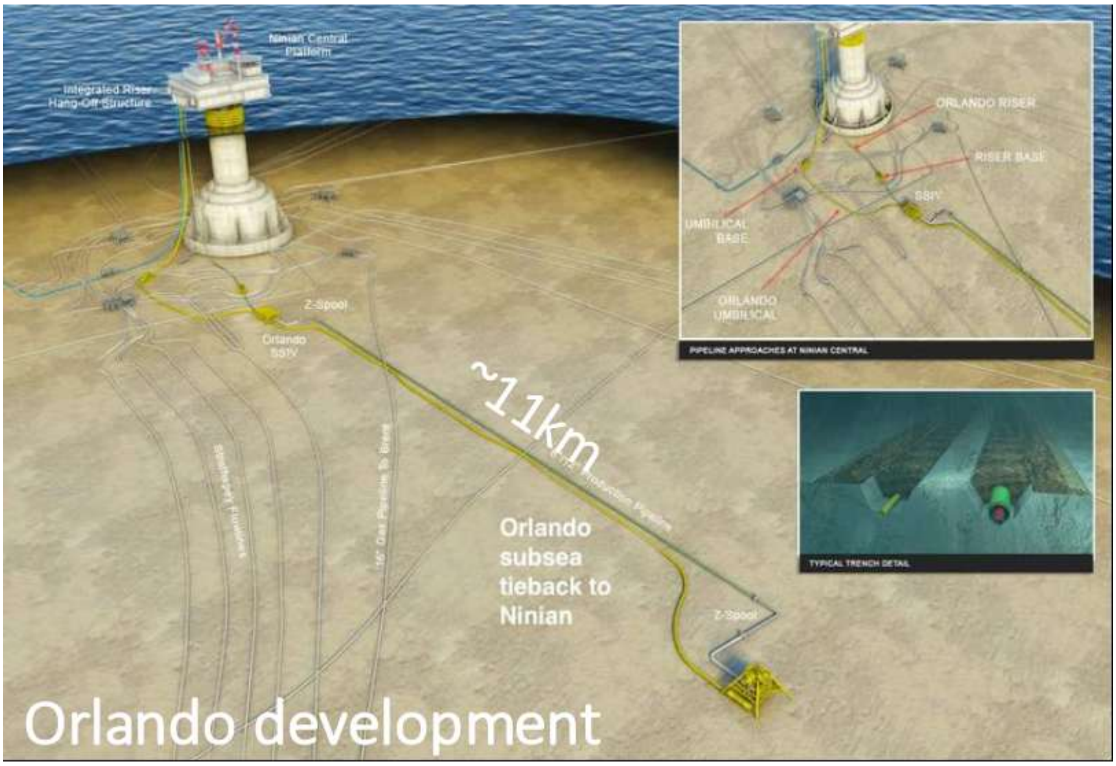

Document Title: **Orlando Field Decommissioning – Comparative Assessment Consultation Draft**

Document Number: **ORL-SECL-HSE-DOC-0007**

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Contents

Figures

Tables

Abbreviations

BAT/BEP	Best Available Technique/Best Environmental Practice
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
CNRI	CNR International (UK) Limited
CoP	Cessation of Production
DECC	Department of Energy & Climate Change, replaced by BEIS
DESNZ	Department of Energy Security and Net Zero
DP	Decommissioning Programme
EA	Environmental Appraisal
HSEQ	Health, Safety, Environment, and Quality
ICES	International Council for the Exploration of the Sea
INTOG	Innovation and Targeted Oil and Gas
IOGP	International Association of Oil and Gas Producers
JNCC	Joint Nature Conservation Committee
LTOBM	Low Toxicity Oil Based Mud
MAT	Master Application Template
MBS	Multibeam Echosounder
MNCR	Marine Nature Conservation Review
NCMPA	Nature Conservation Marine Protected Area
NCP	Ninian Central Platform
NNS	Northern North Sea
OBM	Oil Based Mud
OEUK	Offshore Energies UK
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
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

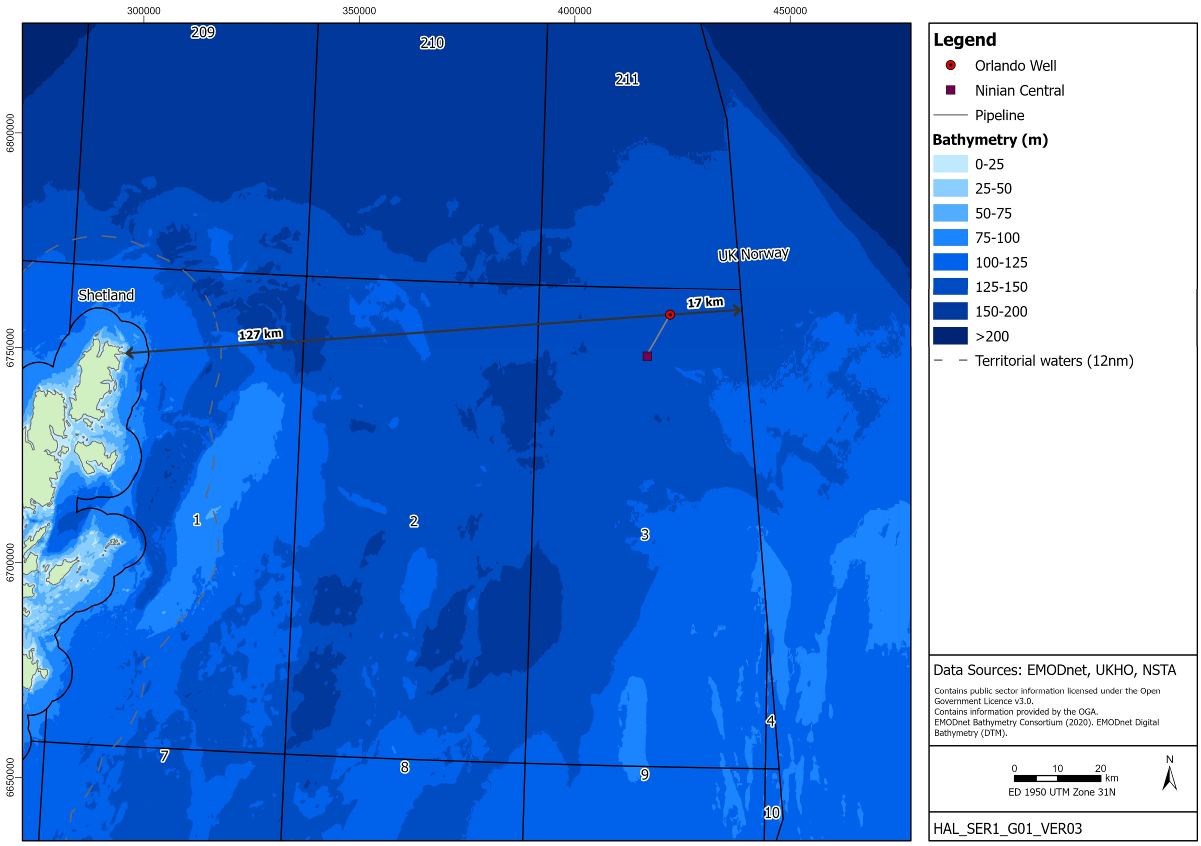
tCO_2eq	Tonnes carbon dioxide equivalent. Standard unit for measuring the impact of different greenhouse gases on climate change, expressed in terms of the amount of CO_2 that would produce the same warming effect.
Te	Tonnes

1.0 Introduction

1.1 Field Overview 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. Due to declining production rates and Cessation of Production (CoP) of the host facility, the NCP, Serica anticipate Orlando CoP Q1-Q2 2027, and are preparing the engineering and environmental input required to inform the Decommissioning Programmes (DP) and Environmental Appraisal (EA).

Figure 1.1: Location of the Orlando Field



The Orlando field was discovered by the 3/3-11 appraisal well drilled by Chevron in 1988/89. The development of the field was approved in 2012/2013 and the drilling of the single production well and installation of the pipeline system was completed in 2018/2019, with first oil in 2019.

1.2 Purpose, Regulatory Context and Approach

The OSPAR Decision 98/3 on the Disposal of Disused Offshore Installations sets out OSPAR Contracting Parties obligations on the decommissioning of offshore installations. Pipelines do not fall within the definition of offshore installations and are not covered by this OSPAR Decision, and there are currently no international guidelines on the decommissioning of disused pipelines

In the UK, the principal legislation for the decommissioning of disused offshore installations and pipelines is the *Petroleum Act 1998* ("the 1998 Act"). Under Part IV of the 1998 Act, and amendments to it through the Energy Act 2008, operators proposing to decommission an offshore installation or submarine pipeline must submit a Decommissioning Programme (DP); the Offshore Petroleum Regulator for Environment and Decommissioning (OPRED) (also referred to in this document as the Regulator) which sits within the Department for Energy Security and Net Zero (DESNZ), is the Regulator responsible for ensuring that the requirements of the Petroleum Act 1998 are complied with.

Where the programme includes the decommissioning of pipelines and umbilicals, Regulator decommissioning guidance (BEIS 2018) indicates a Comparative Assessment (CA) must be carried out to examine all feasible options to inform decisions relating to the decommissioning of those pipelines. Oil and Gas UK guidance (OGUK 2015) expanded on that initially provided by DECC (2011), with the aim of encouraging a consistent approach to the CA process in the UK. The CA for the Orlando pipeline and umbilical has been drafted taking account of these guidance documents.

