Provision of Comparative Assessment & Associated Services

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Provision of Comparative Assessment & Associated Services

CA Report

Premier Oil UK Limited

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Document Number: A-301999-S00-REPT-005

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CA Report

A301999-S00

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EXECUTIVE SUMMARY

Premier Oil have conducted a Comparative Assessment (CA) in support of the Phase II of the Balmoral Area Decommissioning Project (Subsea Infrastructure). The following steps from the Oil and Gas UK CA Guidelines have been completed:

This CA report presents the methodology, decisions which needed to be taken, the preparation works carried out, and the outcomes (recommendations) from the internal and external (with stakeholders) workshops.

The CA for the Phase II of the Balmoral Area Decommissioning Project (Subsea Infrastructure) has focussed on five decommissioning groups (groups 1, 3, 4, 14 and 15).

All other decommissioning groups of the Balmoral Subsea Infrastructure were confirmed at the CA Scoping and Screening stage to be fully removed from the field. The drill cuttings will remain in-situ. The outcome of the CA process has made the following recommendations:

Decommissioning Group	Decommissioning Recommendation
1 – Surface Laid Flowlines & Umbilicals	Full removal All flowlines and umbilicals to be removed (using reverse reeling techniques) and returned to shore for processing.
3 – Trenched & Buried Rigid Flowlines	Leave in-situ All flowlines to have exposed ends and any areas of exposure removed and returned to shore for processing. Local rock placement introduced to mitigate snag hazard from cut ends.
4 – Trenched & Buried Flexible Flowlines & Umbilicals	Full Removal All flowlines and umbilicals to be deburied and removed (using reverse reeling techniques) and returned to shore for processing.
5 – Flexible Jumpers	Full Removal
7 – Rigid Spoolpieces	Full Removal
9 – Control & Chemical Jumpers	Full Removal
11 – Large Subsea Installations – Balmoral Template	Full Removal
12 – Small Subsea Installations	Full Removal
13 – Mattresses – Flexible Concrete Mattresses with Polypropylene Rope	Full Removal
14 – Mattresses – Other (incl. Grout bags)	Leave in-situ All difficult to retrieve mattresses to have local rock placement introduced to mitigate snag hazard. The following caveats apply: 1. Difficult to retrieve mattresses and grout bag that are associated with any subsea infrastructure that is to be fully removed i.e. spool pieces, small subsea installations, etc. shall be fully removed at the time of removing the related equipment. 2. The DP applied for is on the basis that all mattresses be recovered to shore, however, in the likely event of practical difficulties OPRED will be consulted at that time.
15 – Mooring System incl. Anchor Piles	Leave in-situ Mooring chains to be cut at seabed level, recovered and returned to shore for processing. Anchor piles to remain.

Decommissioning Group	Decommissioning Recommendation
16 – Flexible Risers	Full Removal
17 - Surface Laid & Rock Covered Flexible Flowline	Full Removal
18 – Drill Cuttings	Leave in-situ Other than the drill cuttings disturbed and retrieved as part of the Balmoral Template removal, all other drill cuttings to remain in-situ.

The decisions were reached on completion of an appropriate amount of preparatory study work, with clear decision outcomes.

The only infrastructure remaining following decommissioning is proposed to be the already trenched and buried rigid flowlines, the difficult to remove concrete mattresses and the mooring anchor piles and the drill cuttings not recovered with the Balmoral Template. All other infrastructure will be fully removed.

1 INTRODUCTION

1.1 Purpose

The purpose of this document is to present a Comparative Assessment (CA) for the Subsea Infrastructure of the Balmoral Area Decommissioning Project in support of the decommissioning programme. It is produced in satisfaction of the requirement to perform a Comparative Assessment (CA) into any potential derogation application for subsea equipment as detailed in the Decommissioning Guidelines ref. [7] and the CA Guidelines ref. [9].

It describes the field infrastructure addressed, the decommissioning options considered, the CA methodology used and the recommendations made during the CA process.

The Balmoral Area Decommissioning Project covers the following:

- Phase I – Floating Production Vessel (FPV)
- Phase II – Subsea Infrastructure
- Phase III – Wells

Whilst there are some overlaps between the programme phases, this report covers Phase II – Subsea Infrastructure only.

1.2 Background

The Balmoral Area (commonly known as B-Block) consists of the Balmoral, Glamis, Stirling, Brenda and Nicol Fields, all of which produce via the Balmoral FPV (Floating Production Vessel). The third party fields Burghley and Beauly are also tied back to the Balmoral infrastructure. The Balmoral FPV is moored in 143 m water 200 km north east of Aberdeen. The Balmoral Area fields are located within blocks 16/21a and 16/21b in the Central North Sea.

Produced oil is transported via a 14-inch export line which connects to the Brae-Forties Trunk Line. The Balmoral field layout and neighbouring Glamis, Stirling, Brenda and Nicol fields are presented below in Figure 1.1.

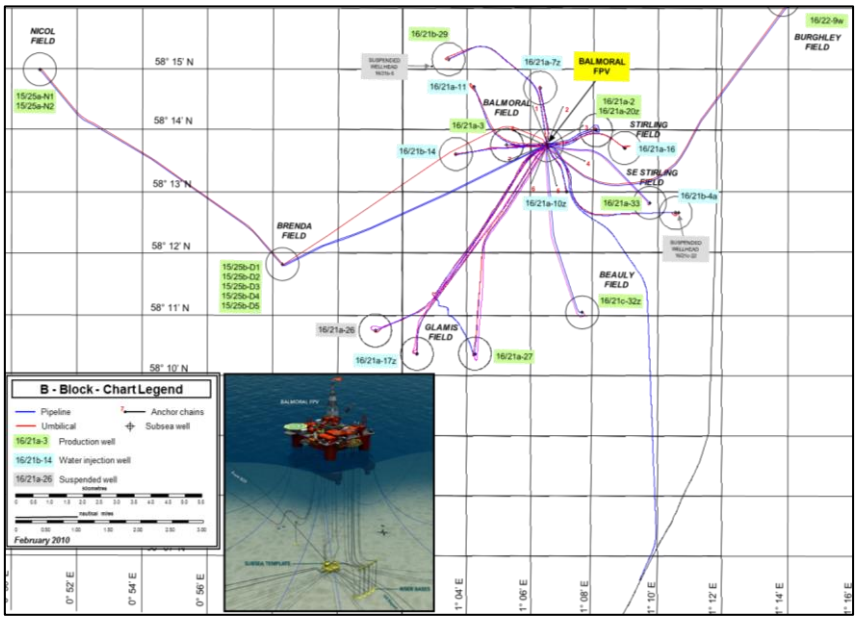


Figure 1.1: Balmoral Field Layout

1.3 Report Structure

This CA Report contains the following:

- Section 1 – An introduction to the document and project, including acronyms and references.
- Section 2 – An overview of the CA methodology and definition of the scoping and boundaries of the CA.
- Section 3 – The decommissioning groups identified and the initial decommissioning approach.
- Section 4 – The CA outcome obtained for Group 1 – Surface Laid Pipelines and Umbilicals.
- Section 5 – The CA outcome obtained for Group 3 – Trenched & Buried Rigid Flowlines.
- Section 6 – The CA outcome obtained for Group 4 – Trenched & Buried Flexible Flowlines & Umbilicals.
- Section 7 – The CA outcome obtained for Group 14 – Mattresses – Other.
- Section 8 – The CA outcome obtained for Group 15 – Mooring System incl. Anchor Piles.
- Appendix A – An explanation of the CA Evaluation
- Appendix B – Stakeholder CA Workshop Minutes
- Appendix C – Group 1 – Detailed Evaluation Results
- Appendix D – Group 3 – Detailed Evaluation Results
- Appendix E – Group 4 – Detailed Evaluation Results
- Appendix F – Group 14 – Detailed Evaluation Results
- Appendix G – Decommissioning Option Data Sheets

1.4 Terms, Abbreviations and Acronyms

AHP	Analytical Hierarchy Process
BAT	Best Available Technology
BEIS	Department for Business, Energy and Industrial Strategy
BEP	Best Environmental Practice
CA	Comparative Assessment
CO_2	Carbon Dioxide
CP	Cathodic Protection
CSV	Construction Support Vessel
DECC	Department for Energy and Climate Change
DP	Decommissioning Programme
DSV	Diver Support Vessel
EMT	Environmental Management Team
FPV	Floating Production Vessel
HAZID	Hazard Identification
HazMat	Hazardous Material

JNCC	Joint Nature Conservation Committee
km	Kilometres
m	Metres
m^2	Metres squared
MCDA	Multi-Criteria Decision Analysis
MEI	Major Environmental Incident
MFE	Mass Flow Excavator
MS	Much Stronger
MW	Much Weaker
NORM	Normally Occurring Radioactive Material
OBM	Oil Based Mud
OD	Outside Diameter
ODU	Offshore Decommissioning Unit
OGA	Oil & Gas Authority
OIW	Oil in Water
OPRED	Offshore Petroleum Regulator for Environment & Decommissioning
P&A	Plug and Abandon
PLL	Potential for Loss of Life
POB	Personnel on Board
ROV	Remotely Operated Vehicle
S	Stronger
SEPA	Scottish Environmental Protection Agency
SFF	Scottish Fishermen's Federation
SRB	Sulphate Reducing Bacteria
VMS	Very Much Stronger
VMW	Very Much Weaker
W	Weaker
WBM	Water Based Mud

1.5 References

1. Inventory & Scoping Report	Balmoral Field Subsea Inventory and Scoping Report, Doc. No.: AB-BL-XGL-LL-ZZ-RP-0002, Rev.: B02, Dated: 15/09/2017.
2. Screening Report	Balmoral Area Decommissioning Screening Report, Doc. No.: AB-BL-XGL-LL-ZZ-RP-0003, Rev.: B04, Dated: 07/05/2020.
3. Method Statement Report	Subsea Infrastructure Decommissioning Method Statement Report, Doc. No.: AB-BL-XGL-LL-SU-MS-0001, Rev.: B02, Dated: 06/02/2018.

