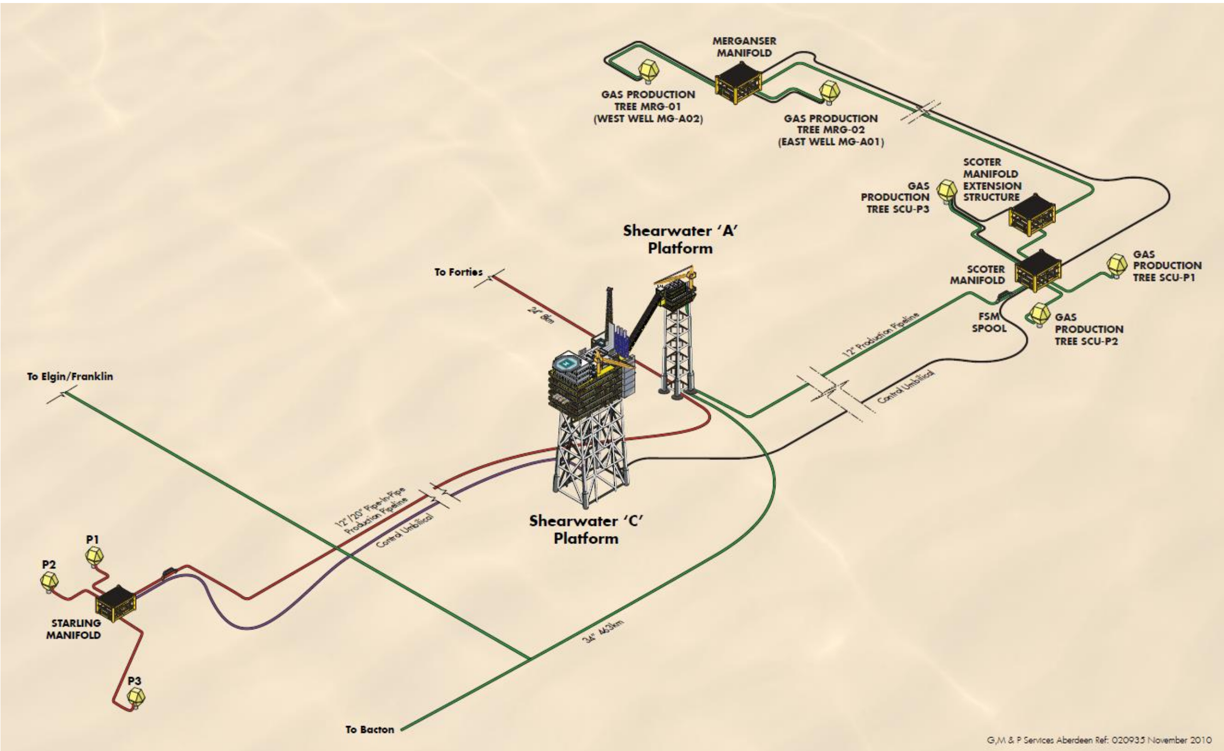
Scoter & Merganser

Comparative Assessment Report



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Revision History

Rev #	Reason for Issue / Change
R01	Issued for review.
R02	Cleared Hold 1 Issued for review by partners, BOM, Legal and ER
A01	Updated with comments from BOM, Legal, ER and partner review Issued to OPRED as 'pre-draft'
A02	Updated with comments received from OPRED to the 'pre-draft'
A03	Issued for Public Consultation
A04	Issued for Approval

List of Holds

Hold #	Reason for Hold
1	Cleared

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External stakeholders consulted during the Scoter & Merganser Decommissioning Comparative Assessment process:

- Scottish Fishermen's Federation (SFF);
- Offshore Petroleum Regulator for Environment and Decommissioning (OPRED);
- Joint Nature Conservation Committee (JNCC);
- Marine Scotland.

"Collectively" referred to in this document as "**stakeholder consultees**".

1. Executive Summary

This document provides a record of the Comparative Assessment (CA) of credible decommissioning options, carried out for the Scoter & Merganser subsea infrastructure. It presents the emerging recommendations for statutory and public consultation in support of the Scoter & Merganser Decommissioning Programmes [1].

The Scoter and Merganser fields are located 250km east of Aberdeen in the Central North Sea (CNS) area of the U.K. Continental Shelf (UKCS). The fields consist of five subsea wells, three at Scoter and two at Merganser, tied-back to Shell's Shearwater platform.

The subsea infrastructure associated with Scoter and Merganser has been subjected to CA in order to determine the optimal solution for decommissioning. This infrastructure includes the 8", 3.8km production pipeline from Merganser to Scoter, the 12", 11.7km production pipeline from Scoter to Shearwater, two umbilical for providing electro-hydraulic control and chemical injection to the well sites and production manifolds, as well as associated tie-in spools, jumpers, mattresses and grout bags.

The CA has been conducted in accordance with the Offshore Petroleum Regulator for Environment and Decommissioning (OPRED) Guidance Notes on Decommissioning of Offshore Oil and Gas Installations and Pipelines under the Petroleum Act 1998 [2].

This CA is submitted by Shell U.K. Limited, registered company number 00140141 (Shell) as operator, on behalf of itself and its co-venturers NEO Energy Natural Resources Limited, registered company number 13018823 (NEO), and Premier Oil UK Limited, registered company number SC048705, all being the recipients of the Section 29 Notices, and throughout this document the terms 'owners', 'we' and 'our' refer to all the co-venturers.

A summary of the recommendations for each scope is presented in Table 1-1 below.

All other subsea infrastructure will be removed during the decommissioning works:

- The production wells will be plugged and made safe;
- The Scoter Manifold will be removed and returned to shore for recycling, including its piles to a depth of 3m below the seabed;
- The Merganser Manifold will be removed and returned to shore for recycling, including its piles to a depth of 3m below the seabed;
- The Scoter Manifold Extension Structure (SMES) will be removed and returned to shore for recycling, including its piles to a depth of 3m below the seabed.

Scope	Scope description	Emerging Recommendation
1	Surface-laid tie-in spools and jumpers	Total removal. Items will be recovered to shore for recycling / disposal
2	Trenched and buried lines	Decommission in situ with ends remediated. Each line will be subject to a depth-of-cover survey and seabed clearance verification on completion of decommissioning to verify the burial status. Any areas of insufficient depth-of-cover will be remediated
3	Scoter umbilical crossing	Decommission in situ, removing the existing concrete mattress cover and installing a continuous rock-berm over the crossings. The total rock-berm will be approximately 270m, with approximately 100m of that section already covered by rock and approximately 170m requiring new rock placement.

Table 1-1 – Emerging Recommendations Summary

2. Introduction

2.1. Purpose

The purpose of this report is to present the emerging recommendations from the comparative assessment for the Scoter & Merganser subsea infrastructure in support of the Scoter & Merganser Decommissioning Programme [1].

The following is included within this document:

- Description of the infrastructure to be decommissioned;
- Description of decommissioning options considered;
- Comparative assessment methodology;
- Emerging recommendations from the comparative assessment.

The decommissioning options for the pipelines and umbilicals have been subjected to a process of comparative assessment in order to determine the optimum method of decommissioning in compliance with the OPRED Guidance Notes [2].

The following pipelines and umbilicals are included in the comparative assessment:

PL Number	Name	Diameter	Approx. Length (km)
PL1945	Scoter Production Pipeline	12”	11.7
PL1945 JAB	Production Tie-in Spoolpiece from Well AB to the Scoter Manifold	6”	0.05
PL1945 JAC	Production Tie-in Spoolpiece from Well AC to the Scoter Manifold	6”	0.05
PL1945 JAD	Production Tie-in Spoolpiece from Well AD to the Scoter Manifold	6”	0.06
PLU1946	Scoter Umbilical	117mm	12
PLU1946 JAB	Umbilical Jumper from Scoter Manifold to Well AB	117mm	0.05
PLU1946 JAC	Umbilical Jumper from Scoter Manifold to Well AC	117mm	0.05
PLU1946 JAD	Umbilical Jumper from Scoter Manifold to Well AD	117mm	0.07
PL2346	Merganser Production Pipeline	8”	3.8
PL2346 J1	Production Tie-in Spoolpiece from Merganser East Well to the Merganser Manifold	6”	0.06
PL2346 J2	Production Tie-in Spoolpiece from Merganser West Well to the Merganser Manifold	6”	0.09
PLU2347	Merganser Umbilical	105mm	4
PLU2347 J1	Umbilical Jumper from Merganser Manifold to Merganser East Well	105mm	0.06
PLU2347 J2	Umbilical Jumper from Merganser Manifold to Merganser West Well	105mm	0.09
PLU2386	Control Umbilical Jumper from Scoter Well AD to the Scoter Manifold	25mm	0.07
PLU2386 J1	Control Umbilical Jumper from Scoter Well AD to the SMES	25mm	0.07
PLU2896	Power & Signal Jumper from Merganser Manifold to Merganser East Well	25mm	0.09
PLU4924	Electrical Control Umbilical from Scoter Well AC to the Scoter FSM Spool	29mm	0.01

Table 2-1 – Pipelines and umbilicals subject to comparative assessment

2.2. Assumptions

Assumptions for the comparative assessment:

- All structures will be recovered as part of the overall decommissioning programme.

2.3. Regulatory Context

The decommissioning of offshore oil and gas installations and pipelines on the UKCS is regulated through the Petroleum Act 1998, as amended by the Energy Act 2008. The U.K.'s international obligations on decommissioning are governed principally by the 1992 Convention for the Protection of the Marine Environment of the North East Atlantic (OSPAR Convention). Agreement on the regime to be applied to the decommissioning of offshore installations in the Convention area was reached at a meeting of the OSPAR Commission in July 1998 (OSPAR Decision 98/3). The OPRED Guidance Notes [2] align with OSPAR Decision 98/3.

Pipelines currently do not fall within the remit of OSPAR Decision 98/3, but it is a requirement of the OPRED Guidance Notes [2] that operators apply the OSPAR framework when assessing pipeline decommissioning options.

Because of the widely different circumstances of each case, OPRED do not predict with any certainty what decommissioning strategy may be approved in respect of any class of pipeline. Each pipeline must therefore be considered in the light of a CA of the credible options, taking into account the safety, environmental, technical, societal and cost impacts of the options. Cost may only be a determining factor when all other criteria emerge as equal.

2.4. General Definitions

The following table specifies the meaning of wording in this report when it is used in a general context to avoid any confusion or doubt.

Wording	Definition for the purposes of this assessment
Pipeline	When pipeline is used in the general text, this should be assumed to mean pipeline in general and may also reference the pipeline system (including spools, cathodic protection etc.), e.g. this can refer to a rigid or flexible pipeline. If a specific pipeline is referenced, then this may also include "rigid" or "flexible" pipeline.
Protection	If protection is referenced this will refer to concrete mattresses and/or grout bags. Any other protection will be specifically referenced.
Structure	When structure is referenced this will refer to the following: • Scoter Production Manifold • Merganser Production Manifold • Scoter Manifold Extension Structure (SMES)

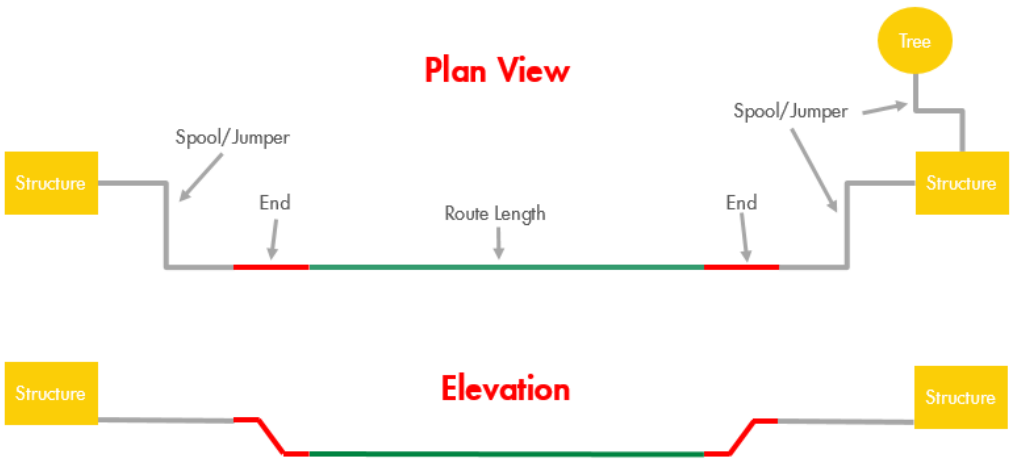
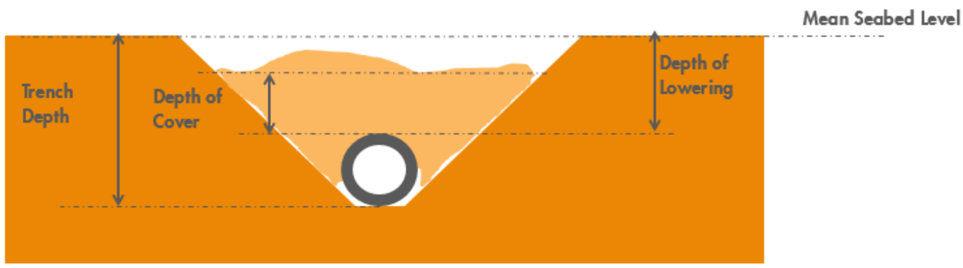
Wording	Definition for the purposes of this assessment
Route Length / End / Spool / Jumper	A single pipeline / umbilical is split into 3 different sections for the purpose of this comparative assessment. The route length, which can generally be described as the section of pipe / umbilical on the bottom of the trench. The end of a pipeline / umbilical in general is the section between the trench transition (as the line comes out of a trench) and the tie-in to the structure (including spools). Finally, the spool or jumper which is the section of pipe / umbilical lain on the seabed and facilitates the tie-in to any structures. The diagram below illustrates the differences between the different sections: 
Burial Depth Definitions	Different definitions will be used for different burial depths. The following diagram illustrates the different burial depth definitions: 
Exposure	When an exposure is described this is essentially when the crown of the pipe or umbilical can be seen. This does not generally mean a hazard.
Reportable Span	A reportable span is a significant span which meets set criteria (FishSAFE criteria) of height above the seabed and span length.
Fluidising	Fluidising is the process of fluidising the seabed to the point where the soil has no inherent strength and hence the pipe or similar will simply fall to the bottom of the trench.

Table 2-2 – General Definitions

2.5. Abbreviations

A&R	Abandonment and recovery	OGA	Oil and Gas Authority
BEIS	Department for Business, Energy and Industrial Strategy (formerly DECC)	OGUK	Oil and Gas UK
CA	Comparative Assessment	OPRED	Offshore Petroleum Regulator for Environment and Decommissioning
CEFAS	Centre for Environment, Fisheries and Aquaculture Science	OSPAR	Oslo Paris Convention for the Protection of the Marine Environment of the North-East Atlantic
CNS	Central North Sea	P&A	Plug and Abandonment (wells)
DOB	Depth of Burial	POB	Persons on Board
DOC	Depth of Cover	PLONOR	Posing Little Or No Risk
EUNIS	European Nature Information System	PMF	Priority Marine Feature
FAR	Fatal Accident Rate	PVA	Particularly Valuable Area
FEED	Front End Engineering Design	QRA	Quantitative Risk Assessment
FSM	Field Signature Method	SFF	Scottish Fishermen's Federation
JNCC	Joint Nature Conservation Committee	SIMOPS	Simultaneous Operations
KP	Kilometre Point	SMES	Scoter Manifold Extension Structure
MCZ	Marine Conservation Zone	UKCS	United Kingdom Continental Shelf
NCMPA	Nature Conservation Marine Protected Area		
OBM	Oil Based Mud		
OCNS	Offshore Chemical Notification System		

Table 2-3 – Table of Abbreviations

2.6. Field Overview

2.6.1. General

Scoter and Merganser are two normal pressure and temperature gas-condensate subsea tie-baccks to the Shearwater Cluster located in Block 22/30a of the Central North Sea (see Figure 2-1).

