatial partitioning. *Marine Ecology Progress Series* **534**: 235-249.
Jumars P, Dorgan K & Lindsay S (2015). Diet of Worms Emended: An Update of Polychaete Feeding Guilds. *Annual Review of Marine Science* **7**: 497-520.
Kirtman B, Power SB, Adedoyin JA, Boer GJ, Bojariu R, Camilloni I, Doblas-Reyes FJ, Fiore AM, Kimoto M, Meehl GA, Prather M, Sarr A, Schär C, Sutton R, van Oldenborgh GJ, Vecchi G & Wang HJ (2013). Near-term Climate Change: Projections and Predictability. In: Stocker TF, Qin D, Plattner G-K, Tignor M, Allen SK, Boschung J, Nauels A, Xia Y, Bex V & Midgley PM (Eds.) Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 953-1028.
Kober K, Webb A, Win I, Lewis M, O'Brien S, Wilson LJ & Reid JB (2010). An analysis of the numbers and distribution of seabirds within the British Fishery Limit aimed at identifying areas that qualify as possible marine SPAs. JNCC Report No. 431. JNCC, Peterborough.

Künitzer A, Basford D, Craeymeersch JA, Dewarumez JM, Dörjes J, Duineveld GCA, Eleftheriou A, Heip C, Herman P, Kingston P, Niermann U, Rachor E, Rumohr H & de Wilde PAJ (1992). The benthic infauna of the North Sea: species distribution and assemblages. *ICES Journal of Marine Science* **49**: 127-143.
Lowe JA, Howard TP, Pardaens A, Tinker J, Holt J, Wakelin S, Milne G, Leake J, Wolf J, Horsburgh K, Reeder T, Jenkins G, Ridley J, Dye S & Bradley S (2009). UK Climate Projections science report: Marine and coastal projections. Met Office Hadley Centre, Exeter, UK, 95pp.
Marine Management Organisation (MMO) (2024). UK sea fisheries statistics 2023, 70pp.
Marine Directorate Data https://data.marine.gov.scot/dataset/2024-scottish-sea-fisheries-statistics-fishing-effort-and-quantity-and-value-landings-ices
Martin E, Banga R & Taylor NL (2023). Climate change impacts on marine mammals around the UK and Ireland. MCCIP Science Review 2023, 22pp.
Muench A, Mendo T, Ransijn J, Durbach I, Gibson T, Swift R & James M (2024). Fisheries Sensitivity Mapping and Displacement Modelling (FiSMaDiM) – Final project report. Report produced for The Crown Estate, OWEC funded project: FiSMaDiM, 35pp.
Myhre G, Shindell D, Bréon F-M, Collins W, Fuglestvedt J, Huang J, Koch D, Lamarque J-F, Lee D, Mendoza B, Nakajima T, Robock A, Stephens G, TTakemura T & Zhang H (2013). Anthropogenic and Natural Radiative Forcing. In: Stocker TF, Qin D, Plattner G-K, Tignor M, Allen SK, Boschung J, Nauels A, Xia Y, Bex V & Midgley PM (Eds.) Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. 659-740.
Newell RC, Seiderer LJ & Hitchcock DR (1998). The impact of dredging works in coastal waters: A review of the sensitivity to disturbance and subsequent recovery of biological resources on the seabed. *Oceanography and Marine Biology: An Annual Review* **36**: 127-178.
Nunes B, Simöes MI, Navarro JC & Castro BB (2020). First ecotoxicological characterization of paraffin microparticles: a biomarker approach in a marine suspension-feeder, *Mytilus* sp. *Environmental Science and Pollution Research* **27**: 41946-41960
OEUK (2022). Well Decommissioning Guidelines Issue 7.
OGA (2021). The OGA Strategy, 13pp. https://www.nstauthority.co.uk/media/7105/the-oga-strategy.pdf
OGA website (29th licensing round): https://www.ogauthority.co.uk/licensing-consents/licensing-rounds/offshore-licensing-rounds/#tabs
OGUK (2013). Long-term degradation of offshore structures and pipelines decommissioned and left *in situ*. Commissioned by Oil & Gas Uk, 41pp.
OGUK (2015). Guidelines for Comparative Assessment in Decommissioning Programmes. Issue 1, 49pp.
Olsgard F & Gray JS (1995). A comprehensive analysis of the effects of offshore oil and gas exploration and production on the benthic communities of the Norwegian continental shelf. *Marine Ecology Progress Series* **122**: 277-306
OSPAR (2009a). Background document on CEMP assessment criteria for the QSR 2010. Monitoring and Assessment Series. OSPAR Publication No. 978-1-907390-08-1. OSPAR Commission.
OSPAR (2009b). Implementation report on Recommendation 2006/5 on a management regime for offshore cutting piles.