This document describes the CA process, the outcomes and the recommended options for the decommissioning of the Orlando pipeline and umbilical.

1.3 Consultation and Stakeholder Engagement

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, and which are relevant to the CA.

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 North Sea Transition Authority (NSTA) (online meetings – 16th September 2024, 16th April 2025, 1st September 2025), 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 Project Overview

2.1 Orlando Facilities Excluded from Comparative Assessment

In accordance with Regulator guidance (BEIS 2018), there is a requirement to remove elements of a development, e.g. subsea installations and small diameter pipelines, and those applicable to Orlando are shown below (reference to PWA identification number (Ident. No.) included where relevant, see Table 2.2 of the DP):

- Subsea installations
  - Production Xmas Tree including Wellhead Protection Structure (WHPS)
  - Production riser base and clump weight
  - Umbilical riser base and clump weight
- Pipelines
  - Dynamic riser (PL4383 Ident. No. 6)
  - Dynamic riser umbilical (PLU4384 Ident No. 1)
  - Surface laid spools (PL4383 Ident. Nos. 1, 2 and 4) and flexible jumpers
  - Orlando Subsea Isolation Valve (SSIV, PL4383 Ident. No. 5) structure
- All exposed mattresses and grout bags (see Protective Materials below)

As these are to be fully removed and returned to shore for reuse, recycling or disposal, these are not considered further in this comparative assessment.

Protective Materials

Concrete mattresses and grout bags are located at the end of the production pipeline trench transitions at the Orlando well and on approach to the SSIV at the NCP end of the pipeline, and cover the pipeline and tie-in spools, up to the wellhead and SSIV. Mattresses also cover the umbilical trench transition and its route to the wellhead, and from the end of trench transition to the SSIV towards the NCP, as well as at pipeline crossings of the dynamic riser and dynamic riser umbilical.

From as-laid information (at installation) and the 2024 inspection survey, the estimated number of mattresses (buried, at trench transitions and estimated to be recoverable) is shown in Table 2.1.

Table 2.1: Estimated mattresses present at Orlando and to be removed

	Mattresses buried[1]	**Mattresses at trench transitions[1]**	**Exposed mattresses to be recovered**
Pipeline	9	2	47
Umbilical	3	1	64
Dynamic riser	-	-	7
Dynamic riser umbilical	-	-	11
Total	**12**	**3**	**129**

Note: [1]Mattresses buried under rock will be decommissioned in situ and mattresses at trench transitions (where these may be partially buried) to be assessed at time of decommissioning for leaving in situ, or recovery.

The mattresses used at Orlando consist of linear concrete elements linked together with high strength non-biodegradable polypropylene rope. Grout bags (of which there may be individual 25kg bags as well as larger bags (1 tonne containing up to 40x25kg bags) are used along surface laid spools on approach to the well and SSIV and at tie in locations as well as at dynamic riser and umbilical crossings within the NCP 500m zone (34 tonnes in total).

Exposed mattresses and grout bags will be recovered where the condition of the mattresses make it viable to do so, in keeping with current guidance (BEIS 2018). Where mattresses have been used in conjunction with rock (e.g. at pipeline crossings) and are completely buried (Table 2.1), then these mattresses will be decommissioned *in situ*. Where mattresses are used at trench transitions and may be partially buried (Table 2.1), these will be fully removed (if practical difficulties are encountered, Serica will consult with OPRED to agree an alternative approach).

Protective materials were installed in 2018 and the 2024 inspection survey suggests no integrity issues with the mattresses. However, decommissioning activities may not commence until 2027, by which time the mattresses will have been *in situ* for 9 years and there is the potential for them to break up while attempting to recover them. The fragmented material would be in the form of single or several concrete segments linked by short sections of polypropylene rope. Most of such material is expected to remain over-trawlable (and analogous to the naturally occurring cobbles and boulders in the area). If mattress fragments are picked up by fishing nets there is the potential for some damage to the catch although again this can be considered analogous to naturally occurring rock in the area. For protective material that is recovered, and following the waste hierarchy, Serica will look to identify options to reuse these, using licensed specialist contractors. If alternative, feasible options cannot be identified, the material will be disposed of to landfill; this worst case has been assumed for the purposes of assessment.

2.2 Orlando Facilities Considered for Comparative Assessment

The following section provides an overview of the infrastructure covered in the Orlando DP that are considered for CA, and the feasible options under consideration for their decommissioning; the Orlando field layout is shown in Figure 2.1.

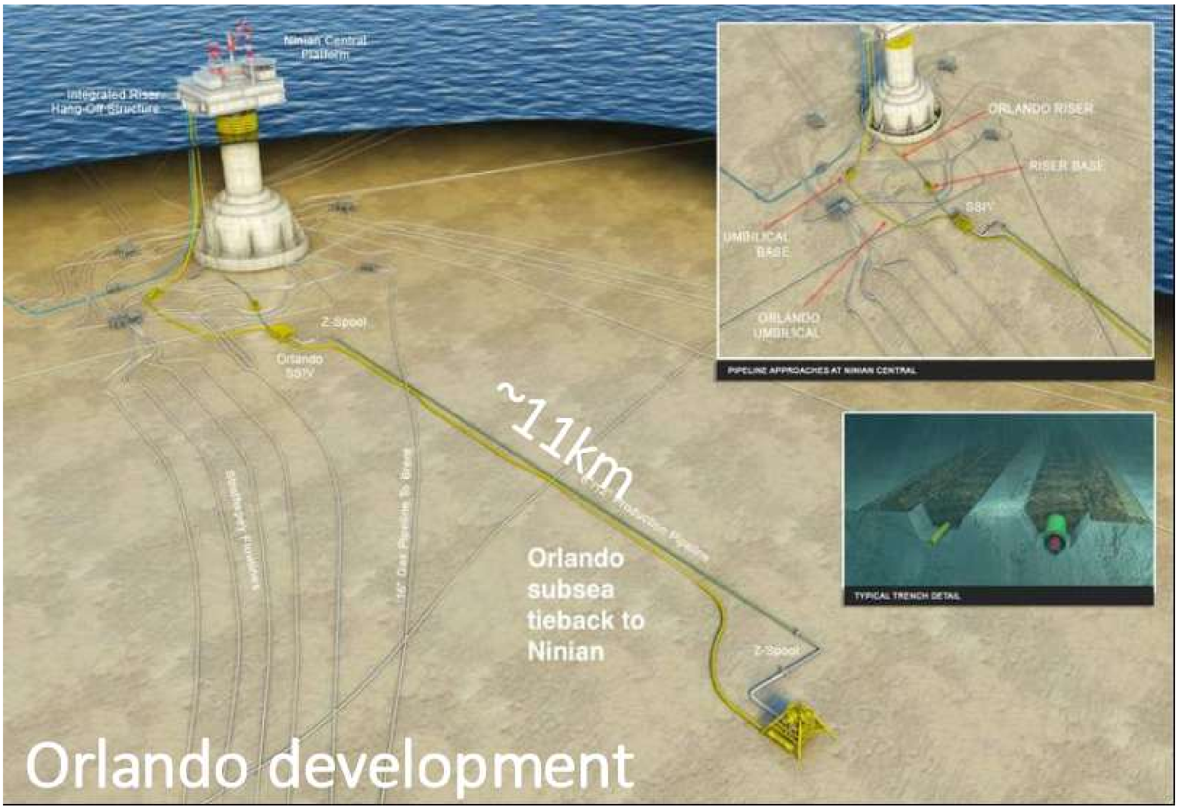
Production pipeline and umbilical

The infrastructure considered in this CA is:

Orlando production pipeline (PL4383 Ident. No. 3): 10.813km, 8"/12" pipe-in-pipe production pipeline which was trenched on installation, and crosses the not-in-use 12" Alwyn to South Cormorant oil pipeline (PL1526), and the active 16" NCP to Brent gas pipeline (PL917), within the NCP 500m safety zone.

Orlando umbilical (PLU4384 Ident No. 2): 11km static umbilical, in a separate trench to the pipeline, with an outside diameter of 169mm. The umbilical also crosses the 12" Alwyn to South Cormorant oil pipeline (PL1526), and the 16" NCP to Brent gas pipeline (PL917).

Figure 2.1: Orlando field layout



At the time of submitting this CA, the production pipeline and umbilical are still in use, with CoP anticipated in Q1-Q2 2027. Prior to decommissioning, the pipeline will be cleaned and flushed. Options for this cleaning and flushing programme are being discussed with CNRI, options for cleaning the chemical and hydraulic cores within the umbilical are also being investigated. Whilst chemical cores could be flushed through into the pipeline via the tree and dropdown spool, it is proposed that hydraulic lines will not be flushed and instead vented to sea when cores are cut (see Orlando Environmental Appraisal document (ORL-SECL-HSE-DOC-0009)).