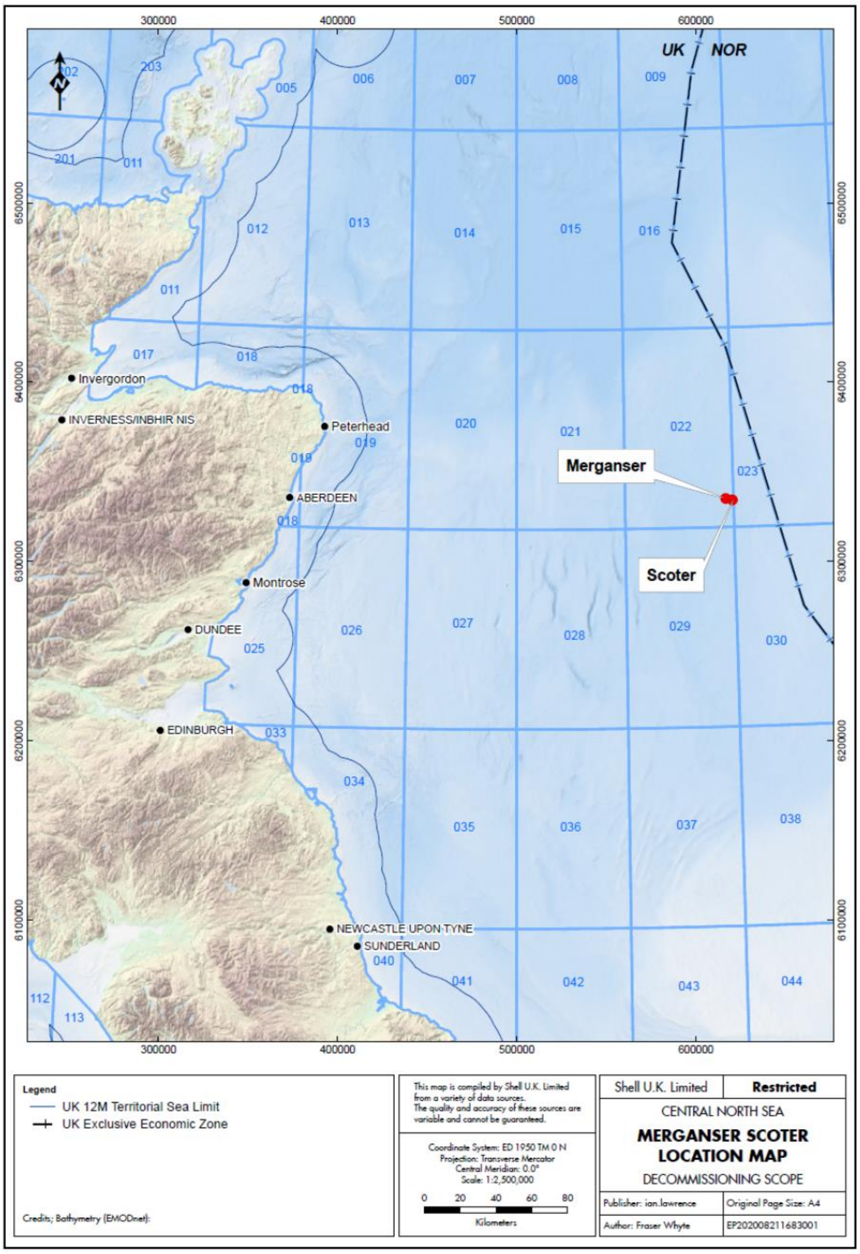


Figure 2-1 – Scoter & Merganser Field Location

Scoter was discovered in 1989 and began production in March 2004, originally from two wells with a third added in August 2006. Merganser was discovered in 1995 and began production in December 2006 from two wells.

Production from the two Merganser wells was routed via 6" super duplex spools to the Merganser Manifold and from there, via an 8" carbon steel 3.8km-long trenched-and-buried pipeline, to the Scoter Manifold Extension Structure (SMES) adjacent to the Scoter well site. A 6" super duplex spool connects the SMES and the Scoter Manifold.

Production from the three Scoter wells was routed via 6" duplex spools to the Scoter Manifold and delivered, together with the production from Merganser, to the Shearwater A platform via a 12" carbon steel 11.7km-long trenched-and-buried pipeline. The 14" Scoter Production Riser brought the production to the platform process facilities. All surface-laid spools and pipeline transitions to and from trenches are protected by concrete mattresses.

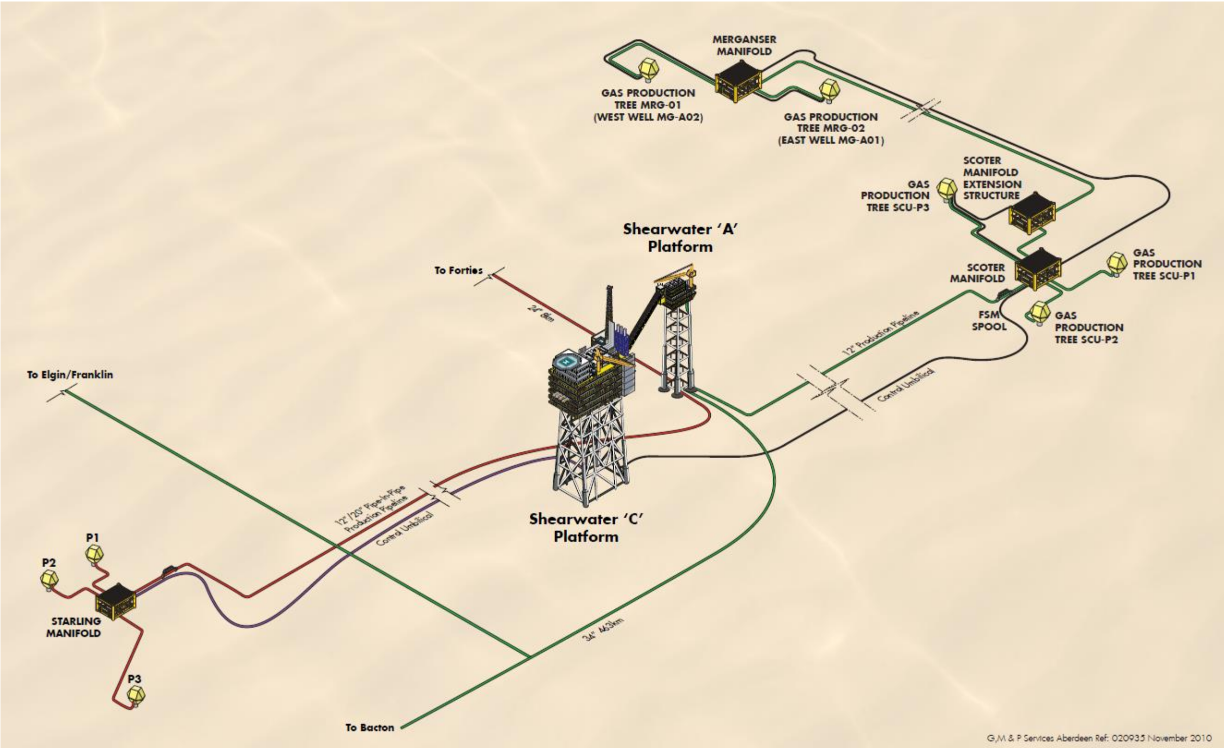


Figure 2-2 – Scoter & Merganser Field Schematic

Electro-hydraulic control and chemical supply is provided to the Scoter Manifold, Merganser Manifold, SMES and all wellheads from controls equipment located on the topsides of the Shearwater C platform. Control and chemical supply are provided to the Scoter Manifold via a 12km-long trenched-and-buried umbilical from Shearwater C and from there via surface-laid umbilical jumpers to the Scoter wells. A further umbilical jumper connects Well AD at Scoter to the SMES. Electro-hydraulic control and chemical supply is provided to the Merganser Manifold via a 4km-long trenched-and-buried umbilical from the Scoter Manifold, and from there to the two Merganser wells via surface-laid umbilical jumpers.

All surface-laid jumpers and umbilical transitions to and from trenches are protected by concrete mattresses.

The Oil and Gas Authority (OGA, now the North Sea Transition Authority) approved Cessation of Production from both fields at any time from 31 August 2020 and Shell formally ceased production on 17 December 2020. In early 2021, Shell flushed and disconnected the Scoter & Merganser subsea infrastructure and removed a 50m section of tie-in spool between the Scoter production pipeline PL1945 and the Scoter production riser to the Shearwater A Platform. These activities were approved by OPRED in a Preparatory Works Request in December 2019, see the Decommissioning Programmes [1] for further details. The Scoter and Merganser umbilicals and control system will remain in place to monitor the wells until 2024, although the chemical cores have been round-trip flushed to Shearwater in 2021.

2.6.2. Environmental Summary of Scoter & Merganser Fields

The seabed sediment in the area around the Scoter and Merganser fields comprise mainly fine muddy sand to sandy mud with intermittent areas additionally containing small quantities (<4%) of gravels. The sediment habitats are mainly assigned to the EUNIS biotope 'Deep circalittoral sand' and 'Circalittoral muddy sand' which, while common throughout the central North Sea (CNS), are listed as 'Endangered' on the European Red List of Habitats.

Hydrocarbon concentrations in sediments were generally low across survey areas within at least 10 km of Scoter and Merganser except where OBM-contaminated cuttings had been discharged. As no OBM was discharged during the drilling of the five production wells, hydrocarbon concentrations in sediments at Scoter and Merganser are anticipated to be at background levels. Any hydrocarbon contamination at Merganser, related to discharges of OBM contaminated cuttings from the E&A well, is expected to be minor on account of both the distance and subsequent biodegradation.

The closest designated area of conservation interest to the Scoter and Merganser fields is the East of Gannet and Montrose Fields Nature Conservation Marine Protected Area (NCMPA), approximately 18 km west of the Merganser manifold. This area is designated for offshore deep sea muds and ocean quahog (*Arctica islandica*) aggregations. The Fulmar Marine Conservation Zone (MCZ) is approximately 58 km south of the Scoter and Merganser manifolds and is designated for subtidal sand, subtidal mud, subtidal mixed sediments and *A. islandica*.

There is a Norwegian Particularly Valuable Area (PVA) for mackerel spawning approximately 25 km east of the Scoter manifold.

Sea pens and faunal burrows observed in the vicinity of the Scoter and Merganser fields are not considered to occur at high enough densities to constitute the Priority Marine Feature (PMF) habitat 'Sea pens and burrowing megafauna' or the Oslo/Paris Convention (OSPAR) threatened and/or declining habitat 'Sea pens and burrowing megafauna communities'.

Methane-Derived Authigenic Carbonate reefs are present at the nearby Culzean field. These are associated with a subsurface salt diapir at Culzean and are not thought to be present at the Scoter and Merganser fields.

At least four cetacean species frequent the area, with high densities of white-beaked dolphin.

Various seabird species are found in low numbers in the area of the decommissioning activities at different seasons throughout the year, with medium densities of combined species in the summer and breeding season. Vulnerability of seabirds to oil spills is predominantly low across the area and during most of the year, but reach a level of High sensitivity in September and October.

The Scoter and Merganser fields lie within spawning grounds for a number of fish species of commercial and/or conservation importance. None of these spawn at the seabed and their populations are consequently less vulnerable to seabed disturbance.

Fishing effort is low to moderate compared with the wider CNS although, the statistics on fishing effort and weight and value of the catch from this area may in part be supressed by the presence of safety zones around oil and gas infrastructure such as Scoter and Merganser.

2.6.3. Scoter & Merganser Field Infrastructure

The fields were developed as subsea tiebacks to Shell UK's Shearwater Platform with the following pipelines and umbilicals.

PARAMETER	Scoter Production Pipeline	Scoter Umbilical	Merganser Production Pipeline	Merganser Umbilical
N# / PL#	N0795 / PL1945	N1481 / PLU1946	N1759 / PL2346	N2842 / PLU2347
Diameter	323.9mm (12")	117mm	219.1mm (8")	105mm
Wall Thickness	23..8mm	N/A	20mm	N/A
Material	Carbon Steel	N/A	Carbon Steel	N/A
Length	11.7km	12km	3.8km	4km
Service	Gas condensate production	Electro-Hydraulic Control and Chemical Injection	Gas condensate production	Electro-Hydraulic Control and Chemical Injection
Current Contents	Hydrocarbon	Production chemicals	Hydrocarbon	Production Chemicals
Coatings	4-layer Polypropylene	N/A	4-layer Polypropylene	N/A
Offshore Crossings	Pipeline crosses 3 Machar lines and is crossed by 2 lines	Umbilical crosses 3 Machar lines and is crossed by 2 lines	None	None

Table 2-4 – Main Pipelines and Umbilicals Summary

The Scoter Pipeline (PL1945) and Scoter Umbilical (PLU1946) cross over the following three lines. Note that the three pipelines form one crossing where PL1945 and PLU1946 leave their respective trenches and are surface-laid for approximately 200m. Details of crossing protection are provided in the sections below.

- PL1357 16" Machar-Marnock Oil Pipeline, operated by BP
- PL1358 Marnock-Machar Control Umbilical, operated by BP
- PL1575 12" Marnock-Machar Water Injection Pipeline, operated by BP

The Scoter Pipeline (PL1945) and Scoter Umbilical (PLU1946) are crossed by the following two lines:

- PL1981 6" Marnock-Machar Gas Lift Line, operated by BP. This line crosses PL1945 and PLU1946 approximately 160m north of PL1358
- PLU3955 Marnock-Machar Electrical Upgrade EECU Umbilical, operated by BP. This line crossed PL1945 and PLU1946 approximately 200m south of PL1575.

Since the CA Workshop was held in October 2019, two new cables have been installed which cross the Merganser Pipeline (PL2346) and Merganser Umbilical (PLU2347). Both Merganser lines are trenched and buried at the point of crossing by the following two cables, approximately 750m from the Merganser Manifold:

- C2414, High Voltage Blyth-Kvilldal Power Cable, operated by the National Grid
- C2415, High Voltage Blyth-Kvilldal Power Cable, operated by the National Grid

Details of the Scoter and Merganser tie-in spools and jumpers are provided in the Decommissioning Programmes [1] with an overview provided below.

The subsea layout at the Merganser Manifold is shown in Figure 2-3, with the red lines indicating that the production spools have been disconnected from the wells and manifold during a separate flush and disconnect campaign. The umbilical jumpers were not disconnected during that campaign.