4. Subsea HAZID Report	Subsea HAZID Report, Doc. No.: A-301999-S00-REPT-003, Rev.: A01, Dated: 14/11/2017.
5. Risk Analysis of Decommissioning Activities	Joint Industry Project Report “Risk Analysis of Decommissioning Activities” (Safetec 2005) [http://www.hse.gov.uk/research/misc/safetec.pdf]
6. Analytical Hierarchy Process	The Analytical Hierarchy Process by T.L. Saaty, McGraw Hill, 1980.
7. Decommissioning Guidelines	BEIS – Guidance Notes, Decommissioning of Offshore Oil and Gas Installations and Pipelines, Nov 2018
8. North Sea Pipeline Decommissioning Guidelines	Decommissioning of Pipelines in the North Sea Region – 2013, Issued by Oil & Gas UK
9. CA Guidelines	OGUK – Guidelines for Comparative Assessment in Decommissioning Programmes, Dated: October 2015, ISBN: 1 903 004 55 1, Issue: 1

2 COMPARATIVE ASSESSMENT METHODOLOGY

2.1 Overview

Comparative Assessment is a process by which decisions are made on the most appropriate approach to decommissioning. As such it is a core part of the overall decommissioning planning process being undertaken by Premier Oil for Phase II of the Balmoral Area Decommissioning Project (Subsea Infrastructure).

CA Guidelines ref. [9] were prepared in 2015 by Oil and Gas UK, where seven steps to the CA process were recommended. Table 2.1 provides an introduction to each of these steps, along with a status and commentary to demonstrate the current position.

Title	Scope	Status	Commentary
Scoping	Decide on appropriate CA method, confirm criteria, identify boundaries of CA (physical and phase).	✓	Inventory & Scoping Report ref. [1] prepared for subsea infrastructure. CA methodology and criteria established for screening and revisited following screening to ensure appropriate to evaluation phase.
Screening	Consider alternative uses and deselect unfeasible options.	✓	Screening workshops held Q3 2017 with internal project team and partners. Specific studies identified that would help evaluation of remaining options. Screening outcomes documented in Screening Report ref. [2]. Additional screening workshop held in Q2 2019 to ascertain the revised approach for Group 11 – Large Subsea Installations – Balmoral Template.
Preparation	Undertake technical, safety, environmental and other appropriate studies. Undertake stakeholder engagement.	✓	Studies identified during screening phase undertaken to inform the evaluation of the remaining options. Studies completed detailed in section 2.4. Stakeholder briefing sessions offered to key stakeholders during Q4 2017.
Evaluation	Evaluate the options using the chosen evaluation methodology.	✓	Internal workshops held during October 2017. Stakeholder Workshop held on 16th November 2017. Evaluation methodology described in Appendix A and outcomes detailed in section 3.
Recommendation	Create recommendation in the form of narrative supported by charts explaining key trade-offs.	✓	The emerging recommendations for the decommissioning options selected are as identified during the Stakeholder Workshop and as detailed in the CA Report (this document).
Review	Review the recommendation with internal and/or external stakeholders.	✓	The Stakeholder Workshop held with external stakeholders (JNCC, SFF, Marine Scotland, BEIS, and OGA) on 16th November 2017 provided opportunity to review emerging recommendations.
Submit	Submit to BEIS as part of/alongside Decommissioning Programme.	✓	The CA Report was submitted in support of the decommissioning programme during Q1 2018. This updated CA Report is to be resubmitted Q2 2020.

Table 2.1: CA Process Overview and Status

2.2 Scoping

The scoping phase of the CA process addresses the following elements:

- Boundaries for CA
- Physical attributes of equipment
- Decommissioning options

These are addressed in the following sub-sections.

2.2.1 CA Boundaries

The boundaries adopted for the Phase II of the Balmoral Area Decommissioning Project (Subsea Infrastructure) are as follows:

- The following will be complete prior to Phase II scope proceeding:
  - All satellite wells will have been disconnected from the subsea infrastructure.
  - All template wells will have been fully plugged and abandoned.
  - All risers will be disconnected from the Balmoral Template and recovered
  - The FPV will have departed the field
- Balmoral Area fields:
  - Balmoral
  - Glamis
  - Stirling
  - Brenda
  - Nicol

In each of the above fields, the following equipment is included:

- All subsea installations including their foundations
- All rigid and flexible subsea flowlines
- Export pipeline
- All control and chemical jumpers
- All spools
- All umbilicals / cables
- All mattresses and deposits
- All drill cuttings
- The FPV moorings and anchor chains

Specific Exclusions from this CA are:

- Burghley and Beauly subsea fields and their associated infrastructure.

2.2.2 Physical Attributes of Equipment

All equipment within the scope of Phase II of the Balmoral Area Decommissioning Project (Subsea Infrastructure) is listed along with the physical attributes that define the equipment. Attributes considered include the following:

- Subsea Installations
  - Type
  - Weight / size / shape
  - General arrangement
  - Installation method
  - Integrity issues
- Pipelines / Flowlines / Spools
  - Pipeline number
  - Type (rigid / flexible)
  - Service (gas / oil / water)
  - Material / diameter / wall thickness / coatings / length
  - Seabed configuration (trenched / buried / surface laid)
  - Details of crossings / mattresses
  - As-left cleanliness / ability to clean lines
  - Integrity issues
- Umbilicals / Cables / Jumpers
  - Material / diameter / wall thickness / coatings / length
  - Seabed configuration (trenched / buried / surface laid)
  - Details of crossings / mattresses
  - As-left cleanliness / ability to clean lines / chemicals used
  - Integrity issues

All equipment associated with Phase II of the Balmoral Area Decommissioning Project (Subsea Infrastructure) along with their physical attributes are listed in full in the Inventory & Scoping Report ref. [1] with a summary of the equipment included in Table 3.2 herein.

2.2.3 Decommissioning Groups

Once the equipment to be decommissioned and their attributes are captured, it is desirable to group similar equipment together. This has the benefit that many items can be considered as a single group and can reduce the number of items for consideration from potentially hundreds, down to a few, thus streamlining the process.

For Phase II of the Balmoral Area Decommissioning Project (Subsea Infrastructure) the decommissioning groups, along with a list of each individual item that makes up the population of those groups, is detailed in full within the Inventory & Scoping Report ref. [1]. A brief summary of the decommissioning groups identified is included in Table 3.1 herein.

2.2.4 Decommissioning Options

With the decommissioning groups established, all potential decommissioning options for each of the groups are identified. The base case for all groups is full removal as per the Decommissioning Guidelines ref. [7] and it is only those decommissioning groups where default full removal is not considered to be the clear recommended solution, that alternative decommissioning options are considered.

Alongside full removal options, the following partial removal scenarios should be considered as specified in Decommissioning Guidelines ref. [7] and North Sea Pipeline Decommissioning Guidelines ref. [8]:

- Installations
  - Re-use in-situ
  - Relocation and re-use
  - Partial removal to land
- Pipelines
  - Re-use
  - Minimal Intervention i.e. exposed end removal
  - Minor Intervention i.e. exposed end / spans / exposure remediation
  - Major Intervention i.e. full re-trench

Table 3.1 lists the decommissioning groups and identifies those which were judged to be appropriate for decommissioning by full removal and those where full removal was not considered the clear recommended solution. Of those groups where full removal was not considered the clear recommended solution, the proposed decommissioning options for each of those groups are detailed as follows:

- Section 4.2 for Group 1 - Surface Laid Flowlines & Umbilicals
- Section 5.2 for Group 3 - Trenched & Buried Rigid Flowlines
- Section 6.2 for Group 4 - Trenched & Buried Flexible Flowlines & Umbilicals
- Section 7.2 for Group 14 - Mattresses – Other
- Section 8.2 for Group 15 - Mooring System incl. Anchor Piles

2.3 Screening Phase

The screening phase of the comparative assessment was carried out during a series of workshops held in Q3 2017. The methodology adopted, workshop attendance and outcomes obtained are detailed fully in Screening Report ref. [2]. The methodology is briefly summarised below.

The screening methodology steps adopted for the Balmoral Area Decommissioning Project were as follows:

- Identify decommissioning groups for full removal
- Review proposed decommissioning options for each remaining group
- Assess decommissioning options and record assessment and outcome in screening worksheets
- Record actions required to support retained decommissioning options
- Compile Screening Report

The decommissioning options for the remaining groups were assessed against the primary assessment criteria suggested in the CA Guidelines ref. [9]. These are:

- Safety
- Environmental

- Technical
- Societal
- Economic

The assessment was performed using a coarse, Red / Amber / Green method, as recommended in the CA Guidelines ref. [9]. An additional category of 'showstopper', coloured dark grey was used. These categories are described Table 2.2.

Category	Description
Attractive	The option is considered attractive i.e. it has positive attributes in terms of the criterion being assessed.
Acceptable	The option is considered acceptable i.e. its attributes are not positive or negative in terms of the criterion being assessed.
Unattractive	The option is considered unattractive i.e. it has negative attributes in terms of the criterion being assessed.
Showstopper	The option is considered unacceptable. Should an option be assessed as unacceptable against any of the criteria, no further assessment is required.

Table 2.2: Screening Assessment Categories

The cumulative assessment for each decommissioning option was then captured based on some basic ground rules. These are:

- Three or more criteria assessed as red resulted in the option being screened out (red).
- For similar full removal options, the likely least onerous option was retained (green) with any more onerous option considered as a sub-set of the less onerous option (light grey).
- For similar leave in-situ options, the most onerous option was retained (green) with any less onerous options considered as a sub-set of the more onerous option (light grey).

This approach was considered appropriate to ensure that the worst-case full removal options were compared to the less onerous leave in-situ options. This ensures, during the evaluation phase, that the assessment is not skewed such that leave in-situ options are selected over full removal options.

The outcomes for each group are summarised in Table 4.2, Table 5.2, Table 6.2, Table 7.1 and Table 8.1.

2.4 Preparation Phase

During the preparation phase, detailed studies / analyses are conducted to provide information to support the Evaluation phase of the Comparative Assessment. The detailed studies / analyses that may be required are often identified early in the CA process. These studies / analyses are then supplemented by additional studies / analyses identified during the screening phase of the CA.

The studies / analyses conducted during the preparation phase of the CA process are as follows:

- Integrity Assessment — A high-level assessment of the residual integrity of the Group 3 flowlines in order to screen the reverse reel options for this group in or out.
- Accelerated Decomposition Review — A review of the latest status within industry of options for performing accelerated decomposition of rigid flowlines.
- Method Statements — Detailed method statements were developed for options carried forward to ascertain the activities and resources required to deliver the option.