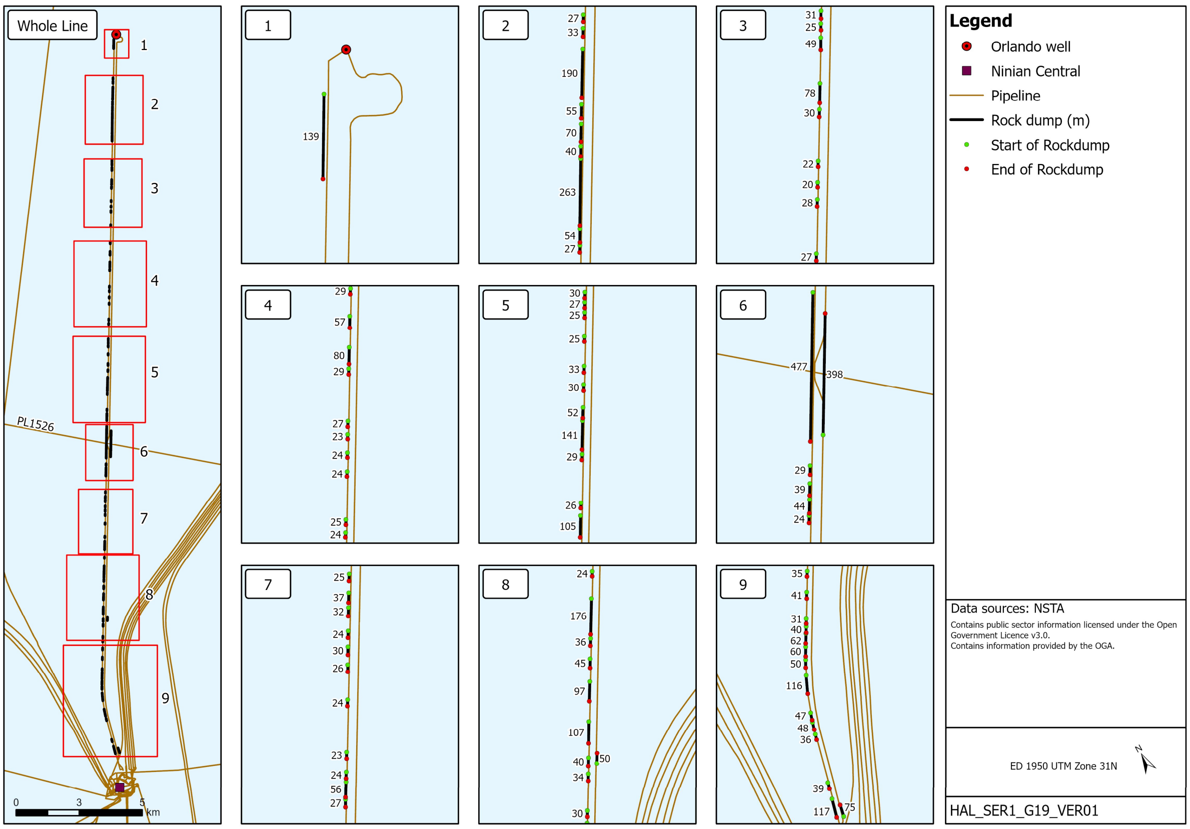
Prior to any decommissioning activities, Serica will ensure the production pipeline has been cleaned and flushed with the contents left being seawater. The aim of the process is to clean the pipeline to as near hydrocarbon free as possible, with only residual hydrocarbon present.

Serica has conducted a wax deposition study to assess the volume of wax expected to remain in the length of the Orlando pipeline at CoP. The study estimates that wax accumulation at CoP will be less than 1% of the total pipeline volume. As part of relevant permit applications, Serica will apply BAT/BEP to minimise any discharges of wax to the marine environment.

At installation, the pipeline and umbilical were trenched separately and backfilled to a minimum depth of 0.6m. Exceptions are at trench transitions, including at crossings (where the umbilical enters the main pipeline trench), and approach to NCP and the wellhead, where the lines are covered in protective material to a minimum depth of 0.6m.

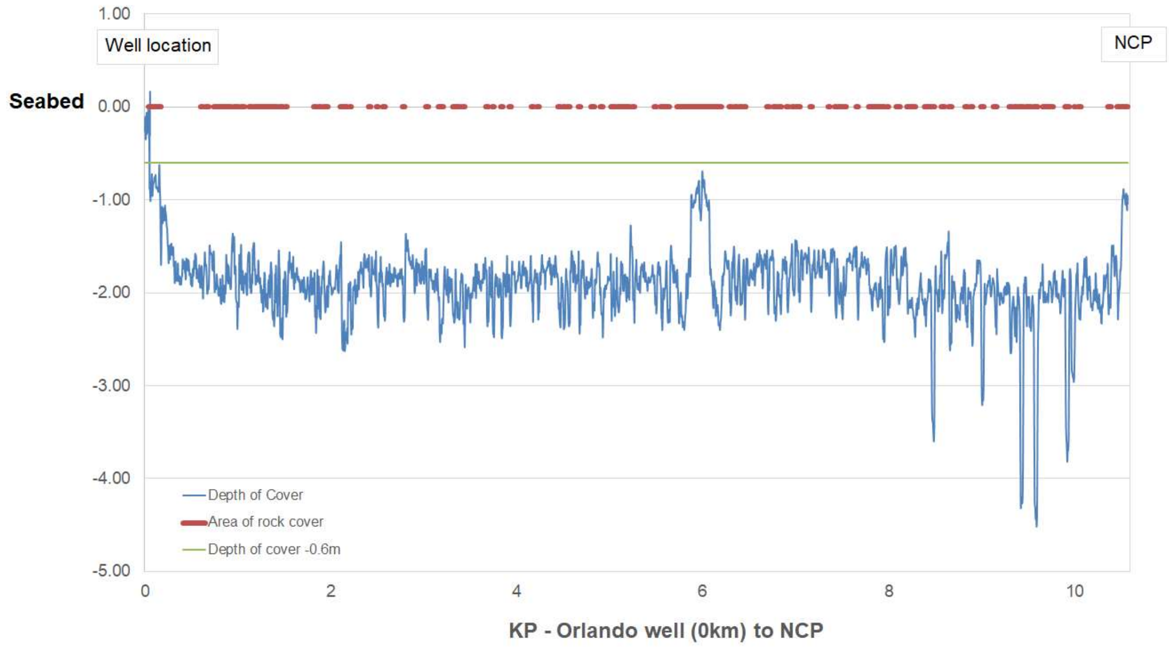
Rock cover overlays the production pipeline and umbilical at strategic locations, including crossings (3,836 tonnes at the Brent crossing and 9,476 at the South Cormorant crossing), and at trench transitions. Rock covers the trench transition of the umbilical towards the SSIV. While the pipeline was mechanically backfilled in its trench, it has been subject to a significant volume of rock deposits to mitigate against potential upheaval buckling (23,497 tonnes on pipeline, 162 tonnes on static umbilical). The total volume of rock cover on the pipeline and umbilical estimated at 36,971 tonnes. Information from a 2024 ROV inspection survey indicated that there were 79 separate rock deposits over the pipeline covering a total extent of 4,350m and 3 separate rock deposits over the static umbilical covering a total extent of 524m (Figure 2.2). It is noted that the survey did not include the NCP 500m zone and therefore did not include the Brent A crossing - estimated at approximately 305m extent over both the pipeline and umbilical from As-laid drawing.

Figure 2.2: Rock cover associated with the Orlando pipeline (pipeline on left in images) and umbilical (on right)



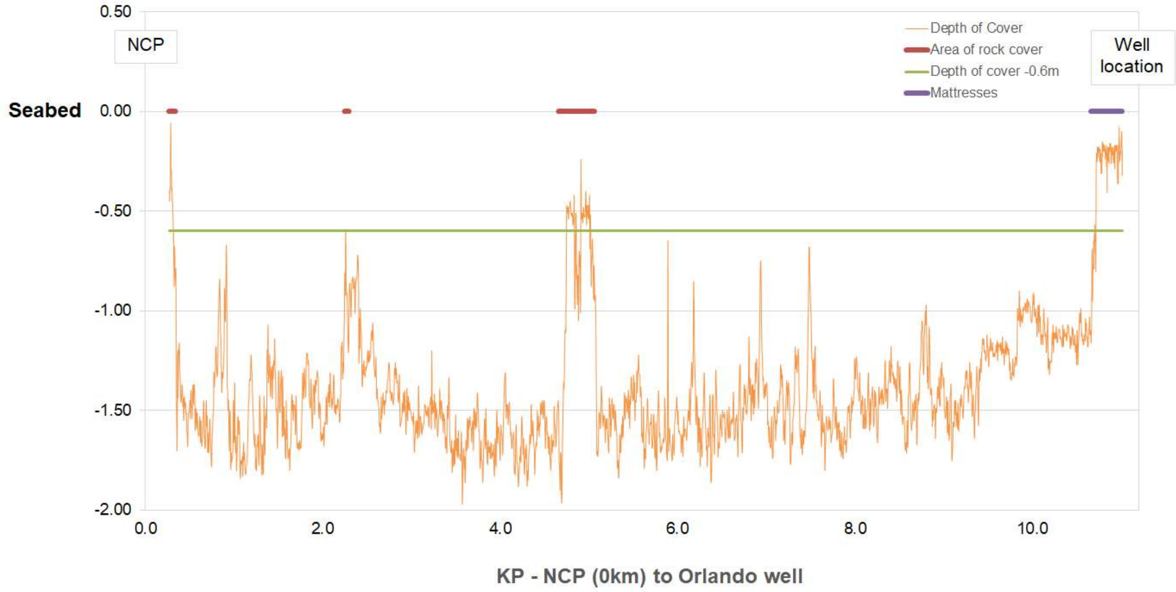
No areas of free-spanning pipeline, or pipeline exposure were recorded in the recent 2024 pipeline inspection (see Figure 2.3 and Figure 2.4 which indicate depth of burial from the same inspection).