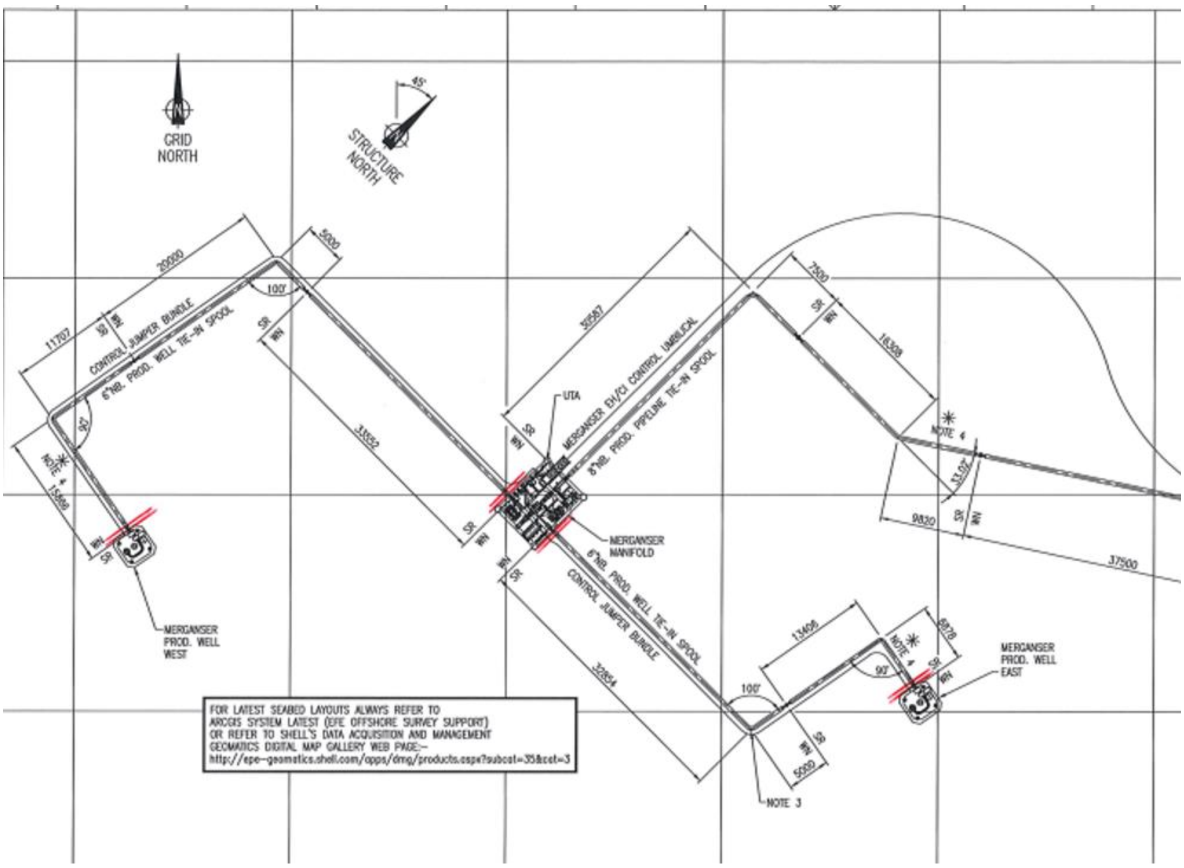


Figure 2-3 – Subsea Infrastructure at the Merganser Manifold

The subsea layout at the Scoter Manifold is shown in Figure 2-4, with the red lines indicating that the production spools were disconnected from the wells and manifold during a separate flush and disconnect campaign. The umbilical jumpers and spools between the Scoter Manifold and Scoter Manifold Extension Structure (SMES) were not disconnected during that campaign.

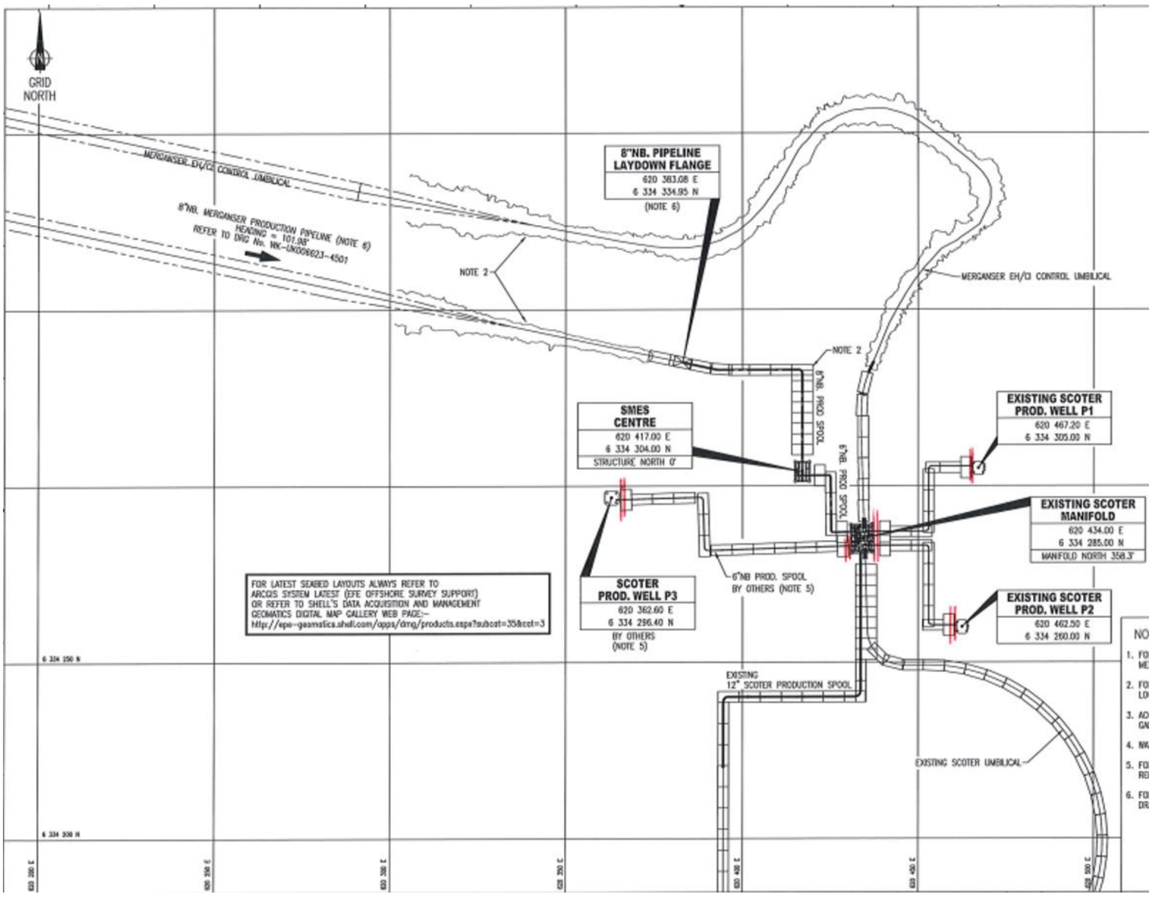


Figure 2-4 – Subsea Infrastructure at the Scoter Manifold

The subsea layout at the Shearwater 'A' Platform, including the Scoter Production Pipeline (PL1945) approach, is shown in Figure 2-5. The tie-in spool highlighted in pink was removed during an earlier flush and disconnect campaign.

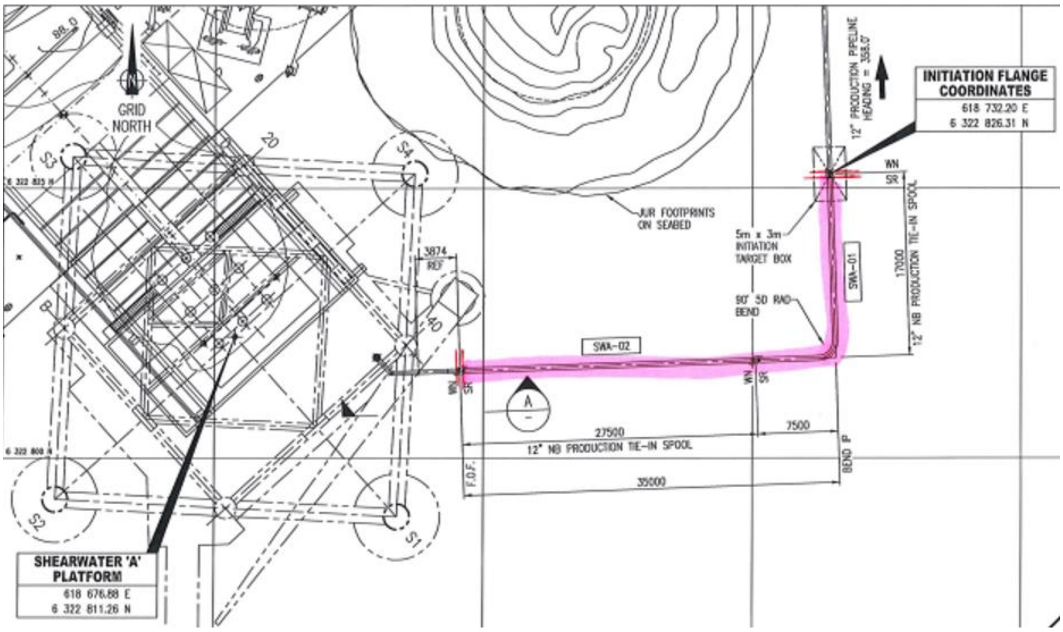


Figure 2-5 – Subsea Infrastructure at the approach to Shearwater 'A'

3. Comparative Assessment Process

3.1. General Process Description

The comparative assessment process was performed in accordance with the OPRED Decommissioning Guidance Notes [2] and guidance was used from the OGUK pipeline Comparative Assessment Guidelines [3].

The following sections present the comparative assessment methodology used for each of the Scoter & Merganser scopes, however a summary of the process used is as follows:

- Scoping of subsea infrastructure to be decommissioned and inventory mapping;
- Decommissioning assessment criteria and sub-criteria;
- Decommissioning options to be considered;
- Screening workshop to initially agree the decommissioning options to take further and any grouping to be considered.
- Selection of groups with similar circumstances, to be assessed as a scope group;
- Traffic light assessment, as required.

Stakeholder engagement and multi-disciplinary reviews have formed an important part of the comparative assessment process.

3.2. Scoping and Inventory Mapping

The initial phase of the comparative assessment process was to identify the scope to be decommissioned and map the inventory which requires decommissioning. This is summarised in section 2.6.3.

3.3. Criteria and Sub-Criteria

The next step in the comparative assessment process is to agree the criteria and sub-criteria to be used. The following table presents the selected criteria and sub-criteria, which was used to assess each option for decommissioning during the comparative assessment process. The criteria are in line with the criteria recommended in the OGUK comparative assessment guidelines [3], except for the impact of operations and legacy impact of operations and legacy impact sub-criteria which have been adapted as shown in the table below.

Criteria	Sub-Criteria	Applicable to	Applicable When	Factors	Potential Sources of data
Safety	**Project risk to personnel – Offshore**	Project team offshore, project vessels crew, diving teams, supply boat crew, heli-ops, survey vessels crew	During execution phase of the project including any subsequent monitoring surveys	Type of activity Number of personnel involved & project duration. Number of crew changes (helicopter transfers) Number of vessels involved & SIMOP activity Numbers, durations and depth that divers are anticipated to work. Any unique or unusual handling or access activities required of personnel.	Decommissioning methodology for each option; vessel study; diving study; etc Coarse QRA data based on POB / exposure, durations and activity Fatal Accident Rate (FAR). Industry data will be used to derive the probability of loss of life.
	Project risk to other users of the sea	Navigational safety of all other users of the sea, fishing vessels, commercial transport vessels, military vessels	During execution phase of the project including any subsequent monitoring surveys	Likelihood of incursion into project exclusion zone by other users of the sea Number and type of transits by project vessels to and from the project work site	Fishing study on anticipated activity in area of activity Other vessels movements review, stakeholder engagement
	Operational risk to personnel – Onshore	Onshore dismantling and disposal sites personnel; extent of materials transfers/ handling on land	During execution phase of the project, through to final disposal of recovered materials	Extent of dismantling required & hazardous material handling anticipated. Numbers of road transfers from dismantling yard to final disposal site.	Decommissioning methodology for each option, considering volume and type of material to be returned to shore Coarse QRA data based on POB / exposure, durations and activity Fatal Accident Rate (FAR)
	Potential for a high consequence event	Project team offshore and onshore; project vessels; diving teams; supply boat crew; heli-ops; survey vessels; onshore dismantling and disposal sites personnel	During execution phase of the project including any subsequent monitoring surveys	Decommissioning philosophy; potential for dropped object over a live pipeline; degree of difficulty anticipated in onshore dismantling	Decommissioning methodology for each option; vessel study; diving study; etc
	Residual risk to other users of the sea	Fishing vessels, fishermen, supply boat crews, military vessel crews, commercial vessel crew and passengers, other users of the sea	Following completion of the Decommissioning project and residual / ongoing impact in perpetuity	Extent of facility / equipment / pipeline left in situ on completion of the project and its likelihood to form a future hazard; likelihood for further deterioration; predicted future fishing activity; proximity of retained facilities to main transport routes	Decommissioning methodology for each option, focussing on volume and type of infrastructure to be left in situ; fishing navigational safety study on anticipated activity in area(s) where infrastructure is decommissioned in situ; assessment(s) of degradation for infrastructure left in situ; stakeholder engagement
Environmental	**Impact of operations**	Environmental impact to the marine environment, nearshore areas and onshore caused by project activities	During execution phase of the project from mobilisation of vessels to the end of project activities at the waste processing / disposal site (does not	Associated planned discharges; marine noise; seabed disturbance, including seabed footprint (area), sediment suspension and contaminated sediment including drill cuttings; protected habitat and species in nearshore, marine and	Asset knowledge, decommissioning methodologies, Environmental Baseline Survey, Habitat Survey, Waste Inventory, Environmental Appraisal Report, project schedule, collision assessment, predicted discharges to sea, historic events

Criteria	Sub-Criteria	Applicable to	Applicable When	Factors	Potential Sources of data
			include landfill and long-term storage impacts) For rock placement, trenching and dredging any seabed disturbance is included here, depending on area of impact – changes to habitat and species are covered in Legacy Impact.	onshore areas – conservation objectives, their presence, impacts, distance from activities; waste processing	
	Energy and emissions and resource consumption	Project activities from vessel mobilisation to the final destination of waste, including the energy and emissions penalty for leaving recyclable material in field. Includes vessel mobilisation, demobilisation, waiting on weather, post-decommissioning monitoring surveys.	During execution phase of the project from mobilisation of vessels to the end of project activities at the waste processing / disposal site (does not include landfill and long-term storage impacts) Not recovering and recycling the installations material will require that raw material and energy will be consumed to replace the materials which would have been recycled if the structure had been brought onshore	Number and type of vessels; duration of vessel activities; tasks vessels are fulfilling; vessel station keeping approach Energy and emissions required to replace recyclable materials not recovered for recycle of re-use Helicopter trips are not to be included as impact is marginal.	Energy and emissions assessment, undertaken per Institute of Petroleum: Guidelines for the Calculation of Estimates of Energy Use and Gaseous Emissions in the Decommissioning of Offshore Structures
	Legacy Impact	Ongoing long term environmental impact and benefit caused by materials left in place or long-term waste storage / landfill	Following completion of the Decommissioning project and residual / ongoing impact For rock placement, trenching and dredging any changes to habitat and species are included here - seabed disturbance is included in Impact of Operations, depending on area of impact.	Waste disposal including onshore landfill and long-term waste storage; habitat alteration and long-term changes in species composition; physical and chemical degradation of products left on the seabed (make and content of material like wax, chemicals, plastic and concrete, steel, debris). CA will be conducted with assumption that reasonable endeavours are used to clean the infrastructure.	Decommissioning methodology for each option, focussing on volume and type of infrastructure to be left in situ; Environmental Baseline Survey; Habitat Survey; Waste Inventory
Technical	**Risk of major project failure** Cost and Schedule overruns. Ease of recovery from excursion.	Overall Project	From project select phase through to completion, including monitoring surveys and ultimate disposal of materials returned to shore.	Maturity of scope definition, confidence level that project will proceed as foreseen; ability to recover from unplanned events which could impact completion of the project as planned; extent of potential re-engineering that may be required and its impact if strategy goes wrong	Decommissioning methodology for each option, concept / pre-FEED study, lessons learned from industry
	Technology demands, Availability / Track Record	Overall Project	From project select phase through to completion, including monitoring surveys and ultimate disposal of materials returned to shore.	Extent of new or emerging technology proposed by the option; extent of application of existing technology to different uses; extent that the approach has been completed before	Decommissioning methodology for each option, concept / pre-FEED study, lessons learned from industry