- Emissions Assessment — Fuel consumption and atmospheric emissions assessment performed for options carried forward based upon activities and resources identified in method statements.
- Underwater Noise Assessment — Underwater noise assessment performed for options carried forward based upon activities and resources identified in method statements.
- Environmental Impact Review — Environmental impact reviews were conducted for options carried forward in areas of planned discharges, unplanned discharges and seabed disturbance based on activities and resources identified in method statements.
- Structural Assessment — Structural assessment performed on the template to inform the template removal options.
- Geotechnical Assessment — Geotechnical assessment applied to the pipeline recovery techniques and the template to inform the decommissioning options.

Each of the above studies is detailed in the Method Statement Report ref. [3].

- Drill Cuttings Assessment — Drill cuttings sampling and analysis to inform the template decommissioning options.

The full findings of the Drill Cuttings Assessment are, at the time of writing this report, yet to be finalised and published.

The findings of the studies / analyses are gathered in preparation for the evaluation phase of the CA. The key information obtained from these studies / analyses, used during the evaluation phase are provided in data sheets, included in Appendix G.

2.5 Evaluation Phase

The evaluation phase of the comparative assessment is where the remaining decommissioning options for each group are evaluated against each other. This evaluation process is conducted according to the CA Guidelines ref. [9] and employs the data obtained during the preparation phase as summarised in the data sheets, included in Appendix G.

The evaluation phase was performed during a number of evaluation workshops where the decommissioning project team and field partners were represented. This enabled the supporting information for each of the decommissioning groups and associated decommissioning options to be interrogated and increased in maturity and definition.

Once the evaluation of the remaining decommissioning groups and options was ready, a CA Workshop was convened with external stakeholders; the CA process to date was described and the evaluation of the remaining options was reviewed. This CA Stakeholder Workshop enabled the invited stakeholders to gain familiarity with the evaluation methodology and the information the supporting studies / analyses had generated. It also allowed the evaluation to be challenged in key areas and, at the culmination of the workshop, outcomes for each of the decommissioning groups were validated.

The CA Stakeholder Workshop was held at Premier Oil's offices in Kingswells, Aberdeen on Thursday November 16th 2017. The attendees were as detailed in Table 2.3.

Name	Company	Role
Doug Cowie	OGA	Stakeholder Representative
Jennie Smith	BEIS OPRED ODU	Stakeholder Representative
Nicola Abrams	BEIS OPRED EMT	Stakeholder Representative

Name	Company	Role
Rosanne Dinsdale	JNCC	Stakeholder Representative
Peter Hayes	Marine Scotland	Stakeholder Representative
Raymond Hall	SFF	Stakeholder Representative
Steven Alexander		Stakeholder Representative
Charles Biagioni	Premier Oil	Subsea Engineer
Dave Goulding		Subsea Engineer
Glyn Pritchard		Subsea Operations Manager
John Lewis		Stakeholder Relations Manager
Kirsty McWilliam		Environmental Consultant
Margaret Christie		Environmental Coordinator
Martyn Akers		HSE Manager
Paul Newby		Subsea Engineer
Pieter voor de Poorte		Subsea Decommissioning Lead
Richard Jameson		Decommissioning Project Manager
John Foreman	Xodus	Comparative Assessment Lead
Nic Duncan		Project Manager
Rob Duncan		Subsea Engineer
Luis Batalla	Repsol Sinopec	Partner Representative
Simon Reid		Partner Representative
Paul Davis	Conoco Phillips	Partner Representative

Table 2.3: Stakeholder Workshop

More detail of the methodology adopted for the evaluation phase of the Phase II of the Balmoral Area Decommissioning Project (Subsea Infrastructure) is detailed in Appendix A.

2.6 Stakeholder Engagement

Premier Oil have engaged with stakeholders throughout Phase II of the Balmoral Area Decommissioning Project (Subsea Infrastructure) and the CA process. This engagement has been conducted to ensure that the stakeholders have been kept informed of the approach being adopted and the activities being performed. A number of key meetings and sessions have been conducted. These are:

- April 2017 - Engagement with Scottish Fishermen's Federation (SFF) to provide upfront summary of the planned Balmoral Area Decommissioning Project (all phases).
- April 2017 - Engagement with SEPA to provide an upfront summary of the planned Balmoral Area Decommissioning Project (all phases) and associated waste management.
- April 2017 - Engagement with EMT, JNCC and Marine Scotland to provide an upfront summary of the planned Balmoral Area Decommissioning Project (all phases).
- Quarterly meetings with OPRED (ODU and EMT) covering, inter alia, CA progress.
- November 2017 – Project briefing offered to all stakeholders. Briefing session taken up by SFF only, where the CA methodology was introduced in advance of the CA Stakeholder Workshop.

3 BALMORAL AREA DECOMMISSIONING GROUPS

Table 3.1 lists all decommissioning groups identified for Phase II of the Balmoral Area Decommissioning Project (Subsea Infrastructure). Early CA scoping and screening activities, detailed in full in the Inventory & Scoping Report ref. [1], identified the decommissioning groups where full removal is the recommended decommissioning approach (highlighted in grey). The remaining groups are subjected to the remainder of the CA process to identify the recommended decommissioning option. These outcomes are also captured in Table 3.1.

Grp	Title	Description	Decommissioning Approach
1	Surface Laid Flowlines & Umbilicals	Group 1 contains all surface laid flowlines and umbilicals.	Subject to full Comparative Assessment
3	Trenched & Buried Rigid Flowlines	Group 3 contains all buried rigid flowlines and trenched but not backfilled umbilicals. Over the operational life of these umbilicals, it is likely that natural burial, will have occurred to some extent.	Subject to full Comparative Assessment
4	Trenched & Buried Flexible Flowlines & Umbilicals	Group 4 includes the flexible flowlines and umbilicals. This grouping is deemed appropriate as flexible flowlines and umbilicals share a similar design and manufacture, consisting of multiple layers of metals and polymers.	Subject to full Comparative Assessment
5	Flexible Jumpers	Group 5 includes any flexible jumper.	Full Removal
7	Rigid Spoolpieces	Group 7 includes any rigid tie-in spool.	Full Removal
9	Control & Chemical Jumpers	Group 9 contains control function and chemical jumpers.	Full Removal
11	Large Subsea Installations – Balmoral Template	Group 11 captures the Balmoral Template structure including the internal piping and manifolds.	Full Removal
12	Small Subsea Installations	Group 12 accounts for all subsea installations excluding the Template.	Full Removal
13	Mattresses – Flexible Concrete Mattresses with Polypropylene Rope	Group 13 captures protection and supports that are expected to be easily recoverable e.g. polypropylene flexible mattresses.	Full Removal
14	Mattresses – Other (incl. Grout bags)	Group 14 contains protection and supports that are expected to be difficult to recover due to integrity and age.	Subject to full Comparative Assessment
15	Mooring System incl. Anchor Piles	Group 15 contains the FPV mooring system which includes the mooring chain and the piled anchor.	Subject to full Comparative Assessment
16	Flexible Risers	Group 16 captures all flexible risers attached to the FPV.	Full Removal

Grp	Title	Description	Decommissioning Approach
17	Surface Laid & Rock Covered Flexible Flowline	Group 17 contains the surface laid and rock covered flexible flowline that was recently introduced (PL4540) as a replacement for a failed line at the Balmoral field. It was agreed that this line would be fully removed.	Full Removal
18	Drill Cuttings	Group 18 contains the drill cuttings in and around the Balmoral Template.	Leave in-situ No full Comparative Assessment required

Table 3.1: Decommissioning Groups and Initial Decommissioning Recommendation

The equipment included in each of these groups is detailed comprehensively in the Inventory & Scoping Report ref. [1]. The quantities of each item per group and per field are summarised for convenience in Table 3.2.

Group	Balmoral	Glamis	Stirling	Brenda	Nicol
1 – Surface Laid Flowlines & Umbilicals	11	3	3	N/A	N/A
3 – Trenched & Buried Rigid Flowlines	14	4	N/A	2	2
4 – Trenched & Buried Flexible Flowlines & Umbilicals	1	5	3	1	1
5 – Flexible Jumpers	48	7	4	14	6
7 – Rigid Spools	16	N/A	N/A	12	4
9 – Control & Chemical Jumpers	N/A	N/A	N/A	8	3
11 – Large Subsea Installations – Balmoral Template	1	N/A	N/A	N/A	N/A
12 – Small Subsea Installations	12	3	0	10	5
13 – Mattresses – Flexible Concrete Mattresses with Polypropylene Rope	72	33	24	128	85
14 – Mattresses – Other (incl. Grout bags)[1]	25	53	N/A	N/A	N/A
15 – Mooring System incl. Anchor Piles	8	N/A	N/A	N/A	N/A
16 – Flexible Risers	18	N/A	N/A	1	N/A
17 – Surface Laid & Rock Covered Flexible Flowline	1	N/A	N/A	N/A	N/A
18 – Drill Cuttings	1	N/A	N/A	N/A	N/A

Table 3.2: Decommissioning Group Quantities

Note 1: Additional 5,450 grout bags across all fields.

3.1 Decommissioning Groups for Full CA

In summary, the decommissioning groups for Phase II of the Balmoral Area Decommissioning Project (Subsea Infrastructure) where full removal was not considered to be the clear recommended solution and that are to be subjected to the full CA process are:

- Group 1 – Surface Laid Pipelines & Umbilicals
- Group 3 – Trenched & Buried Rigid Flowlines
- Group 4 – Trenched & Buried Flexible Flowlines & Umbilicals
- Group 14 – Mattresses – Other (incl. Grout bags)
- Group 15 – Mooring System incl. anchor piles

4 CA - GROUP 1 - SURFACE LAID PIPELINES & UMBILICALS

4.1 Group 1 Characteristics

The individual items that make up Group 1 – Surface Laid Pipelines & Umbilicals are detailed in full in Inventory & Scoping Report ref. [1]. By way of a summary, the key characteristics are:

- Umbilicals and logging cables, constructed from a combination of materials i.e. polymers, steel, copper and fibres
  - Range of ODs from 0.75 to 4.00 inch
  - Range of lengths from 1.4 to 7.9 km
  - 15 items
- Flexible flowlines, constructed from a combination of materials i.e. polymers, steel and fibres
  - Range of ODs from 4.06 to 7.75 inch
  - 2 items each 2.1 km in length
- All installed on surface of seabed
- Total length – 64.5 km
- Total weight – 290 tonnes
- Total of 17 items

The items that make up Group 1 and their key characteristics are listed in Table 4.1.