Figure 2.3: Pipeline depth of cover and location of protection materials



Note: At approximately KP 6.0 where depth of cover approaches 0.6m, pipeline crosses the 12" Alwyn to South Cormorant oil pipeline (PL1526) and there is associated rock cover over the crossing location.

Figure 2.4: Umbilical depth of cover and location of protection materials



Note: At approximately KP 5.0 where depth of cover <0.6m, the umbilical crosses the 12" Alwyn to South Cormorant oil pipeline (PL1526) and there is associated rock cover over the crossing location.

2.3 Environmental Summary

A seasonal summary of the Orlando environment is provided below; a detailed description of the environmental baseline is provided in the Orlando Environmental Appraisal [ORL-SECL-HSE-DOC-0009]

Aspect	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Climate and hydrography	Water depths at Orlando are *ca*. 141m with a gradual shallowing along the pipeline route to the NCP. 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.											
Seabed and sediments	Seabed is generally flat at the Orlando well location, with a gradient of less than 0.1° towards the north west. The sediments within the 2021 seabed 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 one station (closest to the well), which was classed as 'fine sand'. The highest gravel content was observed at stations closest to the well, suggesting that the sediment around the well was modified. Stations around the well displayed evidence of a mixed input of an OBM and a LTOBM. The highest total hydrocarbon content (THC) value was observed at station G03 (73µg/g), exceeding the OSPAR ecological effects threshold (EET) (50 µg/g). There was a decrease in total barium concentrations with distance from the well, with station G03 also displaying the highest total barium concentration. The higher barium concentrations were likely to be from the redistribution of cuttings materials (including drilling fluids) from drilling activities. Stations closer to well also had slightly higher concentrations of some metals (e.g. copper, nickel, lead and zinc) which often associated with drill cuttings.											
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.											
	Key: Period of increased plankton abundance shown in darker blue											

Aspect	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Benthos	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 cirrifera*, *Aricidea catherinae*, *Exogone verugera* (polychaetes) and *Thyasira* spp. 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. The epifauna of the northern North Sea can be characterised at water depths of 167m (112–205m) by echinoids *Echinus* spp., the hermit crabs *Anapagurus laevis*, *Pagurus prideaux*, *P. bernhardus*, and the gastropod *Colus gracilis*. Two other northern North Sea epifaunal assemblages were described: in water depths of 128m (93-165m) characterised by the echinoderm *Astropecten irregularis*, the crustacean *Crangon allmanni*, *Echinus* spp., A. *laevis*, and the polychaete *Hyalinoecia tubic*ola; and 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*. The phyletic composition of the macrofauna sampled by the 2021 survey was generally similar to the 2011 survey and considered typical of the northern North Sea (NNS). Faunal assemblages considered to be all variations of one homogenous community and typical of soft sediment communities within the NNS. Two EUNIS biotopes were observed in a mosaic at both the well site, and across the pipeline: 'Faunal communities of Atlantic circalittoral sand' and 'Faunal communities of Atlantic circalittoral mixed sediment'; consistent with the 2011 survey. Statistical analysis found no correlation between the macrofaunal community and contamination from metals or hydrocarbons, nor were there strong differences in the faunal community in relation to sediment composition.											
	Sensitivity considered similar throughout the year											
Fish	The Orlando infrastructure lies within ICES rectangle 50F1. This overlaps with reported spawning grounds of several commercially important fish species: whiting (Feb-Jun, low intensity); sandeel (Nov-Feb, low intensity); Norway pout (Jan-Apr); saithe (Jan-Apr); cod (Jan-Apr, high intensity (Ellis *et al.* 2012 and rare – Gonzalez-Irusta & Wright 2016); haddock (Feb-May). 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. Nursery grounds for species are also reported from ICES rectangle 50F1: haddock, whiting, Norway pout, sandeels, mackerel, blue whiting, spurdog, herring, ling, hake and monkfish.											
	4	**6**	**5**	**5**	**2**	**1**	**0**	**0**	**0**	**0**	**1**	**1**
	Key: 1 = 1 species spawning, 2 = 2 species spawning etc											
Birds	The 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 (Orlando is >120km from shore) and the availability of prey species; although Orlando is within the maximum foraging ranges of some bird species (e.g. northern fulmar and northern gannet) breeding at colonies on Shetland. 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). Where no data coverage is available, JNCC guidance was used, to reduce the extent of coverage gaps (these are shown in red and highlighted orange, below); this has also resulted in October having a medium sensitivity. All of the surrounding blocks also record low sensitivity, with some months with no coverage, with the exception of Block 3/2 with medium sensitivity in Sept (and Oct, with the JNCC method applied).											
	5	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**4**	**4**	**5**	**5**
	Key: 1 = Extremely high, 2 = Very high, 3 = High, 4 = Medium, 5 = Low, N = No data, red + orange highlight = use of JNCC data gap method											

Aspect	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Marine mammals	Block 3/03 lies within survey stratum NS-F of the SCANS-IV survey. Harbour porpoise was the most abundant species recorded in the survey stratum (0.4393 per km^2), followed by white-beaked dolphin (0.3056 per km^2), and a low density of minke whale (0.0271 per km^2). Harbour porpoise are present year-round, although sightings peak in this area in July and August. The area is distant from seal breeding colonies and haul-out sites; very low densities of both grey and harbour seal are present in the area.											
	Key: Darker colours reflect months when marine mammals most frequently observed											
Conservation sites, habitats and species	None of the Orlando infrastructure is within, or near a marine protected area (i.e. Nature Conservation Marine Protected Area (NCMPA), Special Area of Conservation (SAC) or Special Protected Area (SPA). The closest of these is the Pobie Bank Reef SAC, located *ca*. 81km to the west of Orlando. All other designated sites, e.g. North-East Faroe-Shetland Channel NCMPA, the Faroe-Shetland Sponge Belt NCMPA and the Central Fladen NCMPA are >100km distant. The OSPAR listed habitat 'Sea pen and burrowing megafauna communities' is likely to be present in the Orlando area, with a 2021 seabed survey habitat assessment recording qualifying megafaunal burrows at most transects as being at least 'frequent' on the Marine Nature Conservation Review (MNCR) superabundant, abundant, common, frequent, occasional, rare (SACFOR) scale.											
Other Users	Demersal species have generally represented the highest total weight and value of landings from the Orlando area, followed by pelagic and shellfish species. However, pelagic catches have varied significantly between the years, with the sector representing the highest total weight and value of landings in 2023 and 2024. Fishing effort in the area is low to moderate with demersal gear the predominant type used. 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. There is relatively limited fishing activity in 50F1 (primarily bottom trawl), with less than 400 days a year recorded for two of the last three years of data (2023-2024). The area is within a wider mature oil and gas province, with considerable infrastructure in adjacent Blocks and the wider area. 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 with offshore wind development work; the closest of these to the Orlando location is 323km away. 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. There are no dredging areas, or marine disposal sites in the vicinity and no telecommunication cables cross the proposed inspection survey 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.											
	Sensitivity considered similar throughout the year; overall considered low											

3.0 Comparative Assessment Process

3.1 Initial screening of options

Serica initially identified a comprehensive list of potential decommissioning options for the Orlando pipeline and umbilical which included an initial review of those provided as an example in the OPRED guidance (BEIS 2018). Several options, such as backfill an open trench (both Orlando lines trenched and backfilled), remove by reverse S lay (option considered for large diameter, typically concrete coated pipelines, unlike the Orlando production pipeline which has a small diameter and is not concrete coated), remove by towing (e.g. bundles, Orlando production is pipe in pipe, but not a bundle), were discounted early in the process.

The following options were considered in the option screening assessment:

1. Full removal – full removal of both (trenched and buried) pipeline and umbilical, including those sections under rock crossings (includes deburial)

2. Partial removal – remove (trenched and buried) sections of pipeline and umbilical, leaving those sections under rock *in situ*

3. Leave *in situ* – the (trenched and buried) pipeline and umbilical are decommissioned *in situ* except surface laid sections which are recovered (remediation of cut ends).

The option screening process then reviewed and screened out unrealistic options for the decommissioning of the production and umbilical lines due to clear technical issues and/or clearly unacceptable safety risks.

Reverse reel and cut and lift approaches were considered for the full and partial removal options. Due to the length of the pipeline and umbilical there is considerable technical difficulty in removing rock cover over crossings, trench transitions and spot rock deposit locations (associated with full removal option), and deburial of extensive lengths of pipeline and umbilical prior to removal, followed by mechanical backfill of the trench (associated with both full and partial removal options). There is a high safety risk with respect to reverse reeling the pipeline as parts of it may have a thinner wall thickness (i.e. due to corrosion), and there is an increased risk that the pipeline may part in an uncontrolled manner during the re-reeling process, posing a high risk to personnel onboard and increasing the complexity of recovering separated pipe that falls to the seabed.