Criteria	Sub-Criteria	Applicable to	Applicable When	Factors	Potential Sources of data
Societal	**Commercial impact to fisheries**	Impacts from both the decommissioning operations and the end-points on the present commercial fisheries in and around the field	During and following completion of the Decommissioning project and residual / ongoing impact	Residual impact on fishing areas: • If exclusion zones are to be retained where equipment or materials are left in-situ • If fishing habitats are inhibited as a result of the decommissioning methods adopted	Fishing study on anticipated activity in area of activity; decommissioning methodology for each option focussing on volume and type of infrastructure to be left in situ; vessel study; publicly available data; stakeholder engagement
	Socio-economic impact on communities and amenities	The impact from any near shore and onshore operations and end-points (dismantling, transporting, treating, recycling, land filling) on the health, well-being, standard of living, structure or coherence of communities or amenities. E.g. business or jobs creation, job loss, increase in noise, dust or odour pollution during the process which has a negative impact on communities, increased traffic disruption due to extra-large transport loads.	During and following completion of the Decommissioning project and residual / on-going impact	May be positive or negative; jobs created; establishment of track record; improvements to roads and quaysides; use of limited landfill resource	Decommissioning methodology for each option; publicly available data; stakeholder engagement
Economic	**Cost**	Overall Project	Full decommissioning project cost including future monitoring surveys and proposed remediation, if required	Actual cost estimates are not to be included in the CA report, but a normalised scale can be produced to indicate the comparison between each option	Cost and schedule estimates
	Cost Risk / Uncertainty	Overall Project	Project execution phase and ongoing cost liability (surveys and potential remedial action)	Uncertainty in estimates prepared, potential for / risk of growth through the project, risk will be greater with a larger number of unknowns and where activities are weather sensitive	Risk and opportunity register

Table 3-1 – Comparative Assessment Criteria and Sub-Criteria

3.4. Decommissioning Options and Initial Screening Workshop

3.4.1. Decommissioning Options

The options available for decommissioning have been considered and were assessed as part of the initial screening process to assess each option's feasibility. The options for decommissioning being assessed are shown in section 5.

3.4.2. Initial Screening Workshop

An initial screening workshop was held where experts were consulted to assess the technical feasibility and practicality of each of the decommissioning options relating to each scope. The initial screening workshop also identified which scopes displayed similar characteristics and could therefore be grouped and assessed together.

Guidance on assessment parameters against the five Comparative Assessment criteria was agreed at the initial screening workshop. The assessment criteria parameters are outlined in the Shell Comparative Assessment Procedure EOFL-PT-S-QA-6050-00001 and provided in Appendix B below. These parameters were developed from Appendix A of the Oil and Gas UK Guidelines for Comparative Assessment in Decommissioning Programmes [3], with two amendments for the sub-criteria "impact of operations" and "legacy impact".

3.5. Comparative Assessment Workshops

A Comparative Assessment (CA) workshop was held, including licence partners and the stakeholder consultees to inform the emerging recommendations. During the CA workshop, the scopes were presented to and discussed with the attendees detailing the circumstances associated with each item of infrastructure, the credible options identified, and the impacts against the fourteen CA sub-criteria. The decommissioning recommendations were presented for discussion with the stakeholders in attendance.

3.6. Traffic-light assessment

The assessment of each credible option against the fourteen CA sub-criteria is provided in Section 5, using a simple traffic-light system. An example of the traffic-lighting is shown in Table 3-2 below.

		Option Category	Leave In-Situ	Remediate	Remove
		Include Option for Screening?	☑ Option 1	☑ Option 2	☑ Option 5
Criteria	**Ref**	**Sub Criteria**	**Option 1: Leave In-Situ (Do Nothing)**	**Option 2: Leave In-situ (Remediate with Rock Cover Above Seabed)**	**Option 5: Full Removal**
Safety	1	Project risk to personnel - Offshore			
	2	Project risk to other users of the sea			
	3	Project risk to personnel - Onshore			
	4	Potential of a high consequence even			
	5	Residual risk to other users of the sea			

Table 3-2 – Example Traffic Lighting

Each option can be scored as the following for each sub-criterion:

- Green – comparatively preferable to other options
- Amber – moderately less preferable in comparison to other options scored green, or moderately more preferable than other options scored red
- Red – comparatively less preferable to other options
- Grey – score applied to all options for this sub-criterion as there is no significant difference between any of the options

Note that scores are assigned in comparison to the other credible options available only. A 'red' result, for example, does not necessarily mean that an option is unacceptable or has been ruled out, only that it is not preferable for the associated sub-criterion in comparison to the other options.

Note that cost may only be a determining factor when all other criteria emerge as equal.

4. Decommissioning Options

A brief discussion of the decommissioning options is presented below, which will cover the high-level options of pipeline removal, re-use, remediation or leave in-situ.

4.1. Re-use

The Scoter & Merganser Cessation of Production Report (SMDP-PT-I-AA-5726-00001) outlined the opportunities for re-use that were assessed. As no credible options for re-use were identified for the majority of the infrastructure, the Oil and Gas Authority (now the North Sea Transition Authority) approved the Scoter & Merganser Cessation of Production Report 9 July 2020.

An opportunity to re-use the Scoter Riser on the Shearwater A Platform was identified. To support this re-use, flushing and disconnection of the Scoter and Merganser subsea infrastructure was executed in Q1 2021, whilst flushing of the chemical cores within the Scoter and Merganser control umbilicals was executed in 2021. As this scope was executed prior to the approval of these Decommissioning Programmes, the flush and disconnect campaign was approved under a separate Preparatory Works Request (PWR).

Following the flush and disconnect campaign, the Scoter Production Riser (part of PL1945) was transferred from the Scoter Pipeline Works Authorisation (PWA) 12/W/02 to the PWA for the new development. Therefore, the Scoter Production Riser is not in scope of the Scoter pipelines Section 29 notice or the Scoter Pipeline Decommissioning Programme or this Comparative Assessment.

4.2. Removal

4.2.1. Cut and lift

The cut and lift method to date has been the most commonly used method to remove pipelines. The method requires the pipeline to be un-trenched and water flooded. The pipeline will then be cut into sections by an ROV using hydraulic shears and then recovered by a vessel using a hydraulic lifting beam ready for transport to shore and disposal. A simplified schematic of the cut and lift process is shown in Figure 4-1. The preferred method of cutting will generally be decided by the contractor performing the work, subject to risk assessment and endorsement by Shell, however will most likely be hydraulic shears.

The cut and lift method can be used for the entire pipeline removal or localised sections, such as spools or spans.

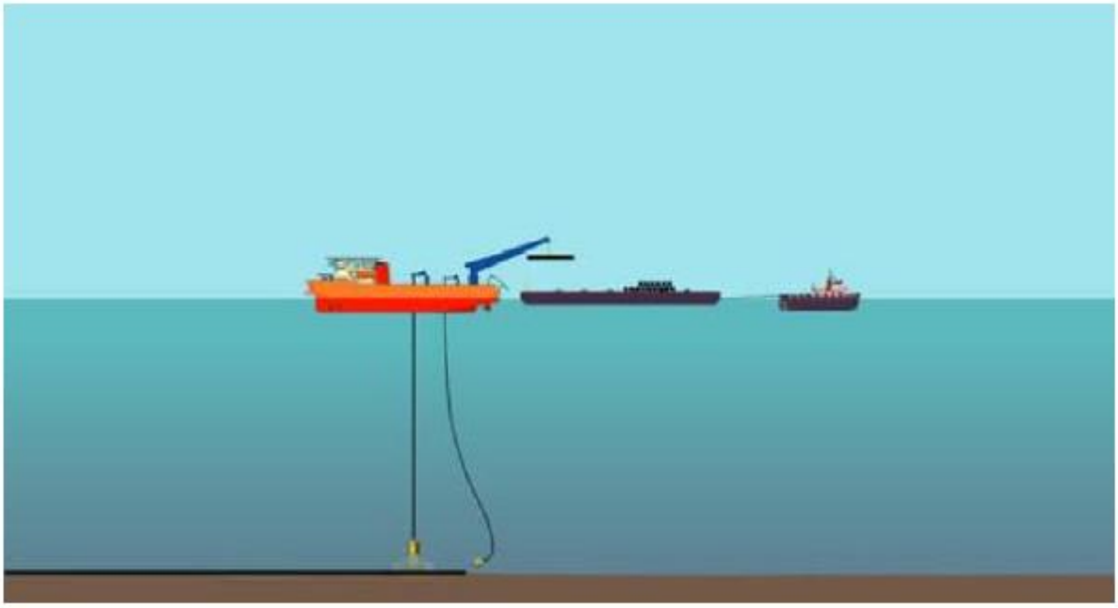


Figure 4-1 – Cut and Lift Pipeline Removal Illustration

4.2.2. Reverse Reel

Reverse reeling of the buried pipelines or umbilicals would potentially require them to first be un-trenched and de-watered to reduce the submerged unit weight. The pipeline or umbilical ends would then need to be cut or disconnected and then the reeling vessel would connect to and recover the end using the A&R (abandonment and recovery) winch until the tensioner could grip and proceed to pull the pipeline or umbilical on to the vessel. The pipeline or umbilical would then need to be connected to the main reel, so that the vessel could proceed to reel on. The pipeline or umbilical would then be transported to shore for disposal or recycling.

4.2.3. Reverse S-lay

Reverse S-lay is a potentially feasible option to recover pipelines. Reverse S-lay is the reversal of the common S-lay installation technique, which generally consists of a pipeline lay vessel or barge equipped with a stinger and tensioner and then the line pipe is welded together on the vessel, prior to being laid onto the seabed, which is controlled by the applied tension to the pipeline.

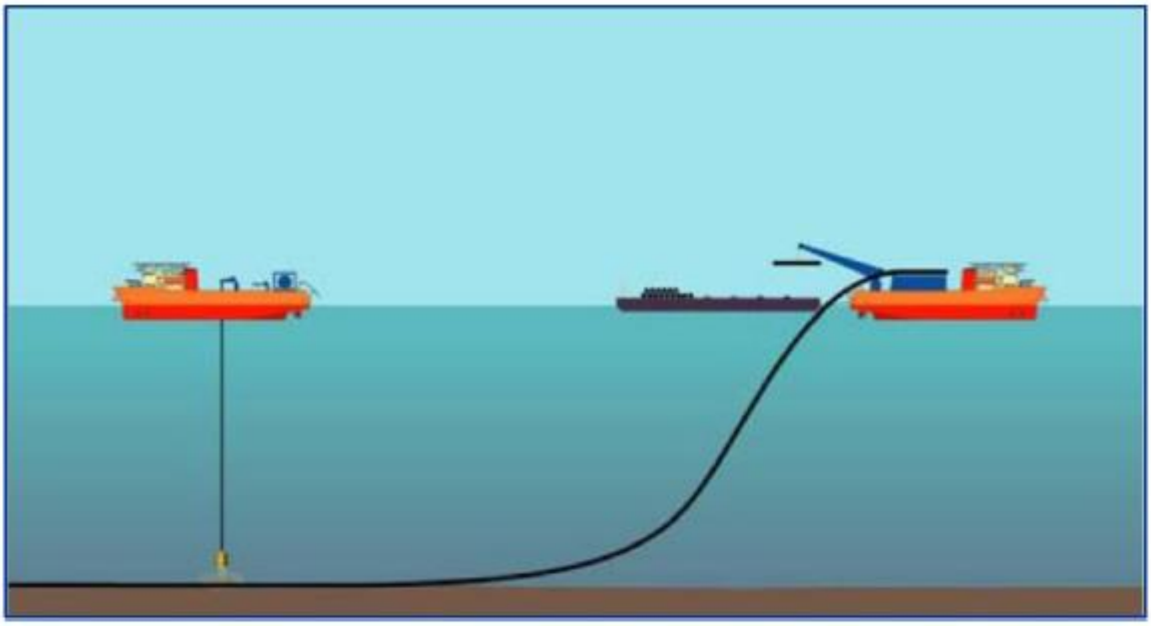


Figure 4-2 – Reverse S-lay Illustration

For the removal process the tensioner would be used to recover the pipeline from the seabed and then it would be cut to manageable lengths on the vessel and transported back to shore.

The pipeline would need to be un-trenched to perform this method of recovery. In addition, it would be prudent to dewater the pipeline (air filled or nitrogen purged) to reduce the equivalent weight of the pipeline and hence reduce the required tension. A summary of the reverse S-lay methodology is set out in Figure 4-2.

4.3. Leave In-situ

4.3.1. Pipelines (No remediation)

This option consists of leaving the pipeline or umbilical in-situ with no further remediation, however the pipeline ends may be cut and buried or cut and rock covered.

4.3.2. Pipelines (Re-trench)

Re-trenching pipelines or umbilicals is an option where lines are subject to increased risk from snagging or becoming unstable (e.g. buoyant pipelines or free spanning pipelines) due to a reduction in the burial depth or cover. The retrenching of a pipeline or umbilical can be performed by a jet trencher, plough or mass flow excavator. Re-trenching on areas with remedial rock may need the rock removed prior to trenching, depending on the rock grade.

4.3.3. Localised Cut and Lift

For localised exposures or areas of low cover, localised cut and lift operations can be used, which would be executed in a similar manner to that shown in section 4.2.1.

4.3.4. Pipelines (Remedial Rock Cover)

Remedial rock cover involves either blanket or locally placing rock at specific locations to increase the cover on the pipeline to reduce the risk of snagging or it affecting other users of the sea. Due to the water depth at Scoter and Merganser (approx. 88m) a fall pipe vessel, shown in Figure 4-3, would be the most likely method for additional rock cover.

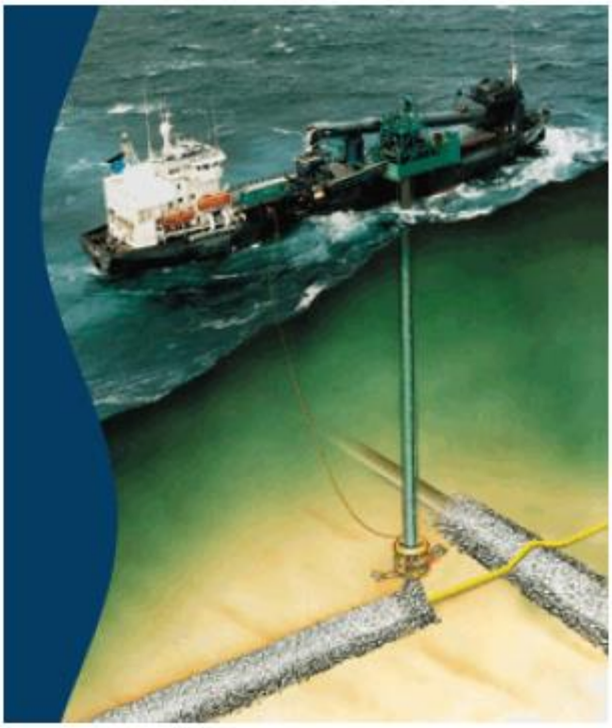


Figure 4-3 – Remedial Rock Cover Installation Illustration

5. Comparative Assessment Results

5.1. Initial Decommissioning Options Screening and Grouping

A number of stakeholder engagements took place during the initial screening phase to further understand and clarify each stakeholder's concerns and views regarding the decommissioning of the Scoter & Merganser Fields.