OSPAR (2014). Levels and trends in marine contaminants and their biological effects – CEMP assessment report 2013. Monitoring and Assessment Series. OSPAR Publication No. 631/2014. OSPAR Commission.
OSPAR (2015). JAMP guidelines for monitoring contaminants in sediments. OSPAR Publication No. 2002-16. OSPAR Commission.
Rachor E, Reiss H, Degraer S, Duineveld GCA, Van Hoey G, Lavaleye M, Willems W & Rees HL (2007). Structure, distribution, and characterizing species of North Sea macro-zoobenthos communities in 2000. In: HL Rees, JD Eggleton, E Rachor & E Vanden Berghe (Eds.) Structure and dynamics of North Sea benthos. ICES Cooperative Research Report 288, 258pp.
Reiss H & Rees HL (2007). Links between infauna, epifauna, and demersal fish distributions. In: HL Rees, JD Eggleton, E Rachor & E Vanden Berghe Eds. (2007). Structure and dynamics of the North Sea benthos. *ICES Cooperative Research Report* **288**: 258pp.
Reiss H, Degraer S, Duineveld GCA, Kröncke I, Aldridge J, Craeymeersch JA, Eggleton JD, Hillewaert H, Lavaleye MSS, Moll A, Pohlmann T, Rachor E, Robertson M, Vanden Berghe E, van Hoey G & Rees HL (2010). Spatial patterns of infauna, epifauna and demersal fish communities in the North Sea. *ICES Journal of Marine Science* **67**: 278-293.
Russell DJF, Jones EL & Morris CD (2017). Updated seal usage maps: the estimated at-sea distribution of grey and harbour seals. Scottish Marine and Freshwater Science Vol 8 No 25, 25pp. doi: 10.7489/2027-1. https://data.marine.gov.scot/sites/default/files//SMFS%200825.pdf
Scottish Government (2015). Scotland's National Marine Plan: A single Framework for Managing our Seas. A report published by The Scottish Government, 144pp.
Searle KR, Butler A, Waggitt JJ, Evans PGH, Quinn LR, Bogdanova MI, Evans TJ, Braithwaite JE & Daunt F (2022). Potential climate-driven changes to seabird demography: implications for assessments of marine renewable energy development. *Marine Ecology Progress Series* **690**: 185-200.
Thaxter CB, Lascelles B, Sugar K, Cook ASCP, Roos S, Bolton M, Langston RHW & Burton NHK (2012). Seabird foraging ranges as a preliminary tool for identifying candidate Marine protected Areas. *Biological Conservation* **156**: 53-61.
Tremlett CJ, Morley N & Wilson LJ (2024). UK seabird colony counts in 2023 following the 2021-22 outbreak of Highly Pathogenic Avian Influenza. RSPB Research Report 76. RSPB Centre for Conservation Science, RSPB, The Lodge, Sandy, Bedfordshire, 118pp.
Tyler-Walters H, James B, Carruthers M (eds.), Wilding C, Durkin O, Lacey C, Philpott E, Adams L, Chaniotis PD, Wilkes PTV, Seeley R, Neilly M, Dargie J & Crawford-Avis OT (2016). Descriptions of Scottish Priority Marine Features (PMFs). Scottish natural Heritage Commissioned Report No. 406.
UKOOA (2001). An analysis of U.K Offshore Oil & Gas Environmental Surveys 1975-95. Prepared by Heriot-Watt University, UKOOA.
Van Dalfsen JA, Essink K, Toxvig Madsen H, Birklund J, Romero J & Manzanera M (2000). Differential response of macrozoobenthos to marine sand extraction in the North Sea and the western Mediterranean. *ICES Journal of Marine Science* **57**:1439-1445.
Van de Velde S, Van Lancker V, Hidalgo-Martinez S, Berelson WM & Meysman FJR (2018). Anthropogenic disturbance keeps the coastal seafloor biogeochemistry in a transient state. Scientific Reports 8: 5582. doi:10.1038/s41598-018-23925-y.
Weinzettel J, Reenaas M, Solli C & Hertwich EG (2009). Life cycle assessment of a floating offshore wind turbine. *Renewable Energy* **34**: 742-747.
Wolf J, Woolf D & Bricheno L (2020). Impacts of climate change on storms and waves relevant to the coastal and marine environment around the UK. MCCIP Science Review 2020: 132–157.

Woodward I, Thaxter CB, Owen E & Cook ASCP (2019). Desk-based revision of seabird foraging ranges used for HRA screening. Report of work carried out by the British Trust for Ornithology on behalf of NIRAS and The Crown Estate. BTO Research Report No. 724, 139pp.
Woodward ID, Thaxter CB, Owen E, Bolton M, Ward RM & Cook ASCP (2024). The value of seabird foraging ranges as a tool to investigate potential interactions with offshore wind farms. *Ocean and Coastal Management* **254**: 107192.
Yellishetty M, Haque N & Dubreuil A (2012). Issues and Challenges in Life Cycle Assessment in the Minerals and Metals Sector: A Chance to Improve Raw Materials Efficiency. In: Sinding-Larsen & Wellmer (Eds.) Non-Renewable Resource Issues. Springer Netherlands, pp 229-246.