ID	Description	Field	OD (inches)	Length (m)	Weight (T)
983	20z Production	Stirling	7.75	2056	82.7
984	20z Gas Lift	Stirling	4.06	2056	29.1
985	A20z Chem Inj Umbilical	Stirling	~4.00	2070	31.1
4342	B29 Sensor Umbilical Logging Cable	Balmoral	0.75	5182	5.2
4343	B14 Sensor Umbilical Logging Cable	Balmoral	0.75	3343	3.3
4344	A3 Chem Inj Umbilical	Balmoral	~4.00	1414	6.7
4345	B14 Control Umbilical	Balmoral	~4.00	3247	13.3
4346	A11 Control Umbilical	Balmoral	~4.00	3513	14.5
4347	B29 Chem Inj Umbilical	Balmoral	~4.00	5157	24.1
4348	A7z Control Umbilical	Balmoral	~4.00	2004	7.3
4349	A2 Chem Inj Umbilical	Balmoral	~4.00	1736	8.2
4350	A16 Control Umbilical	Balmoral	~4.00	2955	12.1
4351	B4a Control Umbilical	Balmoral	~4.00	5517	23.8
4352	A10z Control Umbilical	Balmoral	~4.00	1731	6.4
4353	A26 Sensor Umbilical Logging Cable	Glamis	0.75	7900	7.9
4354	A27 Sensor Umbilical Logging Cable	Glamis	0.75	7000	7.0
4355	A17z Sensor Umbilical Logging Cable	Glamis	0.75	7700	7.7

Table 4.1: Group 1 Items

4.2 Group 1 Decommissioning Options & Screening Outcome

The decommissioning options identified for Group 1 - Surface Laid Pipelines & Umbilicals are detailed in Table 4.2. The colour coding indicates the outcome from the CA Screening process which is fully detailed in Screening Report ref. [2].

Group 1 – Surface Laid Pipelines & Umbilicals		
Category	**Option**	**Description**
Leave in-situ (minimal intervention)	1A - Leave as-is	- No planned intervention, leave lines as-is. - Appropriate legislative considerations shall be addressed and any advisory zones implemented for remaining subsea infrastructure.
Leave in-situ (major intervention)	3A - Disconnect Ends & Trench	- Flowlines / umbilicals already disconnected. - Trench and backfill entire length to adequate depth to remove snag hazards.
	3B - Disconnect Ends & Full Rock Placement	- Flowlines / umbilicals already disconnected. - Rock placement over entire length to acceptable level of depth.
Leave in-situ (re-use)	4 - Re-use in New Development	- Leave flowlines / umbilicals in-situ for use in any potential new developments.
Full removal	5A - Reverse Reel	- Flowlines / umbilicals already disconnected. - Recover using reverse reel technique.
	5B - Cut and Lift	- Flowlines / umbilicals already disconnected. - Cut into sections on seabed. - Bundling cut sections together. - Recover.
	5C - Lift & Cut on Vessel	- Flowlines / umbilicals already disconnected. - Recover to vessel. - Cut into sections on vessel.

Table 4.2: Group 1 Decommissioning Options

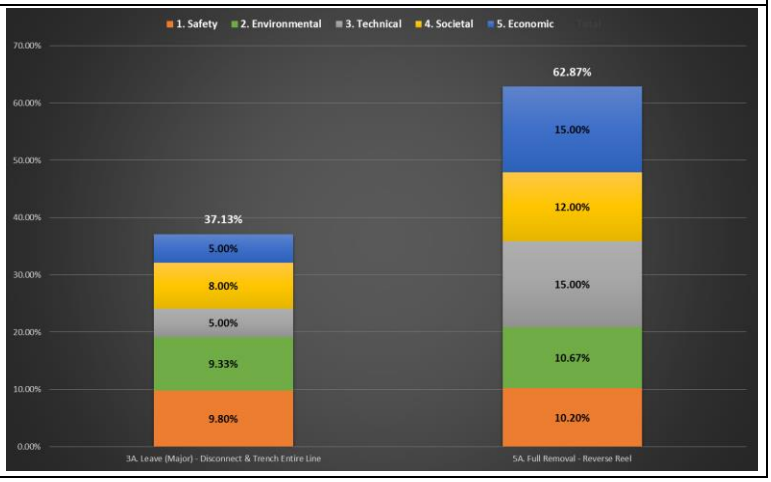
4.3 Group 1 Decommissioning Options for Evaluation

The decommissioning options for Group 1 that remained after screening and which were taken forward to the evaluation phase are:

- Leave in-situ (major intervention)
  - 3A - Disconnect & Trench
- Full removal
  - 5A - Reverse Reel

A summary of the evaluation performed against the remaining group 1 decommissioning options is provided in the following section and in more detail in Appendix C.

4.4 Group 1 Evaluation Summary

<table>
<tr><th colspan="5">Group 1 - Surface Laid Pipelines & Umbilicals</th></tr>
<tr><td rowspan="2">Screening</td><td colspan="2">1A - Leave as-is</td><td>3A - Disconnect Ends & Trench</td><td>3B - Disconnect Ends & Full Rock Placement</td></tr>
<tr><td>4 - Re-use in New Development</td><td>5A - Reverse Reel</td><td>5B - Cut and Lift</td><td>5C - Lift & Cut on Vessel</td></tr>
<tr><td colspan="5">Note: for full attributes tables and assessment see Appendix C</td></tr>
<tr><td rowspan="7">Evaluation</td><td colspan="2">3A - Disconnect Ends & Trench</td><td colspan="2">5A - Reverse Reel</td></tr>
<tr><td>Safety</td><td colspan="3">Option 5A is assessed as the (marginally) most preferred option.
Option 5A is assessed as marginally less preferable than option 3A against Personnel Offshore and High Consequence Events due higher man-hour exposure and potential for integrity failure during reverse reeling operations.
They are assessed as equal against Personnel Onshore and Other Users due to similar operational durations.
Option 5A is much more preferred than option 3A against the Residual Risk criterion due to it being a full removal option and there being a residual burden associated with monitoring and remediation for option 3A.
This cancels out any previous preference for option 3A and makes option 5A marginally preferred over option 3A.</td></tr>
<tr><td>Environment</td><td colspan="3">Option 5A is assessed as the (marginally) most preferred option.
Options 3A and 5A are assessed as being equal against the Marine Impact (Noise), Marine Impact (Planned Discharge), Marine Impact (Unplanned Discharge) and Other Consumptions criteria.
Option 5A is considered preferable to option 3A against the Fuel & Emissions and Seabed Disturbance criteria due largely to the emissions associated with the monitoring and remediation associated with option 3A and the seabed disturbance from the jet trenching operations.
Note: environmental impact of all decommissioning options is low and only a minor differentiator.</td></tr>
<tr><td>Technical</td><td colspan="3">Option 5A is assessed as the most preferred option.
The reverse reeling associated with option 5A is considered routine, whereas it is uncertain if trenching of the lines would be possible due to the congestion of lines in the area and whether it would deliver the outcome desired i.e. line trenched and stable to appropriate depth of burial. This makes option 5A much more preferable than option 3A.</td></tr>
<tr><td>Societal</td><td colspan="3">Option 5A is assessed as the most preferred option.
This is due to a combinaton of the benefit associated with the return of all material to shore and the full return of fishing grounds with this full removal option.</td></tr>
<tr><td>Economic</td><td colspan="3">Option 5A is assessed as the most preferred option.
When considering both short and long-term costs, option 3A was assessed as being much less preferable due to it being around 70% more expensive than option 5A.</td></tr>
<tr><td>Summary</td><td colspan="2">Overall, option 5A is assessed as the most preferred option.
It was clearly preferred against Technical, Societal and Economic criteria and marginally preferred against the Safety and Environmental criteria.
Given that option 5A is also the full removal option, this will form the emerging recommendation for the decommissioning option for this decommissioning group.</td><td colspan="2"> 
</td></tr>
</table>

5 CA - GROUP 3 - TRENCHED & BURIED RIGID PIPELINES

5.1 Group 3 Characteristics

The individual items that make up Group 3 – Trenched & Buried Rigid Pipelines are detailed in full in Inventory & Scoping Report ref. [1]. By way of a summary, the key characteristics are:

- All rigid steel flowlines installed in trenches and buried
- Range of ODs from 3.5 to 14 inch
- Range of lengths from 1.2 to 14.4 km
- Total length – 116 km
- Total weight – 6,650 tonnes
- Total of 22 items

The individual items that make up Group 3 and their key characteristics are listed in Table 5.1.

ID	Description	Field	OD (inches)	Length (m)	Weight (T)
218	Oil export	Balmoral	14.000	14,460	1,920.8
219	A3 Gas Lift	Balmoral	2.375	1,297	11.6
220	A3 Production	Balmoral	4.500	1,302	35.1
221	B29 Gas Lift	Balmoral	2.375	5,045	46.5
222	B29 Production	Balmoral	4.500	5,059	141.3
223	A2 Gas Lift	Balmoral	2.375	1,693	15.2
224	A2 Production	Balmoral	4.500	1,698	46.0
225	A7z Water Injection	Balmoral	6.625	1,818	68.3
226	A10z Water Injection	Balmoral	6.625	1,625	61.0
227	B4a Water Injection	Balmoral	6.625	5,346	204.7
228	A11 Water Injection	Balmoral	6.625	3,311	126.3
229	B14 Water Injection	Balmoral	6.625	2,910	110.4
230	A16 Water Injection	Balmoral	6.625	2,701	102.3
2565	B29 Production	Balmoral	6.625	3,917	213.5
2329	Brenda Production	Brenda	10.75	9,272	720.0
2330	Brenda Gas Lift	Brenda	6.625	9,272	329.0
2350	Nicol Production	Nicol	6.625	9,576	356.0
2351	Nicol Gas Lift	Nicol	3.500	9,583	108.0
638	A26 Production	Glamis	6.625	7,921	621.8
639	A27 Production	Glamis	8.625	6,944	763.7
640	A17z Water Injection	Glamis	8.625	7,613	486.5
980	A27 Service (ex-Blair)	Glamis	4.500	5,758	162.5

Table 5.1: Group 3 Items

5.2 Group 3 Decommissioning Options & Screening Outcome

The decommissioning options identified for Group 3 - Trenched & Buried Rigid Pipelines are detailed in Table 5.2. The colour coding indicates the outcome from the CA Screening process which is fully detailed in Screening Report ref. [2].