Internal workshops to screen the options were held by Shell in 2019 utilising information from both internal and external survey data gathered over the life of the field. The workshops enabled the project team to identify and define credible options for each scope, assessing what data gaps existed for each option and defining whether any studies were required to inform the comparative assessment workshop.

During the initial screening workshop, the credible options for each grouping was assessed against the five CA criteria identified in Section 3.3 and the pipelines and umbilicals were grouped, where applicable, for the purposes of the comparative assessment workshop. A summary of the grouping and options identified for each scope is shown in Table 5-1.

Details of the conclusions for each scope and group are contained within the following sections.

Scope	Description	Decommissioning Options
1	Surface-laid tie-in spools and jumpers PL1945 JAB, PL1945 JAC, PL1945 JAD, PLU1946 JAB, PLU1946 JAC, PLU1946 JAD, PL2346 (ident 7 only), PL2346 J1, PL2346 J2, PLU2347 J1, PLU2347J2, PLU2386, PLU2386 J1, PLU2896, PLU4924	~~Decommission *in situ*~~ ~~Blanket rock cover~~ Total removal
2	Trenched and buried lines PL1945, PLU1946, PL2346 (excl ident 7), PLU2347	~~Decommission *in situ* (no action)~~ Decommission *in situ* with end remediation ~~Total removal~~
3	Scoter umbilical crossing PLU1946	~~Decommission *in situ* (no action)~~ ~~Blanket rock cover~~ Remove mattresses and blanket rock cover ~~Total removal of umbilical not covered by rock~~

Table 5-1 – Summary of Decommissioning Options and Grouping

Notes:

Options with a strikethrough (e.g. ~~Decommission in-situ~~) were deselected during initial screening.

5.2. Scope 1 – Surface-laid tie-in spools and jumpers

This scope includes the surface-laid production spools and surface-laid umbilical jumpers identified below.

At the Scoter well site, the following production spools and umbilical jumpers are included within this scope. Figure 5-1 below indicates the scope in yellow highlight. The red lines indicate where an earlier campaign will disconnect the production spools from the Scoter Manifold and wells.

- PL2346 spool between the Scoter Manifold and Scoter Manifold Extension Structure (SMES)
- PL1945 JAB spool between the Scoter Manifold and Scoter well P2
- PL1945 JAC spool between the Scoter Manifold and Scoter well P1
- PL1945 JAD spool between the Scoter Manifold and Scoter well P3
- PLU1946 JAB between the Scoter Manifold and Scoter well P2
- PLU1946 JAC between the Scoter Manifold and Scoter well P1
- PLU1946 JAD between the Scoter Manifold and Scoter well P3
- PLU2386 between the Scoter Manifold and Scoter well P3
- PLU2386 J1 between Scoter well P3 and the SMES
- PLU4924 between Scoter well P1 and the Scoter FSM spoolpiece

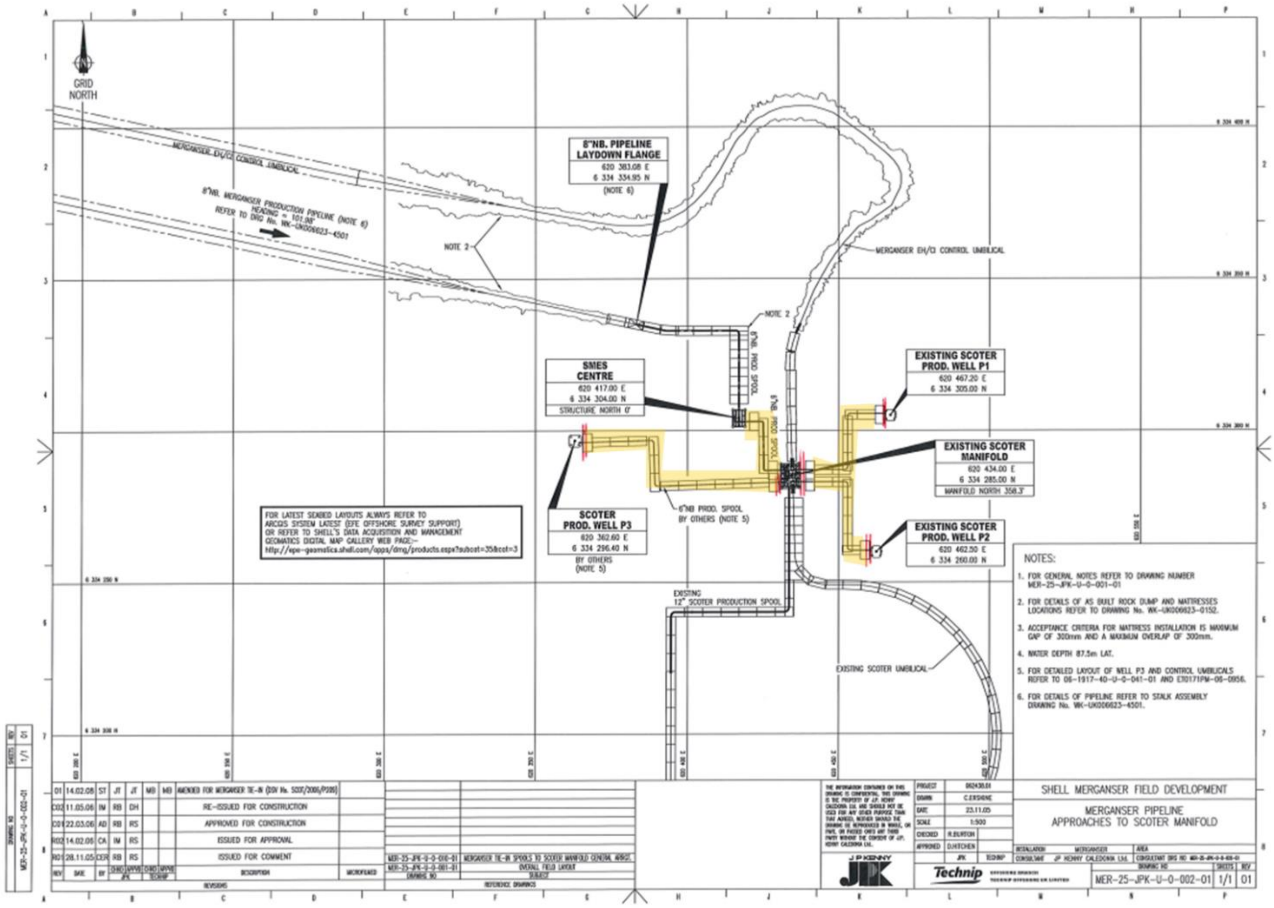


Figure 5-1 – Scope 1 at the Scoter well site (highlighted)

At the Merganser well site, the following production spools and umbilical jumpers are included within this scope. Figure 5-2 below indicates the scope in yellow highlight. The red lines indicate where an earlier campaign will disconnect the production spools from the Scoter Manifold and wells.

- PL2346 J1 spool between the Merganser East Well and the Merganser Manifold
- PL2346 J2 spool between the Merganser West Well and the Merganser Manifold
- PLU2347 J1 jumper between the Merganser Manifold and the Merganser East Well
- PLU2347 J2 jumper between the Merganser Manifold and the Merganser West Well
- PLU2896 retrofit cable between the Merganser Manifold and the Merganser East Well

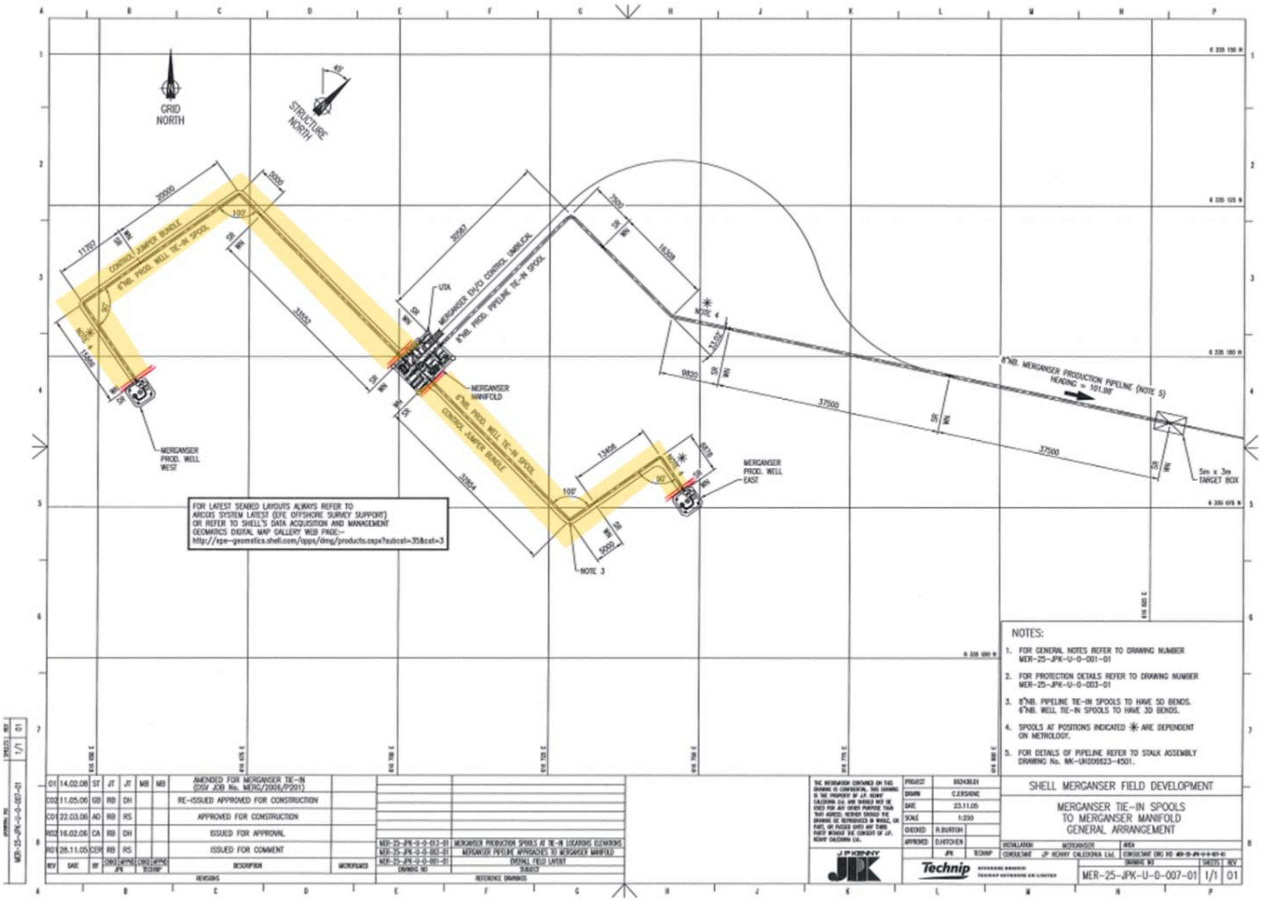


Figure 5-2 – Scope 1 at the Merganser well site (highlighted)

Three credible options were identified for this scope:

- Total removal
- Decommission in situ
- Decommission in situ with rock cover

The output of the Comparative Assessment for Scope 1 was as follows and is summarised graphically in the traffic-light assessment contained in Table 5-2 below.

The three credible options were reviewed against the five CA criteria of safety, environment, technical, societal and economic impacts.

In terms of safety impact, decommissioning the surface-laid spools and jumpers *in situ* was deemed to leave an unacceptable safety risk to future users of the sea, as the infrastructure would present a snagging risk in open water. This option was therefore discounted.

Total removal is in line with both the regulatory expectation and stakeholder preference for a clear seabed on conclusion of decommissioned activities. The spools, jumpers and stabilisation features in this scope are broadly accessible and expected to be in good condition given the age of the field. Therefore, whilst representing a comparatively higher safety risk to project personnel during offshore execution than blanket rock cover, total removal would not impost any unusual or unacceptable safety risks. Further, whilst blanket rock cover would reduce the legacy safety risk of snagging by other users of the sea compared with decommissioning *in situ* without remediation, the resulting rock-berm would also present a comparatively higher future risk than total removal, albeit a minor one.

For environmental impact, total removal would present a less significant impact than blanket rock-cover. The latter would have a comparatively higher long-term impact by introducing new and habitat-altering substrate.

With each option representing a relatively short execution scope and employing well-known, commonly used technology, there is no comparable difference between the options in terms of technical impact.

Similarly, none of the three options would have a significant societal impact – either little or no effect on existing employment, supply chains or waste streams.

In terms of cost, whilst decommissioning *in situ* would represent the lowest operational cost, it would likely result in the highest cost for future monitoring. Conversely, total removal would represent the highest operational cost, but lowest long-term monitoring cost.

Therefore, the recommendation to **remove all lines and exposed mattresses to shore for re-use / recycling and disposal** was presented for discussion and challenge at the CA workshop.

There were no objections to this proposal from the stakeholder consultees.

Criteria	Ref	Sub Criteria	Option 1: Leave In-Situ (Do Nothing)	Option 2: Decommission in situ with blanket rock cover	Option 3: Total Removal
Safety	1	Project risk to personnel - Offshore	g	g	a
	2	Project risk to other users of the sea	b	b	b
	3	Project risk to personnel - Onshore	b	b	b
	4	Potential of a high consequence event	b	b	b
	5	Residual risk to other users of the sea	r	a	g
Environment	6	Marine impact of operations	g	a	a
	7	Energy, emissions, resource consumption	b	b	b
	8	Impact of marine end points (legacy impact)	a	a	g
Technical	9	Risk of major project failure	b	b	b
	10	Technology demands / track record	b	b	b
Societal	11	Commercial impact on fisheries	a	g	g
	12	Socio-economic impact on communities and amenities	b	b	b
Economic	13	Cost	a	a	a
	14	Cost risk and uncertainty	b	b	b

Table 5-2 – Summary of Comparative Assessment Workshop output for Scope 1

Key for colour-blind readers: g – Green, a – Amber, r – Red, b – Blank / grey, i.e. no comparative difference between options

5.3. Scope 2 – Trenched and Buried Lines

This scope includes the trenched and buried sections of the following pipelines and umbilicals:

- PL1945 12" Scoter Production Pipeline
    - Approximately 11.7km between Shearwater A Platform and the Scoter Manifold, including crossings
- PLU1946 Scoter Umbilical
    - Approximately 12km between Shearwater C Platform and the Scoter Manifold, excluding crossings
- PL2346 8" Merganser Production Pipeline
    - Approximately 3.8km between the Merganser Manifold and Scoter Manifold Extension Structure
- PLU2347 Merganser Umbilical
    - Approximately 4km between the Merganser Manifold and the Scoter Manifold

This scope includes the five crossings associated with PL1945 and the two cable crossings of PLU2346 and PLU2347, as detailed in Section 2.6.3 of this document. However, this scope does not include the five crossings associated with PLU1946 which are covered in Section 5.4, Scope 3. It was noted PL1945's crossings include a number of buried mattresses and concrete plinths which are included within the assessment to decommission *in situ*.