Full and partial removal achieved by individually cutting and removing each *ca*. 12m section of pipeline or umbilical would require hundreds of separate cuts. This would come with an increased safety risk to deck/onshore personnel when the pipe/umbilical is back loaded due to large number of cut sections to be handled. OGUK (2013) notes that the cut and lift method creates greater risks to the personnel carrying out the offshore operations and therefore it is preferable to limit that risk exposure by avoiding extensive offshore cut and lift programmes.

3.2 Options taken forward for Comparative Assessment

Options considered for the production pipeline (PL4383 Ident. No. 3)

- **Pipeline Option A**: Leave *in situ* all sections, including sections under existing rock. Cut ends remediated to a minimum depth of 0.6m.

- **Pipeline Option B**: Partial recovery by reverse reel, sections currently under rock (e.g. crossings), along with spot rock cover, would be decommissioned *in situ*. Cut ends remediated to a minimum depth of 0.6m.

Options considered for the umbilical (PLU4384 Ident. No. 2)

- **Umbilical Option A**: Leave *in situ* all sections, including sections under existing rock. Cut ends remediated to a minimum depth of 0.6m.

- **Umbilical Option B1**: Partial recovery by reverse reel. Sections currently under rock (e.g. crossings), along with spot rock cover, would be decommissioned *in situ*. Cut ends remediated to a minimum depth of 0.6m.

- **Umbilical Option B2**: Partial recovery by cut and lift. Sections currently under rock (e.g. crossings), along with spot rock cover, would be decommissioned *in situ*. Cut ends remediated to a minimum depth of 0.6m.

For all options, the remediation of cut ends to a minimum depth of 0.6m will be by rock placement which due to the permanent nature of the deposits is considered worst case.

For those options where *in situ* decommissioning is proposed, some form of future monitoring will be required primarily to ensure the area remains safe for other users of the marine environment. The extent and frequency of this monitoring will be determined on a risk basis and agreed after discussions with OPRED (see Section 6.3).

While previously buried material can become exposed this is considered unlikely in the Orlando area due to the weak currents and sediment type/mobility and that neither freespans nor pipeline exposures have occurred along either the production or umbilical routes.

The risk to other users has also been considered in the context of the extent the area is used by 3rd parties. Section 2.3 indicates that fishing effort in the area is low to moderate, and dominated by demersal trawls, and this, along with the nature and extent of material decommissioned *in situ*, all of which is trenched and buried, will support the formulation of a future monitoring programme which will be discussed with the regulator.

Elements common to all options

The following elements are common to all options:

- The cutting (using hydraulically operated saws or shear cutters), and removal of risers, tie-in spools and jumpers at the well and SSIV
- The removal of exposed protective material (mattress and grout bags including individual grout bags and larger sacks containing multiple grout bags)

In all cases, the removal of protective material and the cutting and removal of risers, tie-in spools and jumpers will result in an operational safety risk to personnel; the base case is not to use divers, with ROV/hydraulic equipment (grabs/cutters) being the preferred option, however, where this is not possible, divers may have to be used. While this area of the North Sea is not subject to vigorous currents, such as those in the southern North Sea, the divers would be working at depth (water depth across the area are *ca.* 141m).

These activities will also likely result in some disturbance to seabed sediments and communities. This disturbance would be localised and limited to benthic communities colonising the hard surfaces of the protective material and those immediately adjacent to the pipeline and umbilical.

Since these effects, common to all options, do not differentiate between the options considered in this CA, they are not considered further in this document. They are however fully assessed within the supporting Orlando Environmental Appraisal (ORL-SECL-HSE-DOC-0009) along with the potential impacts of the preferred option.

4.0 Orlando Comparative Assessment

The approach to CA used for Orlando draws from regulator and industry guidance, and uses a methodology and scoring system to assess and evaluate the relative performance of each of the potential decommissioning options for the pipeline and umbilical, taking into consideration qualitative and quantitative data.

4.1 Comparative Assessment Criteria and Scoring

Criteria for evaluating the relative potential impact/risk of the options were developed with reference to OSPAR Decision 98/3, and regulator (BEIS 2018) and industry (OGUK 2015, IOGP 2024) guidance, covering the following areas:

1. Safety
2. Environmental
3. Technical
4. Societal
5. Economic

Sub-criteria were derived (see Table 4.1) covering:

- The potential risk to life or injury of, personnel of each option
- All potential impacts (including cumulative effects) on the marine environment, including exposure of biota to contaminants, other biological impacts arising from physical effects, impacts on, and interference with, other legitimate uses of the sea
- The potential impact on species of conservation interest (Orlando facilities not within, or close to a designated conservation site)
- All potential impacts on other environmental receptors, including from emissions to the atmosphere
- Consumption of natural resources and energy associated with reuse and recycling
- Potential risk of project failure and technical challenge
- Potential impacts on amenities, the activities of communities and on future uses of the environment
- Costs of each option

The sub-criteria were scored on a five point scale ranging from 1 (Very Low) through to 5 (Very High), where 1 represents best performance/least significant impact/lowest risk and 5 represents worst performance/largest significant impact/highest risk.

Scores for the sub-criteria were then weighted on a three point scale (see Table 4.2) according to the level of definition and understanding of methods, equipment and hazards ("uncertainty"), ranging from Low Uncertainty – high definition and understanding of methods, equipment and hazards (weighting x 1), to High Uncertainty – low level of definition and understanding of methods, equipment and hazards (weighting x 2).

Final scores for each criterion were recorded in matrix format (see Appendix A) with relative ranking for each option derived from the weighted scores using the matrix in Table 4.3.

Where quantitative data are used, these have been based on measurable data i.e. CO_2 emissions (tonnes) and cost estimates (£). Qualitative assessment is based on a range of sources including regional and site specific data, supporting documents including inspection reports, and other reference material including similar decommissioning documentation (i.e. pipeline comparative assessments and environmental appraisals) from projects in the wider North Sea.

Table 4.1: Sub-criteria used for Comparative Assessment

		1	2	3	4	5
Safety	Risk to personnel offshore during decommissioning operations	No risk	Minor/first aid	Medical aid/lost time injury	Permanent disability/fatality	Multiple fatalities
Safety	Risk to personnel onshore during decommissioning operations	No risk	Minor/first aid	Medical aid/lost time injury	Permanent disability/fatality	Multiple fatalities
Safety	Risk to divers during decommissioning operations	No risk	Minor/first aid	Medical aid/lost time injury	Permanent disability/fatality	Multiple fatalities
Safety	Risk to 3rd parties and assets during decommissioning operations	No risk	Loss of access to operational area	Interference with 3rd party operations altering safety risk	Damage to 3rd party asset/damage to vessel	Damage to 3rd party asset requiring remediation/loss of vessel
Safety	Residual risk to 3rd parties	No risk	Potential snagging risk	Damage/loss of fishing gear	Damage to vessel	Loss of vessel
Environment	Chemical discharge	None	PLONOR chemicals only	No warnings or substitution labels RQ<1	Warning labels RQ>1	Warnings and substitution labels RQ>1
Environment	Hydrocarbon release from pipelines	None	<50 litres	50 litres - 500 litres	501 litres - 1000 litres	>1000 litres
Environment	Seabed disturbance and/or habitat alteration including cumulative impact	None	<10% of existing footprint	10% - 50% of existing footprint	>50% - 100% of existing footprint	>100% of existing footprint
Environment	Atmospheric (CO_2) emissions	<500tCO_2 eq	500-1,000tCO_2 eq	1-2,000tCO_2 eq	2-3,000tCO_2 eq	>3,000tCO_2 eq
Environment	Proportion of material recycled	>80%	50% - 80%	30% - <50%	10% - <30%	<10%
Environment	Proportion of material landfilled	0%	<10%	10% - 30%	>30% - 50%	>50%
Environment	Conservation sites and species (including noise effects)	No impact	Potential effects but unlikely to be detectable as within normal variability	Minor detectable effects with rapid recovery	Effects detectable, not affecting site integrity or species population	Significant effects on site integrity or population
Technical	Technical feasibility	Routine operations with high confidence of outcomes Very low risk of failure	Routine operations with good confidence of outcomes Low risk of failure	Non-routine operations but with good experience base Low risk of failure	Non-routine operations with limited experience base Moderate risk of failure	Untried technique Higher risk of failure
Technical	Weather sensitivity	Operations not weather sensitive	Operations are little affected by weather	Requires good weather window	Requires typical summer good weather window	Requires long good weather window
Societal	Residual effect on fishing, navigation or other access (including cumulative)	No effect	Access to area unrestricted	Access to area with charted obstructions	Access to area with uncharted debris and obstructions	Closed access to area
Societal	Coastal communities	No impact	Impacts within normal variability of onshore operations	Short term nuisance during onshore operations	Medium term nuisance during onshore operations	Long term nuisance during onshore operations
Economic	Total cost (criteria for pipelines only)	<£5m	£5-10m	£10-15m	£15-20m	>£20m
Economic	Total cost (criteria for umbilicals only)	<£5m	£5-10m	£10-15m	£15-20m	>£20m
Economic	Residual liability including monitoring and remediation if necessary	No residual liability	Surveys and remediation unlikely to be required	Surveys and remediation requirement anticipated but at declining frequency	Surveys and remediation likely to be required in each 5 year period	Annual survey and potential for remedial work

Table 4.2: Levels of uncertainty weighting

Increasing uncertainty →		
x 1 (Low)	x 1.5 (Medium)	x 2 (High)
High level of definition and understanding of methods, equipment and hazards	Moderate level of definition and understanding of methods, equipment and hazards	Low level of definition and understanding of methods, equipment and hazards

Table 4.3: Ranking of weighted scores

	Uncertainty		
Impact/ Consequence	1 (Low)	1.5 (Medium)	2 (High)
5 (Very High)	5	7.5	10
4 (High)	4	6	8
3 (Medium)	3	4.5	6
2 (Low)	2	3	4
1 (Very Low)	1	1.5	2

Options

Low **Medium** **High**

Best → **Worst**

4.2 Comparative Assessment Workshop

Serica held an initial meeting with members of the Orlando Decommissioning Team (the team) (see below), to:

- Agree the current status of the pipeline and umbilical including protective material
- Identify all potential options for their decommissioning and agree feasible options to take forward to comparative assessment (option screening assessment)
- Review scoring criteria and methodology for the Comparative Assessment

While considering each option in turn, the adequacy of the information base was also reviewed, and any key gaps identified (see further studies/technical notes).