Group 3 - Trenched & Buried Rigid Pipelines		
Category	**Option**	**Description**
Leave in-situ (minimal intervention)	1A - Leave as-is	- No planned intervention, leave lines as-is. - Appropriate legislative considerations shall be addressed and any advisory zones implemented for remaining subsea infrastructure.
	1B - Remove Exposed Ends & Local Rock Placement	- Flowlines already disconnected. - Removal and recovery of exposed ends. - Rock placement to remediate seabed at cut location (small area very local).
	1C - Remove Exposed Ends & Trench / Bury	- Flowlines already disconnected. - Deburial within trench to appropriate location. - Removal and recovery of exposed ends. - Trench / bury flowline cut ends to acceptable burial depth. - No introduction of material.
	1D - Accelerated Decomposition	- Flowlines already disconnected. - Removal and recovery of exposed ends / sections if deemed high snagging potential. - Introduce material / techniques to accelerate the decomposition process - Potential options include reverse polarity Cathodic Protection (CP), Sulphate Reducing Bacteria (SRBs), chemicals, etc.
Leave in-situ (minor intervention)	2A - Remove Exposed Ends / Exposures & Rock Placement	- Flowlines already disconnected. - Removal and recovery of exposed ends. - Removal and recovery of all spans and exposures. - Rock placement at all areas of removal to appropriate level of burial depth.
	2B - Remove Exposed Ends / Exposures & Burial	- Flowlines already disconnected. - Removal and recovery of exposed ends. - Deburial in area of spans and exposures to appropriate location. - Removal and recovery of exposed sections. - Trench / bury flowline cut ends to acceptable burial depth. - No introduction of material.
	2C - Trench / Bury ends and exposures	- Flowlines already disconnected. - Trench / bury ends and exposed sections to acceptable burial depth. - No introduction of material.
	2D - Rock Placement ends and exposures	- Flowlines already disconnected. - Local rock placement on ends and exposures.
Leave in-situ (major intervention)	3A - Disconnect & Re-trench Entire Line	- Flowlines already disconnected. - Re-trench and backfill entire length to remove snag hazards. - No recovery of flowlines. - No introduction of material.
	3B - Disconnect Ends & Full Rock Placement	- Flowlines already disconnected. - Rock placement over entire length to acceptable level of depth. - No recovery of flowlines.
Leave in-situ (re-use)	4 - Re-use in New Development	- - Leave flowlines in-situ for use in any potential new developments

Group 3 - Trenched & Buried Rigid Pipelines		
Category	**Option**	**Description**
Full removal	5A - Deburial & Reverse Reel	- Flowlines already disconnected. - Deburial along entire length. - Recovery using reverse reel techniques. - Residual integrity uncertain.
	5B - Reverse Reel No Deburial	- Flowlines already disconnected. - No deburial. - Recovery using reverse reel techniques through existing cover. - Residual integrity uncertain.
	5C - Deburial & Cut and Lift	- Flowlines already disconnected. - Deburial along entire length. - Cut into sections on seabed. - Bundling cut sections together. - Recover.
	5D - Deburial Lift & Cut on Vessel	- Flowlines already disconnected. - Deburial along entire length. - Recover to vessel. - Cut into sections on vessel. - Residual integrity uncertain.
	5E - Lift & Cut on Vessel	- Flowlines already disconnected. - No deburial. - Recover to vessel through existing cover. - Cut into sections on vessel. - Residual integrity uncertain.

Table 5.2: Group 3 Decommissioning Options

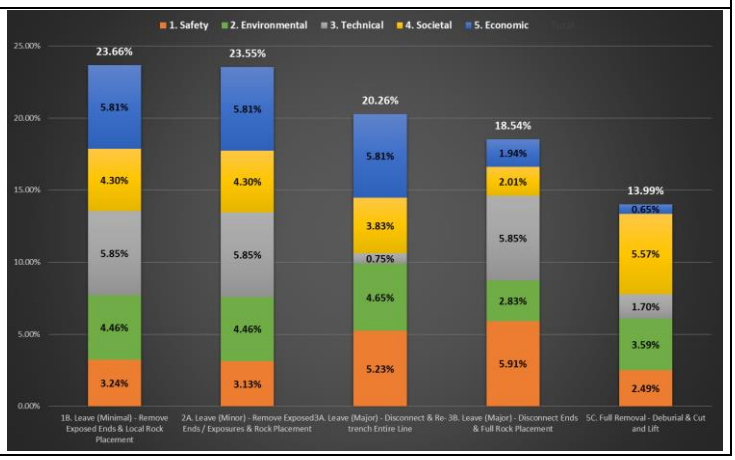
5.3 Group 3 Decommissioning Options for Evaluation

The decommissioning options for Group 3 that remained after screening and which were taken forward to the evaluation phase are:

- Leave in-situ (minimal intervention)
  - 1B - Remove Exposed Ends & Local Rock Placement
- Leave in-situ (minor intervention)
  - 2A - Remove Exposed Ends / Exposures & Rock Placement
- Leave in-situ (major intervention)
  - 3A - Disconnect & Re-trench Entire Line
  - 3B - Disconnect & Full Rock Placement
- Full removal
  - 5C - Deburial & Cut and Lift

A summary of the evaluation performed against the remaining group 3 decommissioning options is provided in the following section and in more detail in Appendix D.

5.4 Group 3 Evaluation Summary

<table>
<tr><th colspan="6">Group 3 – Trenched & Buried Rigid Pipelines</th></tr>
<tr><td rowspan="4">Screening</td><td colspan="2">1A - Leave as-is</td><td>1B - Remove Exposed Ends & Local Rock Placement</td><td>1C - Remove Exposed Ends & Trench / Bury</td><td>1D – Accelerated Decomposition</td></tr>
<tr><td colspan="2">2A - Remove Exposed Ends / Exposures & Rock Placement</td><td>2B - Remove Exposed Ends / Exposures & Burial</td><td>2C - Trench / Bury Ends and Exposures</td><td>2D - Rock Placement Ends and Exposures</td></tr>
<tr><td colspan="2">3A - Disconnect & Re-trench Entire Line</td><td>3B - Disconnect & Full Rock Placement</td><td>4 - Re-use in New Development</td><td>5A - Deburial & Reverse Reel</td></tr>
<tr><td colspan="2">5B - Reverse Reel No Deburial</td><td>5C - Deburial & Cut and Lift</td><td>5D - Deburial Lift & Cut on Vessel</td><td>5E - Lift & Cut on Vessel No Deburial</td></tr>
<tr><td colspan="6">Note: for full attributes tables and assessment see Appendix D</td></tr>
<tr><td rowspan="6">Evaluation</td><td colspan="2">1B - Remove Exposed Ends & Local Rock Placement</td><td>2A - Remove Exposed Ends / Exposures & Local Rock Placement</td><td>3A - Re-trench Entire Line</td><td>3B - Disconnect & Full Rock Placement</td><td>5C - Deburial & Cut and Lift</td></tr>
<tr><td>Safety</td><td colspan="5">Option 3B is assessed as the most preferred option.
It is the most preferable option against Personnel Onshore and equal most preferred option (with option 3A) against Personnel Offshore and High Consequence Events. This is due to shorter offshore operations and the absence of lifting operations through the water column.
Option 3B is less preferred against the Residual Risk criterion than the full removal option but this is not enough to offset the preference from the other criteria.</td></tr>
<tr><td>Environment</td><td colspan="5">Options 1B, 2A and 3A are assessed as equal most preferred option.
Whist there are minor differences in the scores obtained for these options, they are so close it would be difficult to separate them. Option 3A is preferred as no new material is introduced, however the noise generated by the jet trenching operations may have an impact (albeit still very low) whereas options 1B / 2A are preferred as, whilst they introduce a small amount of new material, the noise impact is lower.
Note: environmental impact of all decommissioning options is low and only a minor differentiator.</td></tr>
<tr><td>Technical</td><td colspan="5">Options 1B, 2A, and 3B are assessed as equal most preferred option.
Each of these options are considered as routine subsea operations.
Option 5C is largely routine however there is potential for technical challenges due to the longer duration of the operations and is therefore less preferred.
Option 3A is considered the least preferred technically as it is uncertain if trenching of the lines would be possible due to the congestion of lines in the area and whether it would deliver the desired outcome i.e. line trenched and stable to appropriate depth of burial.</td></tr>
<tr><td>Societal</td><td colspan="5">Options 5C is assessed as the most preferred option.
Due to the societal benefit associated with the return of all material to shore and the recyclability of steel pipelines.
Note: the impact on fishing was assessed as largely similar for all options except option 3B where there was permanent loss of fishing grounds.</td></tr>
<tr><td>Economic</td><td colspan="5">Options 1B, 2A and 3A is assessed as the most preferred option.
When considering both short and long-term costs, whilst there is some variance in the costs for these options, these are assessed as small enough to be considred equal (+/- 10%).
Option 3B is noticeably more expensive (+50%) and option 5C is much more expensive again (+300%).</td></tr>
<tr><td>Summary</td><td colspan="2">Overall, options 1B and 2A are assessed as the most preferred options.
The scores obtained are so close it is impossible to separate them.
They have been assessed as the equal most preferred option against the Environmental, Technical, Societal and Economic criteria.
Whilst they are not assessed as being most preferred in the remaining Safety criterion, they are still assessed as relatively attractive.
Overall given that option 2A eliminates exposures as well as exposed ends, this will form the emerging recommendation for the decommissioning option for this decommissioning group.</td><td colspan="3"> 
</td></tr>
</table>

6 CA - GROUP 4 - TRENCHED & BURIED FLEXIBLE FLOWLINES AND UMBILICALS

6.1 Group 4 Characteristics

The individual items that make up Group 4 – Trenched & Buried Flexible Flowlines and Umbilicals are detailed in full in Inventory & Scoping Report ref. [1]. By way of a summary, the key characteristics are:

- Umbilicals, constructed from a combination of materials e.g. polymers, steel, copper and fibres
  - Range of ODs from 4.00 to 6.00 inch
  - Range of lengths from 2.4 to 9.5 km
  - 7 items
- Flexible flowlines, constructed from a combination of materials e.g. polymers, steel and fibres
  - Range of ODs from 2.00 to 7.75 inch
  - Range of lengths from 3.8 to 5.1 km
  - 4 items
- All installed in trenches and buried
- Total length – 66 km
- Total weight – 1,441 tonnes
- Total of 11 items

The items that make up Group 4 and their key characteristics are included in Table 6.1.