Further, this scope includes the 'ends' of each pipeline and umbilical noted. The definition of an 'end' can be found in Section 2.4 of this document.

The burial status and depth-of-cover for each of these lines can be found in Appendix A of this document, indicating that, with the exception of the pipeline ends, the pipelines and umbilicals are buried to a depth-of-cover exceeding 0.6m.

Three credible options were identified for this scope:

- Decommission *in situ*
- Decommission *in situ* with end remediation
- Total removal

'End remediation' requires that any pipeline or umbilical decommissioned in situ will be trenched or buried to a depth-of-cover of at least 0.6m. It should be noted that this Comparative Assessment and the Scoter & Merganser Decommissioning Programmes will identify the required end state for decommissioned infrastructure. The methodology to achieve that end-state will be determined by the contractor executing the work and approved by Shell. Anticipated methodologies are identified in Appendix A of this document. All end remediation options include the recovery of exposed concrete mattresses and grout bags from the surface-laid sections to shore for recycling or disposal.

The output of the Comparative Assessment workshop for Scope 2 was as follows and is summarised graphically in the traffic-light assessment contained in Table 5-3 below.

The three credible options were reviewed against the five CA criteria of safety, environment, technical, societal and economic impacts.

In terms of safety impact, decommissioning the lines *in situ* with no remediation of the ends would represent an unacceptable legacy risk to other users of the sea, i.e. a snagging risk to the fishing industry. Therefore, the option to 'decommission *in situ* with no action' was discounted.

Assessing the safety risk of the other options, total removal would require the longest offshore campaign – both to debury the pipelines and umbilicals and then to remove them. This would include a large number of lifts from the seabed, with the accompanying increased safety risk to the offshore personnel. This safety risk would also apply to onshore personnel demobilising, transporting and recycling the removed pipelines and umbilicals.

For environmental impact, total removal would require the pipelines and umbilicals to be deburied before backfilling the resulting trenches – both of which would cause significantly higher short-term disturbance to the seabed than decommissioning *in situ* and remediating the pipeline ends.

Conversely, decommissioning the pipelines and umbilicals *in situ* would have a greater long-term environmental impact than total removal. However, noting that the pipelines will be flushed of bulk hydrocarbon ahead of decommissioning and that all material left *in situ* will be buried below the biological zone, the potential impact was not considered to be as severe as the short-term impact of deburying and backfill.

Due to the limited track record of successful reverse reel-lay to realise total removal of buried pipelines and umbilicals on the UKCS, total removal represents a slightly higher technical risk than decommissioning *in situ*.

Further, it was noted that total removal would represent both the highest cost of any option and the highest cost uncertainty due to the potential for the new berms created by backfilling the trenches requiring increased future monitoring.

Therefore, the recommendation to **decommission the listed pipelines and umbilicals *in situ* with end remediation** was presented for discussion and challenge at the CA workshop. Removed infrastructure, including any surface-laid concrete mattresses and grout bags protecting the trench transitions, will be recovered to shore for re-use / recycling and disposal.

There were no objections to this proposal from the stakeholder consultees.

Criteria	Ref	Sub Criteria	Option 1: Decommission *In-Situ* (no action)	Option 2: Decommission *in situ* with end remediation	Option 3: Total Removal
Safety	1	Project risk to personnel - Offshore	g	g	a
	2	Project risk to other users of the sea	b	b	b
	3	Project risk to personnel - Onshore	g	g	a
	4	Potential of a high consequence event	b	b	b
	5	Residual risk to other users of the sea	r	g	g
Environment	6	Marine impact of operations	g	a	r
	7	Energy, emissions, resource consumption	b	b	b
	8	Impact of marine end points (legacy impact)	a	a	g
Technical	9	Risk of major project failure	g	g	a
	10	Technology demands / track record	b	b	b
Societal	11	Commercial impact on fisheries	a	g	g
	12	Socio-economic impact on communities and amenities	b	b	b
Economic	13	Cost	g	g	r
	14	Cost risk and uncertainty	g	g	a

Table 5-3 – Summary of Comparative Assessment Workshop output for Scope 2

Key for colour-blind readers: g – Green, a – Amber, r – Red, b – Blank / grey, i.e. no comparative difference between options

5.4. Scope 3 – Scoter Umbilical Crossing

This scope includes the section of PLU1946 which crosses the following lines:

- PL1357 16" Machar to Marnock Oil Pipeline, is crossed by PLU1946
- PL1358 Marnock to Machar Control Umbilical, is crossed by PLU1946
- PL1575 12" Marnock to Machar Water Injection Pipeline, is crossed by PLU1946

This section of umbilical was identified during the CA Workshop as different to Scope 2 as the crossings are surface-laid and protected by mattresses only, whereas the crossings of PL1945 are completely protected by rock cover to a depth-of-cover in excess of 0.6m. Therefore, this section was assessed separately.

PLU1946 exits its trench on approach to the crossings and is surface-laid across the three listed lines before entering its trench again on the other side of the crossings. The surface-laid area is protected by a combination of mattresses and rock. Scope 3 covers the surface-laid area of PLU1946 only. To either side of the crossings, PLU1946 is crossed by the following lines.

- PL1981 6" Marnock to Machar Gas Lift Pipeline, crosses PLU1946
- PLU3955 Marnock to Machar Electrical Upgrade Umbilical, crosses PLU1946

Where PLU1946 is crossed by these lines, the umbilical is fully trenched and buried beyond a depth-of-cover of 0.6m and is included within Scope 2, see Section 5.3.

The crossing arrangement and extend of Scope 3 is indicated in Figure 5-3 below. This incorporates approximately 250m of PLU1946.

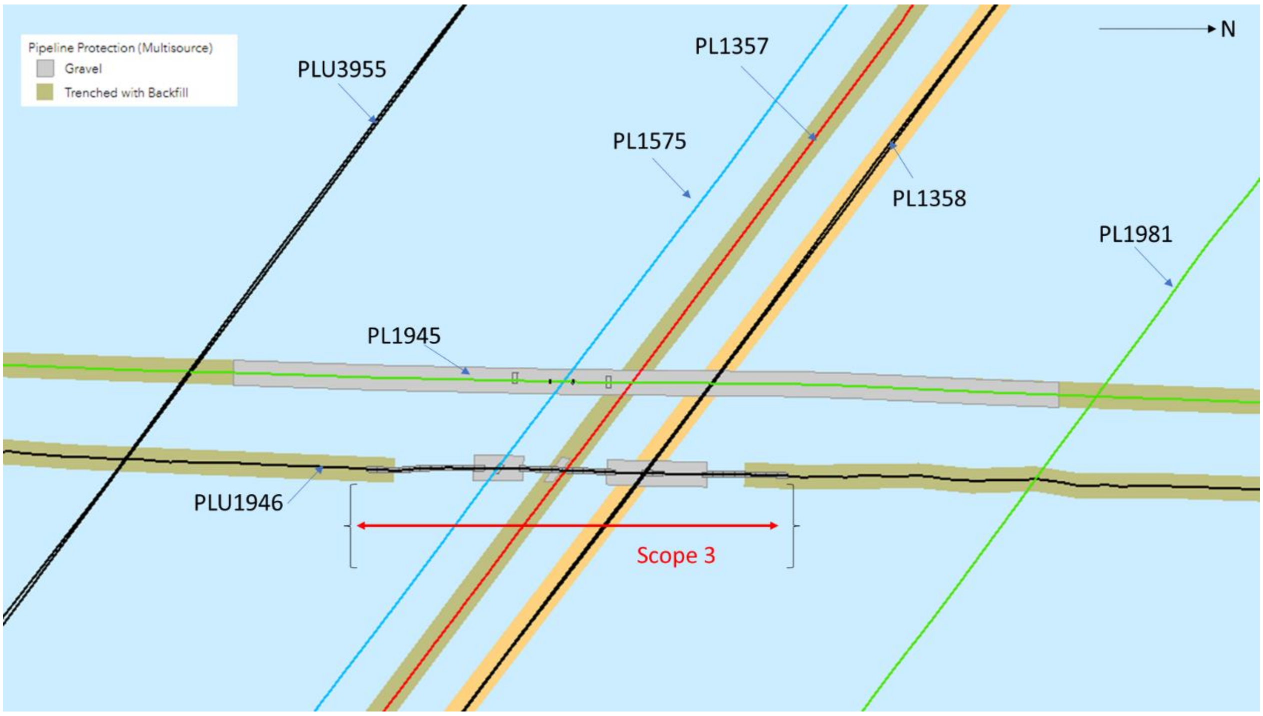


Figure 5-3 – PLU1946 crossings, Scope 3

Four credible options were identified for this scope:

- Decommission *in situ* (no action)
- Blanket rock cover
- Remove mattresses and blanket rock cover
- Total removal of umbilical not covered by rock.

The output of the Comparative Assessment for Scope 3 was as follows and is summarised graphically in the traffic-light assessment contained in Table 5-4 below.

The four credible options were reviewed against the five CA criteria of safety, environment, technical, societal and economic impacts.

Decommissioning the lines *in situ* with no action taken would represent an unacceptable legacy risk to other users of the sea, i.e. a snagging risk to the fishing industry. Therefore, the option to 'decommission *in situ* with no action' was discounted. Similarly, the option to blanket rock cover, without first removing the mattress cover, was discounted as non-compliant with the OPRED Guidance Notes on Decommissioning [1].

This left two remaining options:

- decommission the umbilical *in situ*, remove the existing mattresses and rock cover; orc
- total removal of umbilical not covered by rock.

Both remaining options would involve offshore campaigns of similar duration and therefore comparatively equal costs and a similar level of operating risk to project personnel.

Total removal of the umbilical sections not covered by rock would, however, represent a higher residual safety risk to other users of the sea. During the CA Workshop, representatives of the fishing industry indicated their preference for fewer cut ends, as these would represent future snagging risks even if protected by additional rock. They also indicated a preference for continuous rock berms rather than a series of individual areas of rock within 50m of each other along the length of a pipeline / umbilical, as the latter could destabilise trawlboards causing them to self-bury in the seabed. As two of the crossings, over PL1575 and PL1358, are already rock-covered and would not be removed, removal of the intervening sections would create six cut ends and four individual areas of rock in close proximity.

Therefore, total removal represents a moderately greater safety risk to other users of the sea and has a corresponding commercial impact to fisheries.

Both remaining options would have some immediate marine impact. Short-term seabed disturbance would result from the mattress removal that is common to both options, whilst the removal of the umbilical required for the 'total removal' option only is within the same footprint as the mattress removal and therefore not considered to result in additional disturbance. Both options would require the addition of new rock cover, but again within the footprint that has already been disturbed by the removal of the mattresses. Therefore, both options are considered to have relatively similar short-term impact.

In terms of long-term environmental impact, total removal would have a slightly lower impact by removing material that will otherwise remain buried below the installed rock-berm. Considering the very short length of umbilical to be removed within this scope, the impact was considered to be moderate.

Therefore, the recommendation to **remove the existing mattresses and blanket rock cover the crossing area** was discussed and agreed at the CA workshop. Removed infrastructure, i.e. the existing surface-laid concrete mattresses and grout bags protecting the trench transitions, will be recovered to shore for re-use / recycling and disposal.

There were no objections to this proposal from the stakeholder consultees.

It should be noted that the third-party pipelines being crossed are currently operational. Therefore, it is Shell's proposal that the above scope be executed only once the crossed lines are taken out of service and their decommissioning plans approved by OPRED. This removes the safety risk of lifting concrete mattresses over live pipelines and does not preclude any decommissioning option for the owners of the third-party crossed lines.

Criteria	Ref	Sub Criteria	Option 1: Decommission In-Situ (Do Nothing)	Option 2: Blanket rock cover	Option 3: Remove mattresses and blanket rock cover	Option 4: Total removal of umbilical not covered by rock
Safety	1	Project risk to personnel - Offshore	g	g	a	a
	2	Project risk to other users of the sea	b	b	b	b
	3	Project risk to personnel - Onshore	b	b	b	b
	4	Potential of a high consequence event	b	b	b	b
	5	Residual risk to other users of the sea	r	g	g	a
Environment	6	Marine impact of operations	g	g		a
	7	Energy, emissions, resource consumption	b	b	b	b
	8	Impact of marine end points (legacy impact)	a	r	a	g
Technical	9	Risk of major project failure	b	b	b	b
	10	Technology demands / track record	b	b	b	b
Societal	11	Commercial impact on fisheries	r	g	g	a
	12	Socio-economic impact on communities and amenities	b	b	b	b
Economic	13	Cost	a	g	a	a
	14	Cost risk and uncertainty	b	b	b	b

Table 5-4 – Summary of Comparative Assessment Workshop output for Scope 3

Key for colour-blind readers: g – Green, a – Amber, r – Red, b – Blank / grey, i.e. no comparative difference between options

6. References

Table 6-1 – Supporting Documents		
Ref	Document Number	Title
[1]	SMDP-PT-S-AA-8203-00001	Scoter and Merganser Decommissioning Programmes
[2]	N/A	OPRED GUIDANCE NOTES - Decommissioning of Offshore Oil and Gas Installations and Pipelines November 2018
[3]	N/A	Oil and Gas UK Guidelines for Comparative Assessment in Decommissioning Programmes, Issue 1 October 2015

7. Appendix A: Pipeline Burial Depth Summary

7.1. General

The burial depth of the pipelines and umbilicals is important information when considering leaving pipelines or umbilicals in-situ or removal. The historical survey data for the Scoter & Merganser pipelines has been assessed to determine the pipelines' and umbilicals' burial depth. The following sections present graphical summaries of the Scoter & Merganser pipeline data.

7.2. Pipeline Burial Depth Definition

Generally, there are two definitions for burial depth; depth of lowering and depth of cover, which are both illustrated in Figure 7-1 below. The depth of cover is the conventional definition of burial depth, which is the depth of backfill or rock on top of the pipeline or umbilical. The depth of lowering is the depth of the top of the pipeline or umbilical below the natural mean seabed level. The natural mean seabed level is identified ignoring any berms to the sides of the trench.

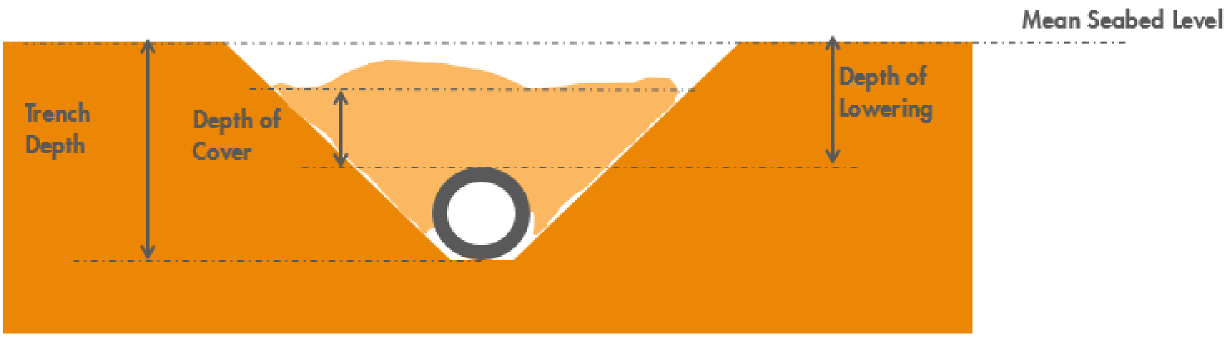


Figure 7-1 – Burial depth definition

The graphics below, Figures APP3-2 to APP3-5, show the depth-of-cover data from as-trenched surveys of the Scoter and Merganser pipelines and umbilicals following their installation in 2002 and 2006 respectively. This survey data was supplemented in the Comparative Assessment Workshop with sonar and ROV survey data from 2004 to 2017 and 2008 to 2017 for Scoter and Merganser respectively.