A workshop was subsequently held to assess those options taken forward for CA. The workshop involved a multi-disciplinary team including:

- Ross Cameron (Orlando Asset Manager – Serica)
- Raj Lal (HSEQ Lead – Serica)
- Angus Laurie (Environmental and Compliance Lead – Serica)
- Shaun Finch (Pipeline Technical Authority – Petrex)
- James Smith (Principal Engineer – Petrex)
- Ronald Massie (Senior Wells Engineer – Petrofac)
- Suzanne Lumsden (Principal Consultant – Hartley Anderson)
- Richard Trueman (Principal Consultant – Hartley Anderson)

The workshop commenced with brief presentations re-affirming the requirement for a comparative assessment to be carried out and that options for pipeline and umbilical decommissioning must be considered on their merit. This must be supported by a robust evidence base, an environmental overview of the area, including a description of any features of conservation interest that may be present, if the infrastructure is not located within a designated site and an overview of the options from an engineering perspective. Information from the original development installation (e.g. as laid drawings), along with pipeline inspection information (e.g. Fugro 2024 ROV inspection survey), commissioned engineering reports (Petrex 2025), were used to inform the CA. Using the agreed criteria and methodology, and the supporting information available, the team then considered each option in turn, within their area of expertise, assigning impact values and level of uncertainty values to generate an overall assessment of the option.

The outcome of the CA process and the resulting recommended decommissioning option for the pipeline and umbilical is described in Section 5 below.

5.0 Orlando Comparative Assessment Outcomes

5.1 Safety

Safety risks are of high importance in the consideration of the decommissioning options, particularly where experience in some operations is relatively limited to date and where the work could involve high levels of human activity on location for long durations. Operations which take long periods of time may also be subject to extension through weather.

For both the pipeline and the umbilical, the highest cumulative number of vessel days is predicted for the partial recovery options (Umbilical Option B2 partial recovery by cut and lift = 131 days (this figure also includes partial recovery of the pipeline by reverse reel (Pipeline Option B)). Similarly, the combined number of vessel days associated with partial recovery by reverse reel of both the pipeline (Pipeline Option B) and umbilical (Option B1) was estimated at 93 days. The shortest duration is for the leave *in situ* options (Pipeline Option A and Umbilical Option A) at 26 days (represents combined days for the pipeline and umbilical work scope).

There is the ability to influence the safety risk associated with the operations for each option, including through the adherence to Serica's Operations and Safety Management systems, and through standard risk reduction procedures including (but not limited to) contractor selection and audit, and training. Additionally, risks are also posed to third parties during offshore works both in the short-term (through physical presence) and longer-term depending on the degree of removal and remediation proposed (see Appendix A).

The highest risk to offshore personnel is associated with the partial recovery options, which will require the excavation/deburial of the production pipeline and umbilical, and the removal and disposal of the lines. While this is routine construction work, given the scale of the partial recovery activities and the lack of experience of working at this scale, there is a greater level of risk and uncertainty associated with the partial recovery options.

The risk to onshore personnel is relative to the quantity of material to be returned to shore for processing, which results in the partial recovery options having the highest (i.e. worst) safety scores under this criteria. Standard practices and mitigation/safeguards for material handling onshore will be in place and there is a high level of definition and understanding associated with onshore activities. However, given the larger quantities of material associated with partial recovery, the potential for incident during material handling and processing is higher.

With respect to safety risks to 3rd parties during decommissioning, for both leave *in situ* and partial recovery options for both the pipeline and umbilical, there will be some exclusion from the area of works for other users including fisheries and shipping during decommissioning activities, however this will be temporary. Therefore, the safety risk is considered comparable across all options. Risks from vessel presence can be mitigated through the use of Notices to Mariners and appropriate vessel markings and lighting. Any works within existing 500m exclusion zones (i.e. around well and the NCP platform) will already be subject to exclusion for other users.

The residual risk to 3rd parties is contingent on a number of factors, the primary one being the potential hazard to fishermen or other users of the marine environment, of material decommissioned *in situ* if this is not adequately buried. Both the pipeline and umbilical are adequately trenched and buried along their lengths, except at the point they transition out of the seabed to surface laid infrastructure. With an absence of free-spanning or pipeline exposure occurring through the life of the field, the only potential snagging hazard identified are the cut ends at these transition locations. However, these would be suitably remediated as part of the decommissioning activities.

Risk is also proportional to the level (effort) and type of fishing carried out in the area; the Orlando area experiences low to moderate fishing effort and effort is focused on demersal species, using demersal trawls. Fishing has not been excluded from the majority of the pipeline and umbilical routes for the duration of field life (*ca*. 7 years at time of comparative assessment submission), with no fishing interaction reported, the only exception being the 500m exclusion zone around the well. Fishing activity was evident from the 2024 inspection video data, along and across the pipeline/umbilical routes.

Risk to 3rd parties is greater under the partial recovery of the pipeline option; the extent of deburial and large number of cut ends to be remediated under this option represents a potentially greater risk to fishing activities with an associated increase in uncertainty of sections becoming exposed or not remaining adequately buried in the longer term given the large number of ends to be remediated. The partial recovery of the umbilical involves the removal of *ca*. 90 % of the umbilical with a much smaller number of cut ends to be remediated than the pipeline partial recovery option. Similar to the leave *in situ* option, the small number of cut ends to be remediated reduces the risk to 3rd parties.

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.

The 2024 inspection survey did not identify any freespans or exposed sections, on the pipeline or umbilical, with both lines being adequately buried (burial depth of at least 0.6m). There have been no fishing related incidents associated with the Orlando pipeline system and, with the exception of the safety zones around the well location and the NCP safety zone, the area has been fished since the system was installed.

5.2 Environment

Seabed disturbance will be generated by all of the decommissioning options, the level of which is proportionate to the level of intervention. The interventions required to expose both pipeline and umbilical sections under each of the partial recovery options to facilitate removal would involve deburial to uncover the pipeline/umbilical buried beneath seabed sediments.

For the umbilical, both partial recovery options (Umbilical Option B1 and B2), achieve the highest scores (representing the worst case in this criteria), since over 90% of the umbilical will be deburied and removed under both options with associated seabed disturbance.

For the pipeline, given that rock covers a large proportion of the pipeline, the extent of deburial with partial recovery of *ca*. 50% of the pipeline and associated seabed disturbance (whilst less than that for the umbilical partial recovery options), is greater than the leave *in situ* option (see Appendix A).

Where it is proposed to leave both the pipeline (Pipeline Option A) and umbilical (Umbilical Option A) *in situ*, these have scored the lowest as they have the lowest requirement for intervention and associated seabed disturbance. Under these options, i.e. where significant deburial and pipeline/umbilical excavation would not take place, the footprint of effect is reduced. Where there are cut end sections on the seabed that require remediation (by the use of rock placement), then these will be very localised and small in area, with the result, the leave *in situ* options for the pipeline and umbilical scored the same for seabed disturbance (<10% of existing footprint); the introduction of new rock however, is considered permanent, across all options.

Emissions of carbon dioxide (CO_2) for each of the options (see Appendix A) reflect the number of vessels involved, duration in the field and the level of material recovered and recycled.

The greatest number of vessel days and associated emissions (Table 5.1), and the largest quantities of material which would be recovered, are associated with the pipeline and umbilical partial recovery options. Recovered materials would be dominated by steel with smaller quantities of copper and plastics in the case of the umbilical.

For Pipeline Option A and Umbilical Option A, emissions associated with replacing the material for these leave *in situ* options (as these materials do not reach the recycling supply chain), were also taken into consideration. The estimated lost opportunity from leaving materials *in situ* (i.e. that if it were recovered it would displace new primary material in the supply chain) was approximately 3,865tCO_2eq[1], which is similar to the difference between the emissions associated with a combination of any of the "B" options, and "A" options which is at least 3,800tCO_2eq, indicating that vessel emissions from removal essentially cancel out any "benefit" of removal.

Table 5.1: Estimated emissions associated with vessels used in each option

Option	Total vessel days	Fuel use (t)	tCO_2eq.
Pipeline Option A	10	152	498
Pipeline Option B	37	552	2,312
Umbilical Option A	12	175	575
Umbilical Option B1	40	605	2,561
Umbilical Option B2	84	1,261	4,717

Notes: fuel use assumed to be 15Te/day, emissions factors used are for diesel after DECC (2008), and GWP factors follow Forster et al. (2021), includes emissions from those elements common to all options.