ID	Description	Field	OD (inches)	Length (m)	Weight (T)
222A	B29 Production	Balmoral	4.00	5,048	109.0
980	A27 Service	Glamis	2.00	2,351	33.9
644	A26 Chemical Injection Umbilical	Glamis	~4.00	7,995	104.0
645	A27 Chemical Injection Umbilical	Glamis	~4.00	7,098	92.5
4356	A17z Control Umbilical	Glamis	~4.00	7,714	82.3
646	A13 Chemical Injection Umbilical	Glamis	~4.00	5,841	76.1
2000	Stirling Production	Stirling	7.75	3,798	152.7
2001	Stirling Gas Lift	Stirling	4.47	3,824	68.7
2002	SES Control Umbilical	Stirling	~4.00	3,900	15.9
2328	Brenda Control Umbilical	Brenda	~6.00	8,729	278.0
2352	Nicol Control Umbilical	Nicol	~4.00	9,494	128.0

Table 6.1: Group 4 Items

6.2 Group 4 Decommissioning Options & Screening Outcome

The decommissioning options identified for Group 4 - Trenched & Buried Flexible Flowlines and Umbilicals are detailed in Table 6.2. The colour coding indicates the outcome from the CA Screening process which is fully detailed in Screening Report ref. [2].

Group 4 - Trenched & Buried Flexible Flowlines and Umbilicals		
Category	**Option**	**Description**
Leave in-situ (minimal intervention)	1A - Leave as-is	- No planned intervention, leave lines as-is. - Appropriate legislative considerations shall be addressed and any advisory zones implemented for remaining subsea infrastructure.
	1B - Remove Exposed Ends & Local Rock Placement	- Flowlines / umbilicals already disconnected. - Removal and recovery of exposed ends. - Rock placement to remediate seabed at cut location (small area very local).
	1C - Remove Exposed Ends & Trench / Bury	- Flowlines / umbilicals already disconnected. - Deburial within trench to appropriate location. - Removal and recovery of exposed ends. - Trench / bury flowline / umbilical cut ends to acceptable burial depth. - No introduction of material.
Leave in-situ (minor intervention)	2A - Remove Exposed Ends / Exposures & Rock Placement	- Flowlines / umbilicals already disconnected. - Removal and recovery of exposed ends. - Removal and recovery of all spans and exposures. - Rock placement at all areas of removal to appropriate level of burial depth.
	2B - Remove Exposed Ends / Exposures & Burial	- Flowlines / umbilicals already disconnected. - Removal and recovery of exposed ends. - Deburial in area of spans and exposures to appropriate location. - Removal and recovery of exposed sections. - Trench / bury flowline / umbilical cut ends to acceptable burial depth. - No introduction of material.
	2C - Trench / Bury Ends and Exposures	- Flowlines / umbilicals already disconnected. - Trench / bury ends and exposed sections to acceptable burial depth. - No introduction of material.
	2D - Rock Placement Ends and Exposures	- Flowlines / umbilicals already disconnected. - Local rock placement on ends and exposures.
Leave in-situ (major intervention)	3A - Disconnect & Re-trench Entire Line	- Flowlines / umbilicals already disconnected. - Re-trench and backfill entire length to remove snag hazards. - No recovery of flowlines / umbilicals. - No introduction of material.
	3B - Disconnect & Full Rock Placement	- Flowlines / umbilicals already disconnected. - Rock placement over entire length to acceptable level of depth. - No recovery of flowlines / umbilicals.

Group 4 - Trenched & Buried Flexible Flowlines and Umbilicals		
Category	**Option**	**Description**
Leave in-situ (re-use)	4 - Re-use in New Development	- Leave flowlines / umbilicals in-situ for use in any potential new developments
Full removal	5A - Deburial & Reverse Reel	- Flowlines / umbilicals already disconnected. - Deburial along entire length. - Recovery using reverse reel techniques.
	5b - Reverse Reel No Deburial	- Flowlines / umbilicals already disconnected. - No deburial. - Recovery using reverse reel techniques through existing cover.
	5C - Deburial & Cut and Lift	- Flowlines / umbilicals already disconnected. - Deburial along entire length. - Cut into sections on seabed. - Bundling cut sections together. - Recover.
	5D - Deburial Lift & Cut on Vessel	- Flowlines / umbilicals already disconnected. - Deburial along entire length. - Recover to vessel. - Cut into sections on vessel.
	5E - Lift & Cut on Vessel	- Flowlines / umbilicals already disconnected. - No deburial. - Recover to vessel through existing cover. - Cut into sections on vessel.

Table 6.2: Group 4 Decommissioning Options

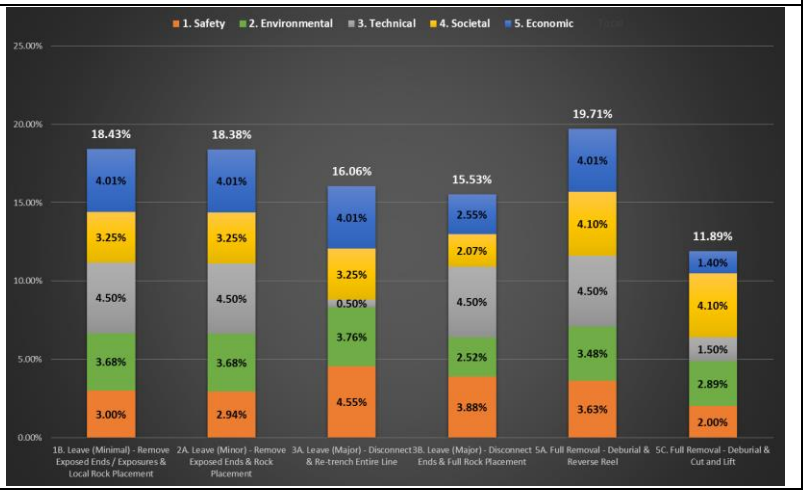
6.3 Group 4 Decommissioning Options for Evaluation

The decommissioning options for Group 4 that remained after screening and which were taken forward to the evaluation phase are:

- Leave in-situ (minimal intervention)
  - 1B - Remove Exposed Ends & Local Rock Placement
- Leave in-situ (minor intervention)
  - 2A - Remove Exposed Ends / Exposures & Rock Placement
- Leave in-situ (major intervention)
  - 3A - Disconnect & Re-trench Entire Line
  - 3B - Disconnect & Full Rock Placement
- Full removal
  - 5A - Deburial & Reverse Reel
  - 5C - Deburial & Cut and Lift

A summary of the evaluation performed against the remaining group 4 decommissioning options is provided in the following section and in more detail in Appendix E.

6.4 Group 4 Evaluation Summary

<table>
<tr><th colspan="8">Group 4 - Trenched & Buried Flexible Flowlines and Umbilicals</th></tr>
<tr><td rowspan="3">Screening</td><td>1A - Leave as-is</td><td>1B - Remove Exposed Ends & Local Rock Placement</td><td>1C - Remove Exposed Ends & Trench / Bury</td><td>2A - Remove Exposed Ends / Exposures & Rock Placement</td><td colspan="2">2B - Remove Exposed Ends / Exposures & Burial</td></tr>
<tr><td>2C - Trench / Bury Ends and Exposures</td><td>2D - Rock Placement Ends and Exposures</td><td>3A - Disconnect & Re-trench Entire Line</td><td>3B - Disconnect & Full Rock Placement</td><td colspan="2">4 - Re-use in New Development</td></tr>
<tr><td>5A - Deburial & Reverse Reel</td><td>5B - Reverse Reel No Deburial</td><td>5C - Deburial & Cut and Lift</td><td>5D - Deburial Lift & Cut on Vessel</td><td colspan="2">5E - Lift & Cut on Vessel No Deburial</td></tr>
<tr><td colspan="8">Note: for full attributes tables and assessment see Appendix E</td></tr>
<tr><td rowspan="6">Evaluation</td><td colspan="2">1B - Remove Exposed Ends & Local Rock Placement</td><td>2A - Remove Exposed Ends / Exposures & Local Rock Placement</td><td>3A - Re-trench Entire Line</td><td>3B - Disconnect & Full Rock Placement</td><td>5A - Deburial & Reverse Reel</td><td>5C - Deburial & Cut and Lift</td></tr>
<tr><td>Safety</td><td colspan="6">Option 3A is assessed as the most preferred option.
It is the most preferable option against Personnel Offshore, Personnel Onshore, Other Users and High Consequence Events. This is due to the shorter duration offshore operations, reduced onshore operations (no material being returned to shore for cleaning / processing) and the absence of lifting operations through the water column. Option 3A is less preferred against the Residual Risk criterion than the full removal options but this is not enough to offset the preference from the other criteria.</td></tr>
<tr><td>Environment</td><td colspan="6">Options 1B, 2A and 3A are assessed as equal most preferred option.
Whist there are minor differences in the scores obtained for these options, they are so close it would be difficult to separate them. Option 3A is preferred as no new material is introduced, however the noise generated by the jet trenching operations may have an impact (albeit still very low). Options 1B / 2A are preferred as, whilst they introduce a small amount of new material, the noise impact is lower.
Note: environmental impact of all decommissioning options is low and only a minor differentiator.</td></tr>
<tr><td>Technical</td><td colspan="6">Options 1B, 2A, 3B and 5A are assessed as equal most preferred option.
Each of these options are considered routine subsea operations.
Option 5C is largely routine however there is potential for technical challenges due to the longer duration of the operations and is therefore less preferred.
Option 3A is considered the least preferred technically as it is uncertain if trenching of the lines would be possible due to the congestion of lines in the area and whether it would deliver the desired outcome i.e. line trenched and stable to appropriate depth of burial.</td></tr>
<tr><td>Societal</td><td colspan="6">Options 5A and 5C are assessed as equal most preferred option.
Due to the societal benefit associated with the return of all material to shore.
Note: the impact on fishing was assessed as largely similar for all options except option 3B where there was permanent loss of fishing grounds.</td></tr>
<tr><td>Economic</td><td colspan="6">Options 1B, 2A, 3A and 5A are assessed as equal most preferred option.
When considering both short and long-term costs, whilst there is some variance in the costs for these options, these are assessed as small enough to be considred equal (+/- 10%).
Option 3B is noticeably more expensive (+25%) and option 5C is more expensive again (+50%).</td></tr>
<tr><td>Summary</td><td colspan="3">Overall, Option 5A is assessed as the most preferred option.
It has been assessed as the equal most preferred option against the Technical, Societal and Economic criteria.
Whilst it is not assessed as being most preferred in the remaining Environmental and Safety criteria, it is still assessed as relatively attractive.
Whilst, overall it is only marginally preferred to options 1B and 2A, given that option 5A is a full removal option, this will form the emerging recommendation for the decommissioning option for this decommissioning group.</td><td colspan="3"> 
</td></tr>
</table>