A brief explanatory note is provided for each line.

On the completion of decommissioning activities, Shell will perform a depth-of-cover survey for the full length of each line being decommissioned *in situ*. The results of these surveys will be presented to OPRED in a similar linear graph format as part of the Close Out Report.

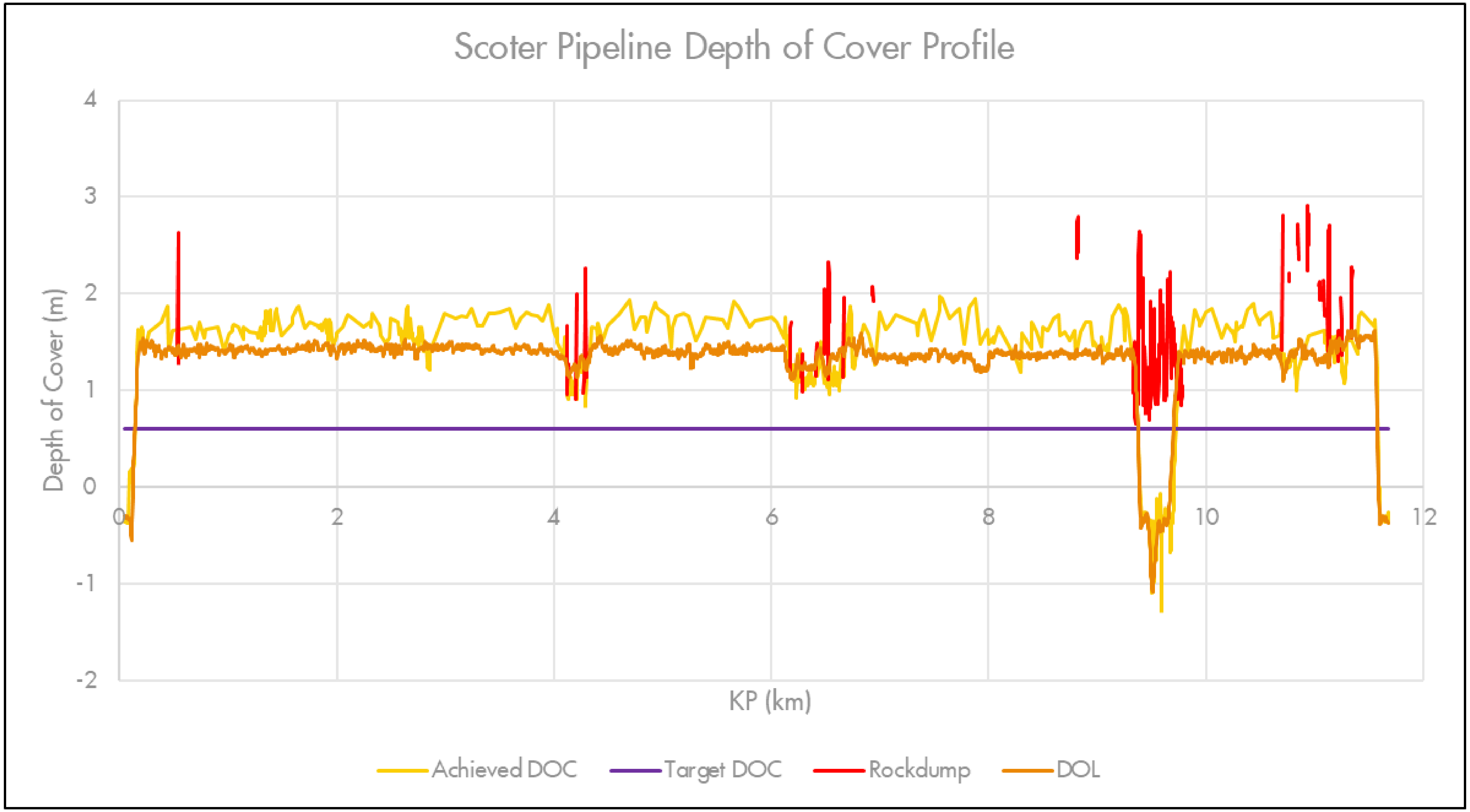


Figure 7-2 – Scoter Production Pipeline Survey Results Summary (N0795 / PL1945)

Figure 7-2 shows the survey results from the 2002 as-installed depth-of-cover survey. The horizontal purple line indicates the minimum target depth-of-cover (0.6m) in line with the OPRED Guidance Notes [2]. The red lines indicate areas of rock cover. At ~KP4.2, ~KP6.4 and ~KP11-11.5, the rock was installed to prevent upheaval buckling of the pipeline. At ~KP 9.2-9.6, the rock was installed to protect the crossing detailed in Table 1.10.

The depth-of-cover achieved across the pipeline is well in excess of the target 0.6m.

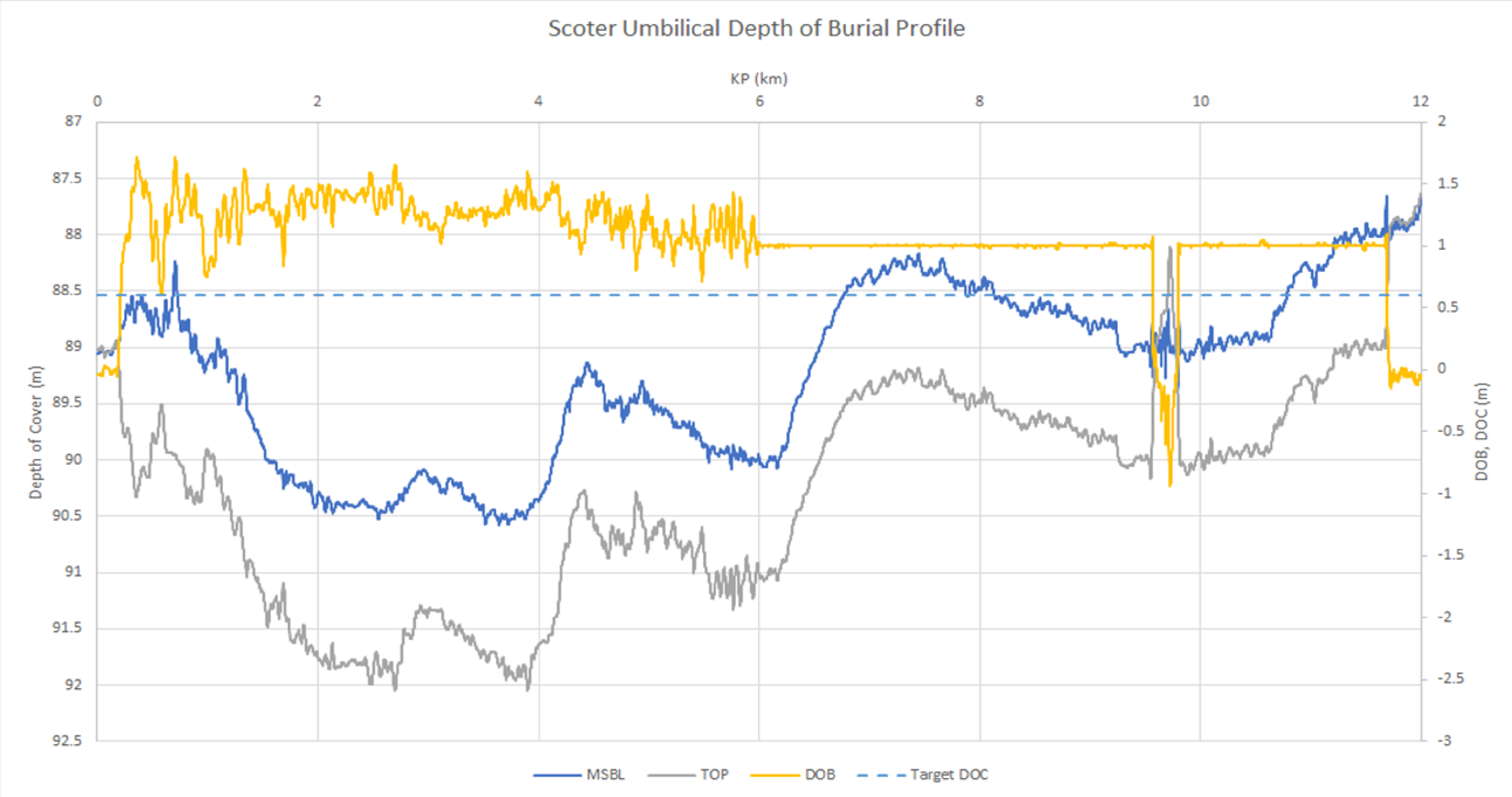


Figure 7-3 – Scoter Umbilical Survey Results Summary (N1841 / PLU1946)

Figure 7-3 shows the survey results from the 2002 as-installed depth-of-cover survey. The horizontal dashed blue line indicates the minimum target depth-of-cover (0.6m) in line with the OPRED Guidance Notes [2]. The Scoter umbilical was laid in a pre-cut trench and allowed to naturally backfill. The blue line indicates the Mean Seabed Level (MSBL) and the grey line indicates the Top of the Pipe (TOP) as tracked during the as-installed survey. This provides the Depth of Burial (DOB) shown in the yellow line. Subsequent sonar surveys indicate that the pre-cut trench has backfilled completely, therefore the Depth of Burial indicated is assumed to be the current Depth of Cover.

The depth-of-cover achieved across the trenched and buried sections of the umbilical is well in excess of the target 0.6m. The lower depth-of-cover shown at ~KP9.4-9.7 indicates the crossings detailed in Table 1.10.

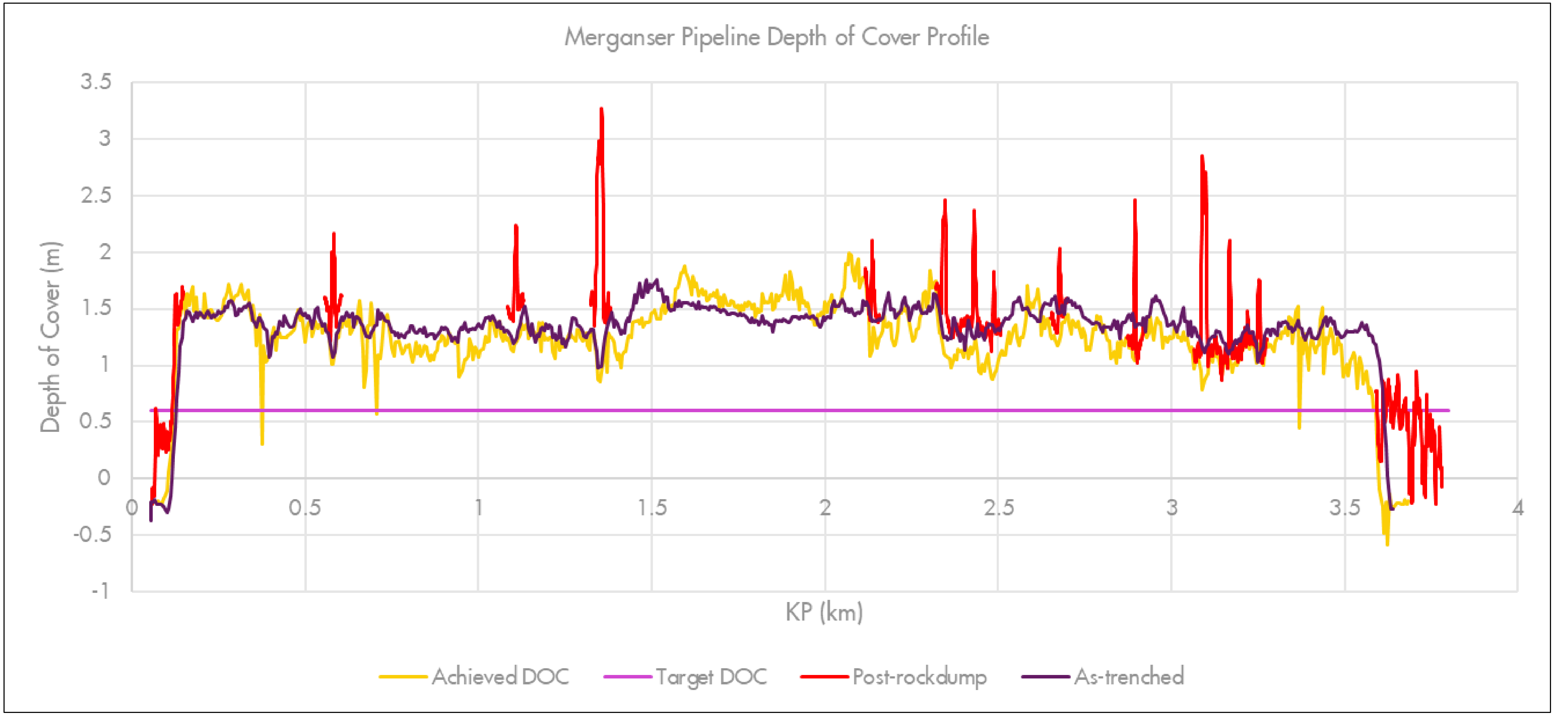


Figure 7-4 – Merganser Production Pipeline Survey Results Summary (N1759 / PL2346)

Figure 7-4 shows the survey results from the 2006 as-installed depth-of-cover survey. The horizontal purple line indicates the minimum target depth-of-cover (0.6m) in line with the OPRED Guidance Notes [2]. The red lines indicate areas of rock cover, installed either to mitigate areas of low cover following pipelay or to prevent upheaval buckling. The extended rock-cover at ~KP3.6 onwards indicates the rock covering the transition from the pipeline's trench on approach to the Merganser Manifold. The three 'spikes' in the yellow line (~KP0.4, ~KP0.75, ~KP3.4), indicating the achieved Depth-of-Cover, were assessed by the survey team to be 'noise' during the survey which distorted the results and are not representative of seabed conditions. These areas were presented during the Comparative Assessment for discussion with the stakeholders present.

The depth-of-cover achieved across the trenched and buried pipeline is well in excess of the target 0.6m.