The Orlando infrastructure is not located within a conservation site which is part of the National Site Network (i.e. Special Areas of Conservation (SAC), Special Protection Areas (SPAs), or Nature Conservation Marine Protected Areas, NCMPA). The closest of these sites is the Pobie Bank Reef SAC (81km away), the

[1] *Based on the representative emissions intensity of primary and secondary materials as reported in IoP (2000), Hammond & Jones (2011), Circular Ecology (2024).*

North-East Faroe-Shetland Channel NCMPA[2], the Faroe-Shetland Sponge Belt NCMPA[3] and the Central Fladen NCMPA[4] (all >100km away).

The mobile qualifying interests of certain sites (e.g. seals and seabirds) may be present across the Orlando area at some distance from site boundaries. Additionally, protected species such as cetaceans (e.g. harbour porpoise) may also be present.

Of particular concern to cetaceans is noise. No explosive cutting is proposed to be undertaken as part of the pipeline/umbilical decommissioning options and pipeline cutting is unlikely to represent a significant source of underwater noise (e.g. Pangerc *et al.* 2017). Noise from vessel activity associated with the decommissioning activities has the potential to contribute to existing noise levels in the area, and longer campaigns (i.e. partial recovery) result in longer vessel time and related noise. Though this is not expected to be a source of likely significant effect for protected marine species (e.g. all cetaceans), this has been considered in the environmental appraisal.

The potential presence of the OSPAR listed threatened and/or declining habitat 'Sea pens and burrowing megafauna communities' was noted by the 2011 seabed survey of the Orlando area but a detailed SACFOR assessment was not undertaken, as this survey preceded the publication of the JNCC guidance (JNCC 2014). Subsequent, photographic data from the 2021 seabed survey 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. 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 two), the OSPAR designated 'Sea pen and burrowing megafauna communities' habitat is likely to be present. A precautionary approach was adopted and a higher scoring for conservation sites and species was applied to the partial recovery options given the greater level of intervention and seabed disturbance associated with these.

Any implications for species of conservation interest, from the selected options are considered in the Environmental Appraisal.

5.3 Technical Feasibility

For both pipeline and umbilical, technical risks are higher for the partial recovery options than for those which propose to leave the pipeline and umbilical *in situ*. The recovery options are generally considered of moderate complexity, involving routine offshore operations such as deburial and removal of the pipeline and umbilical. However, there is limited experience in carrying out these operations at the proposed scale required, such as the deburial and reverse reel of over 6km of pipeline, and therefore there is a higher level of uncertainty.

Similarly, whilst the partial recovery of the umbilical by reverse reel or cut and lift is feasible, uncertainties exist due to the scale of the operations which could compromise the removal operation. However, there

[2] https://jncc.gov.uk/our-work/north-east-faroe-shetland-channel-mpa/
[3] https://jncc.gov.uk/our-work/faroe-shetland-sponge-belt-mpa/
[4] https://jncc.gov.uk/our-work/central-fladen-mpa/

is more experience of doing these operations with umbilicals than pipelines and therefore the level of risk and uncertainty is slightly lower (see Appendix A).

5.4 Weather Sensitivity

The partial recovery options include reverse reeling or cut and lift which require good weather windows and given the scale of operations are probably limited to the summer months, in contrast to the leave *in situ* options, which are of much shorter duration and therefore less affected by weather.

5.5 Society

Societal effects associated with the decommissioning options reflect the potential for residual effects on fishing, navigation or other access associated with what remains under and on the seabed following decommissioning, as well as potential effects on coastal communities from onshore operations. The residual effects refer to the long-term implications of the options considered.

For all options, all cut ends will be remediated (by the use of rock placement) so that they are overtrawlable, and therefore access to fisheries will be unrestricted. Fishing has been restricted from the 500m exclusion zone around the well but under all options the removal of the zone following decommissioning will mean that access to this area is also unrestricted. Therefore, all options have been given the same relatively low risk score. However, there is a considerable amount of rock deposited along the pipeline route resulting in a large number of cut ends to be remediated along the length of the pipeline for Pipeline Option B, with an associated increase in uncertainty of sections becoming exposed or not remaining adequately buried in the longer term. The number of cut ends to be remediated associated with the partial recovery of the umbilical (Umbilical Options B1 and B2) is much less than for the pipeline and therefore the uncertainty score is the same as the leave *in situ* option (Appendix A).

The Orlando area is of low to moderate importance to commercial fisheries, and the potential disruption of fishing activity would be restricted to temporary spatial interaction with vessels undertaking decommissioning activities and in transit. This will represent a short-term increment to existing vessel presence in the area associated with field operations and wider commercial shipping. It is not regarded that any chosen option will lead to the long-term exclusion of other user activities including fishing, shipping, tourism and recreation and potential future use for marine renewable energy or carbon capture and storage (CCS).

With respect to coastal communities, a range of effects could be generated from the return to shore of component parts of the pipeline and umbilical, with the greatest quantity of such materials recovered and returned to shore associated with the partial recovery options. These effects could include visual intrusion (e.g. from the transit of vessels to shore), and noise, dust, fumes and odour associated with onshore material processing (though note that only licenced yards would be used). The level of work to be undertaken onshore, and related employment continuity assuming the use of established yards, will in part depend on the selected decommissioning option, e.g. substantially fewer materials will be returned to shore should the pipeline and umbilical be decommissioned *in situ*.

5.6 Economic

Economic risks are primarily associated with the estimated cost of each decommissioning option and these are closely linked with the number of vessel days required to complete operations; partial recovery options (ranging from an estimated £10 million (pipeline Option B) to >£20 million (umbilical Option B2), are significantly more expensive than the leave *in situ* options (<£5 million), although it should be noted that these are highly driven by market conditions at the time of vessel contracting. Also, given the scale of the partial recovery operations and associated uncertainty in the costings, the assessment has erred on the side of caution with the risk score.

With respect to the residual liability associated with the decommissioning options in terms of future monitoring and remediation, all options have the same risk score (surveys and remediation requirement anticipated but at declining frequency), but with a greater level of uncertainty with respect to the residual liability associated with the partial recovery options. This is associated with the deburial of the pipeline and umbilical and the remediation and monitoring of lots of cut ends compared to leaving *in situ* where there would only a small number of cuts to remediate and monitor. Also, monitoring data suggests that leaving the pipeline and umbilical *in situ*, both of which have been exposed to demersal fishing activities (as evidenced by trawl marks observed by the 2024 pipeline inspection survey), without incident and have remained adequately buried since installation, would be unlikely to result in increased risk with respect to residual liability.

6.0 Summary and Recommended Options for Orlando Pipeline and Umbilical Decommissioning

6.1 Summary

The cutting and removal of spool pieces, jumpers, and riser connections and the removal of exposed protective material (mattresses and grout bags) where safe to do so, is common to all the decommissioning options considered and will, therefore, be carried out. In all cases, this will result in seabed disturbance where there is intervention, and discharge of pipeline/umbilical contents at disconnect; relevant applications will be made to OPRED (e.g. chemical permits) prior to activities being carried out.

Highest (worst) scoring options

The partial recovery options scored the highest across all categories. They represented the highest safety risk to personnel off- and onshore (i.e. related to the scale of the operations and the quantity of material being handled off- and onshore). The environmental scores for these options were high as partial recovery would generate a significant area of seabed disturbance, particularly for the umbilical which would be as great as that which would have been associated with installation. The more extensive seabed disturbance and longer time in field associated with the partial recovery options were more likely to result in detectable effects with respect to conservation sites and species (e.g. disturbance to potential OSPAR listed 'sea pen and burrowing megafauna communities' habitat, displacement of marine mammals). Given water depths at Orlando and bottom current regime, rapid seabed recovery following seabed disturbance is unlikely. For example, the 2024 inspection survey indicated that disturbance associated with pipeline installation was still present.

There would also be greater volumes of CO_2 emissions from longer vessel times in the field. Though partial recovery provides substantial returns to shore of recyclable material which could offset future emissions by displacing primary materials from the supply chain, this was largely counteracted by emissions from vessels involved in removal.

The technical feasibility of partial recovery operations, particularly of the pipeline resulted in a high score. This was primarily due to the proposed scale of the deburial, cutting and recovery (by reverse reel) operations and the lack of experience at such scale.

The costs of partial recovery options were significantly greater than options to leave *in situ*, particularly for the cut and lift of the umbilical (Umbilical Option B2), due to the extensive vessel time required for these operations.

Lowest (best) scoring options

The lowest total scores were achieved for the options to decommission the pipeline and umbilical *in situ*, with remediation, where required, to ensure adequate burial (to minimum 0.6m) of the cut ends, noting that the pipeline and umbilical are all presently buried to a depth greater than 0.6m.

The low values were due to a combination of safety, low risk to personnel off and onshore (e.g. related to quantity of material being handled), limited interaction with the seabed and seabed disturbance, lower technical risk and costs.

6.2 Recommended Proposed Options

A summary of the preferred options and the rationale for these is shown in Table 6.1 below.