7 CA - GROUP 14 - MATTRESSES – OTHER

7.1 Group 14 Characteristics

The individual items that make up Group 14 – Mattresses – Other are detailed in full in Inventory & Scoping Report ref. [1]. By way of a summary, the key characteristics are:

- Difficult to remove mattresses of the older, wire connected style
- Related to Balmoral and Glamis fields
- Balmoral – 25 items
- Glamis – 53 items
- Total weight – 445 tonnes
- Total of 78 items
- In addition, 5,450 grout bags across all fields.

7.2 Group 14 Decommissioning Options & Screening Outcome

The decommissioning options identified for Group 14 - Mattresses – Other (incl. Grout bags) are detailed in Table 7.1. The colour coding indicates the outcome from the CA Screening process, fully detailed in Screening Report ref. [2].

Group 14 - Mattresses – Other (incl. Grout bags)		
Category	**Option**	**Description**
Leave in-situ (minimal intervention)	1A - Leave as is	- No planned intervention, leave mattresses as-is. - Appropriate legislative considerations shall be addressed and any advisory zones implemented for remaining subsea infrastructure. - All mattresses falling into the 'other' group, i.e. those that are in danger of breaking apart on recovery, will be left-in-situ.
Leave in-situ (minor intervention)	2A - Rock Placement	- Rock placement over mattresses to eliminate snag hazard. - Base case assumptions: - 78 mats, 5,450 grout bags, overall approx. 2,000 m^2. - Some mattresses partially buried. - Also covers bitumen mats, wire mats, hexagonal blocks (wire), grout bags.
Leave in-situ (major intervention)	3A - Burial	- Perform in-situ burial of mattresses. - Likely to need innovation / new technology development.
Leave in-situ (re-use)	4 - Re-use in New Development	- Leave mattresses in-situ for use in any potential new developments
Full removal	5A - Diver Removal	- Removal and recovery of mattresses using divers. - Includes grout bags.
	5B - Mechanical/ROV Removal	- Removal and recovery of mattresses using ROV with diver support as required. - Includes grout bags. - Desire to reduce diver involvement but accepted that diver assistance likely to be required, assume 50%.

Table 7.1: Group 14 Decommissioning Options

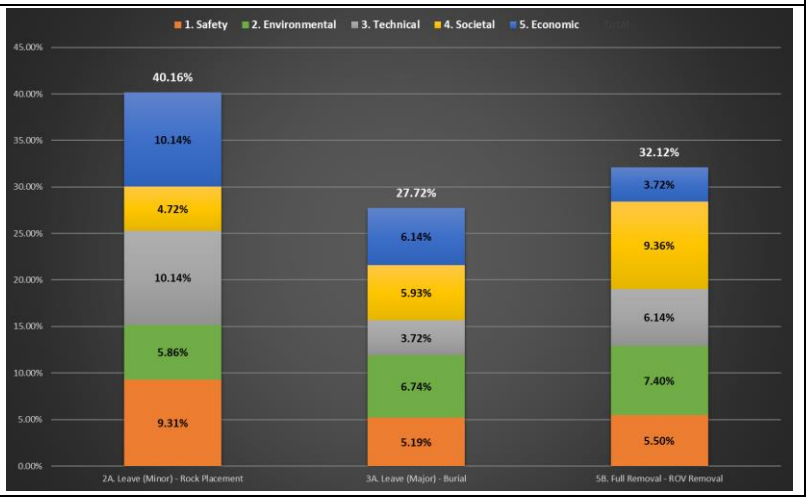
7.3 Group 14 Decommissioning Options for Evaluation

The decommissioning options for Group 14 that remained after screening and which were taken forward to the evaluation phase are:

- Leave in-situ (minor intervention)
  - 2A - Rock Placement
- Leave in-situ (major intervention)
  - 3A - Burial
- Full removal
  - 5B – Mechanical / ROV Removal

A summary of the evaluation performed against the remaining group 14 decommissioning options is provided in the following section and in more detail in Appendix F.

7.4 Group 14 Evaluation Summary

<table>
<tr><th colspan="5">Group 14 – Mattresses – Other</th></tr>
<tr><td rowspan="2">Screening</td><td colspan="2">1A - Leave as-is</td><td>2A - Rock Placement</td><td>3A - Burial</td></tr>
<tr><td colspan="2">4 - Re-use in New Development</td><td>5A - Diver Removal</td><td>5B - Mechanical/ROV Removal</td></tr>
<tr><td colspan="5">Note: for full attributes tables and assessment see Appendix F</td></tr>
<tr><td rowspan="6">Evaluation</td><td colspan="2"></td><td>2A - Rock Placement</td><td>3A – Burial</td><td>5B - Mechanical/ROV Removal</td></tr>
<tr><td>Safety</td><td colspan="3">Option 2A is assessed as the most preferred option.
It is the most or equal most preferable option against Personnel Offshore, Personnel Onshore, Other Users and High Consequence Events. This is due to the shorter duration offshore operations and lower personnel exposure due to less personnel on rock dump vessel than the DSV required for other options resulting in lower PLL, reduced onshore operations (no material being returned to shore for processing) and the absence of lifting operations through the water column. Option 2A is less preferred against the Residual Risk criterion than the full removal option but this is not enough to offset the preference from the other criteria.</td></tr>
<tr><td>Environment</td><td colspan="3">Option 5B is assessed as the most preferred option.
All options are assessed as equal against the Marine Impact (Noise), Marine Impact (Planned Discharge) and Fuel & Emissions criteria.
Option 2A is assessed as most preferable against the Marine Impacts (Unplanned Discharge) criterion, however this is more than offset by option 3A and option 5B being equally preferred against the Other Consumptions criterion (due to rock cover required under option 2A) and by option 5B being preferred from a Seabed Disturbance perspective (due to the smallest area of limited seabed disturbance when performing full removal).
Note: environmental impact of all decommissioning options is low and only a minor differentiator.</td></tr>
<tr><td>Technical</td><td colspan="3">Option 2A is assessed as the most preferred option.
The technical challenges associated with both option 3A – Burial and to a lesser extent option 5B – Mechanical / ROV Removal resulted in the more routine subsea operations associated with option 2A making it the most preferred.</td></tr>
<tr><td>Societal</td><td colspan="3">Option 5B is assessed as the most preferred option.
The introduction of rock placement on the seabed was considered least preferable from a fishing perspective. This, coupled with the (minor) benefit associated with returning the mattresses for processing resulted in the full removal option being the most preferred.</td></tr>
<tr><td>Economic</td><td colspan="3">Option 2A is assessed as the most preferred option.
When considering both short and long-term costs, option 5B was much more expensive (+300%) as was option 5B (+200%).</td></tr>
<tr><td>Summary</td><td colspan="2">Option 2A is assessed as the most preferred option.
It has been assessed as the most preferred option against the Safety, Technical and Economic criteria.
It was assessed as being least attractive against the Environmental and Societal criteria but this was not enough to offset the other assessment.
Option 2A will form the emerging recommendation for the decommissioning option for this decommissioning group.</td><td colspan="2"> 
</td></tr>
</table>

8 CA - GROUP 15 - MOORING SYSTEM INC. ANCHOR PILES

8.1 Group 15 Characteristics

The individual items that make up Group 15– Mooring System are detailed in full in Inventory & Scoping Report ref. [1]. By way of a summary, the key characteristics are:

- 8 off mooring chains
  - Length – 1,550 m each, total length – 12,400 m
  - Weight – 260 tonnes each, total weight – 2,080 tonnes
- 8 off mooring anchor piles, fully buried
- 1.58m in diameter, 36m in length
- Weight – 63.9 tonnes each, total weight – 511.2 tonnes

8.2 Group 15 Decommissioning Options & Screening Outcome

The decommissioning options identified for Group 15 - Mooring System incl. Anchor Piles are detailed in Table 8.1. The colour coding indicates the outcome from the CA Screening process, fully detailed in Screening Report ref. [2].

Group 15 - Mooring System incl. Anchor Piles		
Category	**Option**	**Description**
Leave in-situ (minimal intervention)	1A - Leave as is	- No planned intervention, leave mooring system as-is. - Appropriate legislative considerations shall be addressed and any advisory zones implemented for remaining subsea infrastructure.
Leave in-situ (minor intervention)	2A - Remove Mooring Chain to below seabed	- Pull chains taut, cut and remove chain. - Leave piles in-situ. - Base assumption: - Top of pile is approx. 6 m below seabed level. - Chain is attached to pile a further 14 m deeper down the length of the pile into the seabed. - ROV vessel to support cutting and potential re-burying if required. - Possibility that the trench created by movement of the chain through the soil will allow the chain, once cut, to automatically re-bury. A Mass Flow Excavator will be available as a back-up if required to ensure not exposed.
Leave in-situ (major intervention)	3A - Burial of Chain	- Perform trenching and burial of anchor chains.
	3B - Rock dump of full chain length	- Perform rock dump of anchor chains.
Leave in-situ (re-use)	4 - Re-use in New Development	- Leave piles / chains in-situ for use in any potential new developments
Full removal	5A - Deburial & Removal of Chains and Piles	- Perform full deburial of piles. - Remove and recover piles and chains. - Needs dredging 6 m below seabed to find the top of the pile (which itself is challenging). - Requires excavation of significant areas / volumes of seabed.