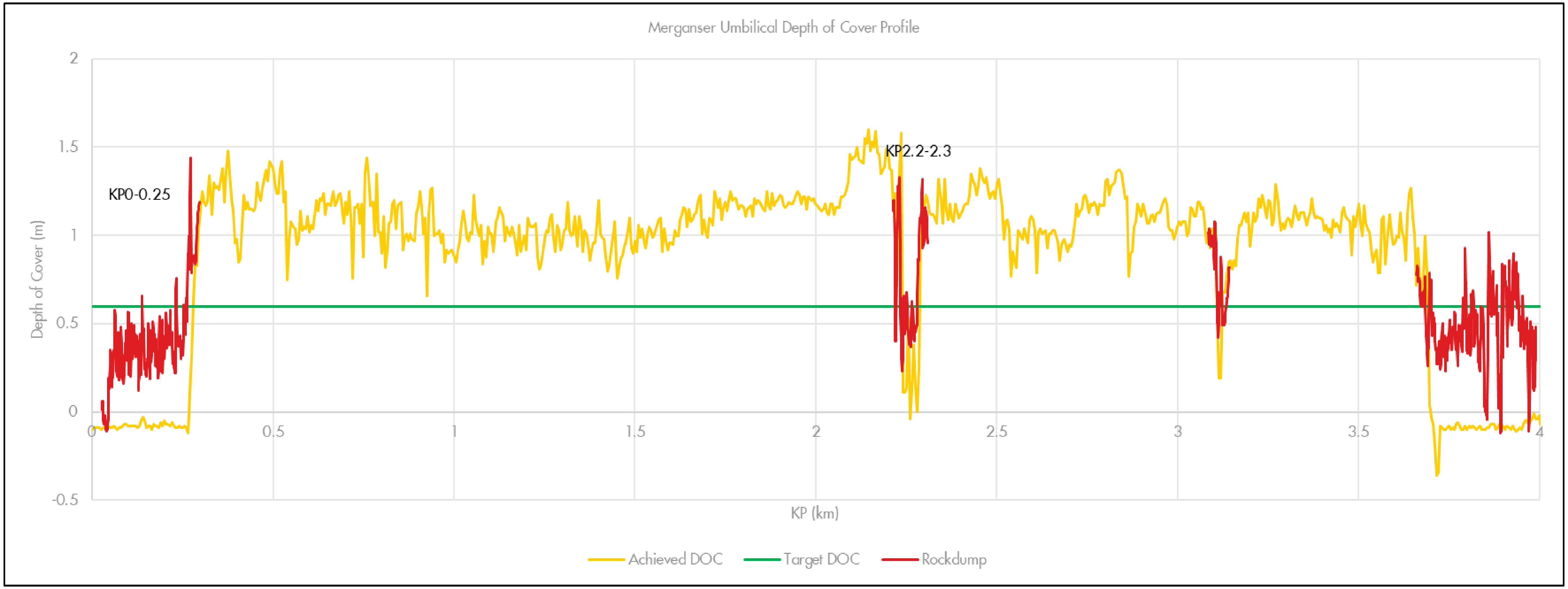


Figure 7-5 – Merganser Umbilical Survey Results Summary (N2842 / PLU2347)

Figure 7-5 shows the survey results from the 2006 as-installed depth-of-cover survey. The horizontal green line indicates the minimum target depth-of-cover (0.6m) in line with the OPRED Guidance Notes [2]. The red lines indicate areas of rock cover, installed to mitigate areas of low cover following the as-laid survey of the umbilical. The extended red lines at the start and end of the umbilical indicate the rock-cover protecting the transitions from the umbilical's trench on approach to the SMES and Merganser Manifold respectively.

The depth-of-cover achieved across the trenched and buried umbilical is well in excess of the target 0.6m.

8. Appendix B – CA Assessment Guidance

Criteria	Sub-Criteria	Applicable to	Applicable When	Green	Amber	Red
Safety	Project risk to personnel – Offshore	Project team offshore, project vessels crew, diving teams, supply boat crew, heli-ops, survey vessels crew	During execution phase of the project including any subsequent monitoring surveys	Minimal preparatory activity to be completed prior to start of removal activity. No underdeck / overside working. Minimal materials handling on deck or barge during removal. Minimal diver activity.	Some preparatory activity to be completed prior to start of removal activity – but straight forward. Limited underdeck / overside working. Some materials handling activity on deck or barge during removal – but straight forward. Increased diver activity for short intervals and for less than 25% project duration.	High level of preparatory activity to be completed prior to start of removal activity. Significant underdeck / overside working. Multiple materials handling activity on deck or barge during removal. Extended diver activity throughout entire project phase.
	Project risk to other users of the sea	All other users of the sea, fishing vessels, commercial transport vessels, military vessels	During execution phase of the project including any subsequent monitoring surveys	Minimal project activity outside existing exclusion zone. Minimal additional vessels transits to and from shore.	Moderate project activity outside existing exclusion zones but for short durations. Some additional vessel transits to and from shore of significant sized vessels. No complex transits.	Significant project activity outside existing exclusions zones but for most of project duration. Some complex transits to shore.
	Operational risk to personnel – Onshore	Onshore dismantling and disposal sites personnel; extent of materials transfers/ handling on land	During execution phase of the project, through to final disposal of recovered materials	Medium sized / volume of structures returned as waste - moderate dismantling required onshore, minimal work at height. Minimal contaminated materials to be returned, capable of being processed in existing facilities without additional specialist equipment or treatment.	Large size / volume of structures returned as waste – more dismantling required onshore, some working at height possible. Some contaminated materials may be returned, may require some additional specialist equipment or treatment.	Significant sized or awkward shaped structures returned as waste – significant working at height required, significant and complex dismantling and materials handling activities required. Significant volumes of contaminated materials handling and clean up anticipated; or requires onerous levels of additional specialist equipment / treatment.
	Potential for a high consequence event	Project team offshore and onshore; project vessels; diving teams; supply boat crew; heli-ops; survey vessels; onshore dismantling and disposal sites personnel	During execution phase of the project including any subsequent monitoring surveys	Short vessel campaign (summer campaign); low level vessel SIMOPS; minimal helicopter crew changes anticipated; few lifting operations; all straightforward and not over live plant.	Prolonged vessel campaigns; some vessel SIMOPS; helicopter crew changes possible; some lifting operations; recovered structures lifted onto vessels for backload but not over live plant.	Extensive vessel campaigns; multiple mob / demob; multiple vessel SIMOPS; helicopter crew changes likely; major lifting operations, some very large lifts; possible lifts of structures over live trunk lines.
	Residual risk to other users of the sea	Fishing vessels, fishermen, supply boat crews, military vessel crews, commercial vessel crew and passengers, other users of the sea	Following completion of the Decommissioning project and residual / ongoing impact in perpetuity	None anticipated as clear seabed on completion of project, all material left in situ is adequately trenched or buried below mean seabed level.	Some materials which are proud of mean seabed level / not trenched or buried but are otherwise protected, i.e. rock-covered or present minimal risk of snagging due to their inherent structure (e.g. large diameter trunklines). Other mitigations in place (retention of exclusion zones).	Material left in situ is proud of the seabed and not protected by rock-cover and could represent a future snagging risk; mitigation available is limited to marking on admiralty charts. Material left in situ would require significant future monitoring and / or future mitigation measures.
Environmental	Impact of operations	Environmental impact to the marine environment, nearshore areas and onshore caused by project activities	During execution phase of the project from mobilisation of vessels to the end of project activities at the waste processing / disposal site (does not include landfill and long-term storage impacts) For rock placement, trenching and dredging any seabed disturbance is included here, depending on area of	No associated discharges*[1]; No behavioural disturbance to any marine mammals; Area of disturbance equal or less than area disturbed during installation and/or operations; No disturbance to drill cuttings accumulation*[2]; Extend of the sediment resuspension equal or less than the extent caused during operations and/or installation;	Non-SUB, GOLD or E/PLONOR chemicals discharges*[1]; Temporary changes to behaviour of any marine mammals i.e. temporary move away from the area; Area of disturbance is up to two times bigger than the area disturbed during installation and / or operation; Less than half the volume of the drill cuttings deposits*[2] will be disturbed;	Any other chemical discharges*[1] (other than in Amber) e.g. SILVER, OCNS A-C or no longer CEFAS registered; Permanent damage / change to behaviour of any mammals (i.e. move away permanently and / or permanent damage to hearing); Area of disturbance more than two times bigger than the area disturbed during installation and / or operations; AND Greater than half the volume of the drill cuttings will be disturbed; AND

Criteria	Sub-Criteria	Applicable to	Applicable When	Green	Amber	Red
			impact – changes to habitat and species are covered in Legacy Impact.	No protected / sensitive species and or habitats affected; Onshore processing can be completed by existing facilities without additional specialist equipment / treatment*4	Extent of the sediment resuspension is up to two times bigger than during operation and/or installation; Presence of protected / sensitive species and/or habitats identified and confirmed by a survey*3; Onshore processing requires moderate levels of specialist equipment / treatment, additional qualified personnel, etc	Sediment resuspension is more than twice than during operation and/or installation; Presence of designated protected species and/or habitats*3; Onshore processing requires onerous or offsite levels of specialist equipment / treatment
	Energy, emissions and resource consumption	Project activities from vessel mobilisation to the final destination of waste, including the energy and emissions penalty for leaving recyclable material in field. Includes vessel mobilisation, demobilisation, waiting on weather, post-decommissioning monitoring surveys.	During execution phase of the project from mobilisation of vessels to the end of project activities at the waste processing / disposal site (does not include landfill and long-term storage impacts) Not recovering and recycling the installations material will require that raw material and energy will be consumed to replace the materials which would have been recycled if the structure had been brought onshore	Short duration and/or small number of vessels during decommissioning operation and future monitoring; Small volume of material left in situ	Moderate duration and number of vessels during decommissioning operation and future monitoring; Moderate volume of material left in situ	Significant duration and number of vessels required for operations and future monitoring; Significant volume of material left in situ
	Legacy impact	Ongoing long term environmental impact caused by materials left in place or long-term waste storage / landfill	Following completion of the Decommissioning project and residual / ongoing impact For rock placement, trenching and dredging any changes to habitat and species are included here - seabed disturbance is included in Impact of Operations, depending on area of impact.	Minor volumes of material to landfill; No hazardous waste requiring long-term storage; No change to habitat or species composition (introduction of no new materials); No material left ON the seabed; and / or inert material left IN the seabed (trenched or buried)	Moderate volumes of material to landfill; Non-hazardous waste requires disposal (landfill) OR Small amount of hazardous waste requiring treatment and / or long term-storage; Possible / temporary alteration of species composition due to habitat alteration with recovery and recolonization of the area by original species; Inert material left ON the seabed; or contaminated material left IN the seabed posing no significant threat to the environment *5	Majority of recovered material destined for landfill; Majority of hazardous waste long-term storage; Permanent habitat alteration with permanent changes in species composition; Material left ON or IN the seabed containing contaminated material that poses a significant long term threat to the environment*6
Technical	Risk of major project failure	Overall Project	From project select phase through to completion, including monitoring surveys and ultimate disposal of materials returned to shore.	High level of confidence that schedule slippage can be accommodated within the contingency and float in the plan; high level of confidence that cost increases can be accommodated by contingency UAP budget allocation; slippage to schedule and growth in cost anticipated is small; assets and equipment are immediately available to facilitate recovery and stabilise the situation after an incident; speed of recovery is anticipated to be swift; limited impact on planned campaign schedule is anticipated as remaining planned activities can continue in the interim.	Less confidence in cost and schedule, however moderate level of delay and cost overrun is anticipated as worst case; assets and equipment are available in a reasonable timeframe from onshore to stabilise the situation after an incident; speed of recovery is anticipated to be longer due to some re-engineering of activities being required; considerable impact on the planned campaign schedule is anticipated, as remaining planned activities cannot continue in the interim.	Significant delays are possible if upsets occur pushing removals phase into a separate season and increased cost overrun possible; re-engineering required to develop procedures and identify assets and equipment to stabilise the situation after an incident; speed of recovery is anticipated to be slow due to re-engineering and procurement of new equipment; significant impact on the entire project schedule and company reputation.

Criteria	Sub-Criteria	Applicable to	Applicable When	Green	Amber	Red
	Technology demands, Availability / Track Record	Overall Project	From project select phase through to completion, including monitoring surveys and ultimate disposal of materials returned to shore.	The proposed concept has been successfully implemented in the past; technological feasibility of the concept is beyond doubt; industry and expert opinion consistently concludes that the proposed solution is technically robust and complies with existing legislation; vessels and most supporting equipment are industry-standard with good track record of successful operation with no new marine asset construction required; some minor supporting equipment may require investment to aid development or proof of use as planned, however it is anticipated that this can be completed successfully ahead of the project schedule; the supply chain is generally readily available in the present market; project schedule is reasonable and equipment availability is within project timetable.	The proposed concept has been seriously considered for several directly comparable assets in the past but has not yet been used; technological feasibility of the concept requires some additional engineering development; expert opinion is united in confidence that the proposed solution is generally technically sound and complies with existing legislation; some vessels require some investment to aid minor development, however there is widespread confidence within the industry that this shall be completed successfully; more supporting equipment requires early investment to aid development, however it is anticipated that this will be completed successfully ahead of the project schedule; the supply chain requires some engagement to meet project requirements; project schedule can be managed to suit equipment availability within the overall project timetable.	The proposed concept is not mature; technological feasibility of the concept requires considerable engineering to prove; there is some doubt within the industry and expert opinion is divided on whether the proposed solution is technically sound and can comply with existing legislation; vessel require investment to aid their development and construction; other supporting equipment requires investment to aid development; there is uncertainty within the industry that this will be completed successfully ahead of the project schedule; the supply chain requires development; project schedule is tight but may be managed to suit equipment availability.
Societal	Commercial impact to fisheries	Impacts from both the decommissioning operations and the end-points on the present commercial fisheries in and around the field	During and following completion of the Decommissioning project and residual / ongoing impact	The status of the area / site post-decommissioning will have no effect on commercial fisheries.	The status of the area / site post-decommissioning results in small areas of fishing ground or water column becoming inaccessible to fishing and is lost to fishing over prolonged period.	The status of the area / site post-decommissioning results in larger areas of fishing ground or water column becoming inaccessible to fishing and is lost to fishing over a prolonged period.
	Socio-economic impact on communities and amenities	The impact from any near shore and onshore operations and end-points (dismantling, transporting, treating, recycling, land filling) on the health, well-being, standard of living, structure or coherence of communities or amenities. E.g. business or jobs creation, increase in noise, dust or odour pollution during the process which has a negative impact on communities, increased traffic disruption due to extra-large transport loads.	During and following completion of the Decommissioning project and residual / on-going impact	No or minor negative impact: short-term (<6 months) impact on local communities causing potential minor nuisance from some aspects of the operations, but would cease and revert to previous condition on completion of specific short term operations. Short-term (<6 months) impact on local amenities for some or all of the operations, but would cease and revert to previous condition on completion of operations, without the need for mitigation. Positive impact: new business or long term employment created, extends beyond duration of the operation by more than 1 year. Permanent road and other infrastructure improvements created.	Some negative impact on local communities, leading some actual deterioration in quality of life, deterioration would exist while actual operations were being carried out but would essentially cease as soon as operations were completed and quickly revert to pre-operation condition; some impact on local amenities, leading to some actual deterioration in amenities; deterioration would exist whilst actual operations were being carried out. Some mitigation / remedial work would be required when operations were completed to restore amenities to pre-operational condition. Short term and local positive impact on communities as localised increased job prospects created for duration of the operation. No permanent positive impact on amenities anticipated.	Significant and long-term (>1 year) negative impact on local communities leading to noticeable deterioration in quality of life during the operations. Anticipated this would persist for a period of 6 months to 1 year after actual operations had ceased. Significant and long-term (>1 year) impact on local amenities, leading to noticeable deterioration during the operations. Mitigation / remedial work would be required when operations were completed to restore amenities to pre-operational condition. No positive impact on communities or amenities. Existing businesses and infrastructure can accommodate operations.
Econ omic	Cost	Overall Project	Full decommissioning project cost including future monitoring surveys and proposed remediation, if required	Lowest cost option	-	Highest cost option

Criteria	Sub-Criteria	Applicable to	Applicable When	Green	Amber	Red
	Cost Risk / Uncertainty	Overall Project	Project execution phase and ongoing cost liability (surveys and potential remedial action)	Scope reasonably defined and understood; estimate developed using recognised and validated estimating tools; validated cost basis industry norms from similar work already carried out.	Some uncertainty / information gaps in parts of the scope and / or equipment used; estimate developed using recognised and validated estimating tools; validated cost basis using industry norms, some information gaps in norms due to costs of new or emerging equipment rates not being available.	Uncertainty in many areas of the scope and in equipment used; OOM estimate only developed; significant information gaps in norms due to costs of new / emerging equipment rates not being available.