Table 6.1: Options proposed

Infrastructure	Preferred Option	Rationale for selection
PL4383 Ident. No. 3 (10.813km, 8"/12" pipe-in-pipe production pipeline)	**Option A**: Leave *in situ* all sections, including sections under existing rock. Cut ends remediated to a minimum depth of 0.6m. The remediation of cut ends will be by rock placement which due to the permanent nature of the deposits is considered worst case. An estimated total of 470 tonnes of rock (worst case and includes 100% contingency) will be required to remediate the pipeline cut ends at both the well and SSIV.	Both the pipeline and umbilical are good candidates for *in situ* decommissioning as both are adequately trenched and buried (minimum depth of 0.6m above top of pipeline and umbilical) and have not been subject to the development of freespans, or exposures. This is expected to remain so due to the relatively low energy environment (minimal seabed sediment movement). Leaving the pipeline and umbilical *in situ* results in significantly lower risks in terms of: • Safety of personnel • Seabed disturbance • Greenhouse gas emissions • Potential impacts on protected habitats and species or those of conservation concern • Technical feasibility • Cost With respect to the residual liability in terms of future monitoring and remediation, all options have the same risk score, but with a greater level of certainty with respect to the residual liability associated with the leave *in situ* options. This is associated with monitoring data during field operation, which indicates that the pipeline and umbilical have remained adequately buried since installation, while being exposed to demersal fishing activities without incident. This suggests that leaving the pipeline/umbilical *in situ* would be unlikely to result in increased risk with respect to residual liability.
PLU4384 Ident. No. 2 (11km static umbilical)	**Umbilical Option A**: Leave *in situ* all sections, including sections under existing rock. Cut ends remediated to a minimum depth of 0.6m. The remediation of cut ends will be by rock placement which due to the permanent nature of the deposits is considered worst case. An estimated total of 470 tonnes of rock (worst case and includes 100% contingency) will be required to remediate the umbilical cut ends at both the well and SSIV.	

6.3 Legacy and Liability Management

An as-left survey will be undertaken at completion of the decommissioning activities. The approach for Orlando will be to carry out the survey following a similar scope to a pipeline inspection survey, using non-intrusive methods (e.g. ROV, drop-down camera, multibeam echosounder (MBES)) to identify any material remaining on the seabed that could be deemed a snagging hazard. Any material identified will be recovered.

The as-left post decommissioning survey will include the pipeline/umbilical routes, and also the area covered by the existing 500m safety zone around the Orlando well. Serica will continue to liaise with CNRI on the extent and scope of planned CNRI surveys within the NCP 500m safety zone.

In terms of future surveys, this will be based on a risk based programme of monitoring, using non-intrusive ROV or MBES, commensurate with the material proposed to be decommissioned *in situ*, taking into consideration that no freespans or exposures are present, or have previously developed along the infrastructure, that the lines are adequately buried or trenched to at least 0.6m and where this has not been the case (i.e. at cut ends), remediation will have been carried out, that the 2021 post-drilling survey (report dated (Fugro) 2025) indicated no sediment contamination around the Orlando well area and the fishing effort in the area is low to moderate. The monitoring programme will be developed in discussion with OPRED and in liaison with the relevant fishing bodies.

7.0 Conclusions and Key Points

The Orlando Decommissioning Team identified all feasible decommissioning options for the Orlando pipeline and umbilical system and these were considered against a set of criteria and scoring system developed to allow their inter-comparison. The assessment was undertaken by a team with a good knowledge and experience of the development, including its current status and the environment within which it is located.

The overarching conclusion of the comparative assessment process is that the partial recovery options have the highest (i.e. worst) scores for the production pipeline (PL4383 - Option B) and the static umbilical (PLU4384 - Umbilical Option B1 and B2), and are therefore the least preferable options for these lines.

The preferred options for the Orlando production pipeline and static umbilical as concluded by the comparative assessment are *in situ* pipeline decommissioning Option A and Umbilical Option A.

8.0 References

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Appendix A – Pipeline and Umbilical Comparative Assessment Scored Options Matrix

		Option A - PL4383 Leave in situ all sections, including sections under existing rock. Cut ends remediated to a minimum depth of 0.6m			Option B - PL4383 Partial recovery by reverse reel, sections currently under rock (e.g. crossings), along with spot rock cover, would be decommissioned in situ. Cut ends remediated to a minimum depth of 0.6m		
Criteria	Sub criteria	Risk/ Impact	Relative Uncertainty	Weighted Score	Risk/ Impact	Relative Uncertainty	Weighted Score
Safety	Risk to personnel offshore during decommissioning operations	2	1	2	3	1.5	4.5
Safety	Risk to personnel onshore during decommissioning operations	2	1	2	3	1	3
Safety	Risk to divers during decommissioning operations	3	1	3	3	1	3
Safety	Risk to 3rd parties and assets during decommissioning operations	2	1	2	2	1	2
Safety	Residual risk to 3rd parties	2	1	2	3	1.5	4.5
			Total	11		Total	17
			Average	2.2		Average	3.4
Environment	Chemical discharge	1	1	1	1	1	1
Environment	Hydrocarbon release from pipelines	2	1	2	2	1	2
Environment	Seabed disturbance and/or habitat alteration including cumulative impact	2	1	2	4	1.5	6
Environment	CO_2 emissions (tCO_2 eq.)	1	1	1	4	1	4
Environment	Proportion of material reused/recycled	2	1	2	2	1	2
Environment	Proportion of material landfilled	3	1	3	3	1	3
Environment	Conservation sites and species	2	1.5	3	4	1.5	6
			Total	14		Total	24
			Average	2.0		Average	3.4
Technical	Technical feasibility	1	1	1	4	2	8
Technical	Weather sensitivity	2	1	2	4	1	4
			Total	3		Total	12
			Average	1.5		Average	6.0
Societal	Residual effect on fishing, navigation or other access (including cumulative)	2	1	2	2	1.5	3
Societal	Coastal communities	1	1	1	2	1	2
			Total	3		Total	5
			Average	1.5		Average	2.5
Economic	Total cost	1	1.5	1.5	3	2	6
Economic	Residual liability including monitoring and remediation if necessary	3	1	3	3	1.5	4.5
			Total	4.5		Total	10.5
			Average	2.3		Average	5.3
			Total	35.5		Total	68.5
			Average	7.1		Average	13.7

Criteria	Sub criteria	Umbilical Option A - PLU4384 Leave in situ all sections, including sections under existing rock. Cut ends remediated to a minimum depth of 0.6m			Umbilical Option B1 - PLU4384 Partial recovery by reverse reel. Sections currently under rock (e.g. crossings), along with spot rock cover, would be decommissioned in situ. Cut ends remediated to a minimum depth of 0.6m			Umbilical Option B2 - PLU4384 Partial recovery by cut and lift. Sections currently under rock (e.g. crossings), along with spot rock cover, would be decommissioned in situ. Cut ends remediated to a minimum depth of 0.6m		
		Risk/ Impact	Relative Uncertainty	Weighted Score	Risk/ Impact	Relative Uncertainty	Weighted Score	Risk/ Impact	Relative Uncertainty	Weighted Score
Safety	Risk to personnel offshore during decommissioning operations	2	1	2	3	1.5	4.5	3	1.5	4.5
Safety	Risk to personnel onshore during decommissioning operations	2	1	2	3	1	3	3	1	3
Safety	Risk to divers during decommissioning operations	3	1	3	3	1	3	3	1	3
Safety	Risk to 3rd parties and assets during decommissioning operations	2	1	2	2	1	2	2	1	2
Safety	Residual risk to 3rd parties	2	1	2	2	1	2	2	1	2
			Total Average	11 2.2		Total Average	14.5 2.9		Total Average	14.5 2.9
Environment	Chemical discharge	3	1	3	3	1	3	3	1	3
Environment	Hydrocarbon release from pipelines	1	1	1	1	1	1	1	1	1
Environment	Seabed disturbance and/or habitat alteration including cumulative impact	2	1	2	5	1.5	7.5	5	1.5	7.5
Environment	CO_2 emissions (tCO_2 eq.)	2	1	2	4	1	4	5	1	5
Environment	Proportion of material reused/recycled	3	1	3	3	1	3	3	1	3
Environment	Proportion of material landfilled	4	1	4	4	1	4	4	1	4
Environment	Conservation sites and species (including noise effects)	2	1.5	3	4	1.5	6	4	1.5	6
			Total Average	18 2.6		Total Average	28.5 4.1		Total Average	29.5 4.2
Technical	Technical feasibility	1	1	1	3	1.5	4.5	3	1.5	4.5
Technical	Weather sensitivity	2	1	2	4	1	4	4	1	4
			Total Average	3 1.5		Total Average	8.5 4.3		Total Average	8.5 4.3
Societal	Residual effect on fishing, navigation or other access (including cumulative)	2	1	2	2	1	2	2	1	2
Societal	Coastal communities	1	1	1	2	1	2	2	1	2
			Total Average	3 1.5		Total Average	4 2.0		Total Average	4 2.0
Economic	Total cost	1	1.5	1.5	3	2	6	5	2	10
Economic	Residual liability including monitoring and remediation if necessary	3	1	3	3	1.5	4.5	3	1.5	4.5
			Total Average	4.5 2.3		Total Average	10.5 5.3		Total Average	14.5 7.3
			Total Average	39.5 7.9		Total Average	66.0 13.2		Total Average	71.0 14.2