Table 8.1: Group 15 Decommissioning Options

8.3 Group 15 Decommissioning Options for Evaluation

The decommissioning options for Group 15 that remained after screening and which were taken forward to the evaluation phase are:

- Leave in-situ (minor intervention)

- 2A - Remove Mooring Chain to below seabed

> Full removal

- 5A - Deburial & Removal of Chains and Piles

It should be noted that during the screening phase of the comparative assessment, it was clear that assessing option 2A where the mooring chains are removed to seabed level with the piles remaining in-situ versus the option 5A, the full removal option using a detailed evaluation methodology as per the other groups was not a justified or efficient use of project resources.

As such, it was deemed appropriate to perform the evaluation of the option 2A versus option 5A using a narrative based method, similar to the approach adopted during screening. This is in keeping with the CA Guidelines ref. [9] where a lighter approach is acceptable where the assessment and thus outcome is clear.

8.4 Group 15 Evaluation Summary

Group 15 – Mooring System incl. Anchor Piles			
Screening	1A - Leave as-is	2A - Remove Mooring Chain to below seabed	3A - Burial of Chain
	3B - Rock Dump of full chain length	4 - Re-use in New Development	5A - Deburial & Removal of Chains and Piles

Evaluation	2A - Remove Mooring Chain to below seabed	5A - Deburial & Removal of Chains and Piles
Safety	**Option 2A is assessed as the most preferred option.** Whilst a full, detailed evaluation has not been conducted, it is estimated that option 2A could be completed in a matter of hours whereas option 5A is estimated to require more than a year of 24 hour per day vessel operations. Given the burial of the piles to 6m below seabed level, there is not expected to be any material difference between option 2A and option 5A from a residual risk perspective. As such, from a safety perspective, option 2A is most preferred.	
Environment	**Option 2A is assessed as the most preferred option.** Given the likely difference in operational durations from hours for option 2A to years for option 5A, fuel & emissions will be much higher for option 5A. The environmental impact from the seabed disturbance associated with the excavation associated with option 5A is assessed as being much greater than option 2A. Remaining environmental criteria are expected to be largely similar for each option.	
Technical	**Option 2A is assessed as the most preferred option.** The technical challenges associated with both location of the top of the mooring piles and the ability to excavate the quantities of the material required to expose the mooring piles, whilst not insurmountable are much greater than those faced with option 2A which would be considered largely routine in nature.	
Societal	**Option 2A and 5A assessed as equal most preferred option.** The societal benefit to both fishing industry and other users was considered largely similar for both options, with both returning fishing grounds. One minor benefit was the job creation (or retention) associated with the longer duration of operations with option 5A but this was not assessed as significant enough to move the options from equal to each other.	
Economic	**Option 2A is assessed as the most preferred option.** When considering both short and long-term costs, whilst these have not be quantified, option 5A would be expected to be many time higher than option 2A, given the difference in operational durations from days to years.	
Summary	**Option 2A is assessed as the most preferred option.** It has been assessed as the most preferred option against the Safety, Environmental, Technical and Economic criteria. In summary, the higher safety exposure, technical challenge, expense and higher environmental impact associated with the full removal option is not justified due to there being no material gain over option 2A. Option 2A will form the emerging recommendation for the decommissioning option for this decommissioning group.	

9 RECOMMENDATIONS

The outcomes obtained from performing the comparative assessment of the decommissioning groups and decommissioning options for Phase II of the Balmoral Area Decommissioning Project (Subsea Infrastructure) are summarised here.

There were a number of groups where full removal was the recommended decommissioning approach without any further comparative assessment. These are:

- Group 5 - Flexible Jumpers
- Group 7 - Rigid Spoolpieces
- Group 9 - Control & Chemical Jumpers
- Group 11 - Large Subsea Installations – Balmoral Template
- Group 12 - Small Subsea Installations
- Group 13 - Mattresses – Flexible Concrete Mattresses with Polypropylene Rope
- Group 16 - Flexible Risers
- Group 17 - Surface Laid & Rock Covered Flexible Flowline

The drill cuttings in and around the Balmoral Template were considered in conjunction with the template removal. There will be disturbance of the drill cuttings during the template removal, with some drill cuttings recovered along with the template. All other drill cuttings will be left in-situ.

The full comparative assessment process was applied to the remaining decommissioning groups. The recommended decommissioning option for these group are as follows:

- Group 1 - Surface Laid Flowlines & Umbilicals
  - Option 5A - Reverse Reel.
  - A full removal option where the flowlines and umbilicals (already disconnected) will be recovered fully and returned to shore for processing using reverse reeling techniques.

- Group 3 - Trenched & Buried Rigid Flowlines
  - Option 2A - Remove Exposed Ends / Exposures & Rock Placement.
  - A partial leave-in situ option where the exposed ends of the flowlines (already disconnected) will be removed as close to the trench transition as possible. These exposed ends will then be returned to shore for processing.
  - Areas of exposure will also be removed as close to the area where the exposure occurs. These exposed sections will be recovered and returned to shore for processing.
  - The cut ends will be buried within the trench as far as is possible with local rock placement where required to mitigate any snag hazard from the cut ends.

- Group 4 - Trenched & Buried Flexible Flowlines & Umbilicals
  - Option 5A - Deburial & Reverse Reel.
  - A full removal option where the flowlines and umbilicals (already disconnected) will be recovered fully and returned to shore for processing using reverse reeling techniques.
  - Whilst deburial has been included in the methodology for removal, should it be permissible for reverse reeling to be conducted without deburial, this shall be the approach adopted.
- Group 14 - Mattresses – Other (incl. Grout bags)

- Option 2A - Rock Placement
- A leave in-situ option where the difficult to retrieve concrete mattresses will have local rock placement introduced to manage snag hazard.

Although the emerging recommendation from the CA is rock placement, it is only marginally preferred over the full removal option. As such, the following approach will be applied:

- Difficult to retrieve mattresses and grout bags that are associated with any subsea infrastructure that is to be fully removed i.e. spool pieces, small subsea installations, etc. shall be fully removed at the time of removing the related equipment.
- The DP applied for is on the basis that all mattresses be recovered to shore, however, in the likely event of practical difficulties OPRED will be consulted at that time where there is the potential to rock cover mattresses as the final decommissioning solution.

> Group 15 - Mooring System incl. Anchor Piles

- Option 2A - Remove Mooring Chain to below seabed
- A partial leave in-situ option where the anchor chains will be pulled taught and cut at an appropriate depth below the seabed.
- These cut sections of chain will be recovered and returned to shore for processing.
- Remaining chain section to be buried using mass flow excavator if required.
- All anchor piles will remain in-situ although the top of these piles is approximately 6m below the seabed.

APPENDIX A EVALUATION METHODOLOGY

Appendix A.1 CA Evaluation Methodology

Premier Oil has selected a Multi Criteria Decision Analysis (MCDA) methodology for the evaluation phase of the CA. This methodology uses a pairwise comparison system based on the methodologies of the Analytical Hierarchy Process (AHP) by T.L. Saaty, described in various publications, such as Analytical Hierarchy Process ref. [6]. This allows the relative importance of each differentiating criteria to be judged against each other in a qualitative way, supported by quantification where appropriate. The key steps for the evaluation phase of the CA are as follows:

- Define Differentiating Criteria – this was completed in July 2017 and listed in Table 9.1;
- Define Options – completed as part of CA Screening;
- Pre-populate worksheets for internal CA workshops – based on all the studies undertaken the worksheets were pre-populated in advance of the internal CA workshops;
- Perform internal CA workshop;
- Discuss attributes of each option against each differentiating criteria – the discussion was recorded 'live' during the workshop in order that informed opinion and experience was factored into the decision-making process;
- Perform scoring (see Section Appendix A.5);
- Perform sensitivity analyses to test the decision outcomes;
- Export worksheets as a formal record of the workshop attendees' combined opinion on the current preferred options, the 'Emerging Recommendations';
- Evaluate whether the CA needs to 'recycle' to the Preparation phase to obtain any further information to help inform decision making;
- Discuss Emerging Recommendations with stakeholders (November 2017); and
- Recycle process as required prior to decision on the selected options which will be presented in the Decommissioning Programme and assessed in the Environmental Impact Assessment.

The sections below describe how the MCDA methodology has been applied.

Appendix A.2 Differentiating Criteria & Approach to Assessment

A key step in setting up the CA was agreeing and defining the appropriate criteria that differentiates between each of the tabled options. As a starting point, the criteria considered for this CA were taken from the DECC (now BEIS) Guidelines for Decommissioning of Offshore Oil and Gas Installations and Pipelines which are as follows (in no particular order):

- Safety
- Environmental
- Economic
- Technical
- Societal

These differentiating criteria were found to be appropriate for the decommissioning options tabled and were taken forward as the primary differentiating criteria for the CA. Additional sub-criteria and definitions were added for clarity and are shown Table 9.1 alongside the approach used for assessment under each criteria or sub-criteria.

Criteria	Sub-Criteria	Description	Approach to Assessment
1. Safety	1.1 Personnel Offshore	This sub-criterion considers elements that impact risk to offshore personnel and includes, project team, project vessel crew, diving teams, supply boat crew, and survey vessel crew. It should be noted that crew changes are performed via port calls. Any requirement for handling HazMat / NORM shall also be addressed here.	Potential for Loss of Life (PLL) metrics were calculated for each option. This allows a quantified direct comparison between options. A coarse HAZID was conducted to identify elements associated with the options that had potential for High Consequence Events. The coarse HAZID also addressed the legacy risk component associated with the options.
	1.2 Personnel Onshore	This sub-criterion considers elements that impact risk to onshore personnel. Factors such as any requirement for dismantling, disposal operations, material transfer and onshore handling may impact onshore personnel. Any requirement for handling HazMat / NORM shall also be addressed here.	
	1.3 Other Users	This sub-criterion covers the impact associated with the risk to other users. Considers elements such as collision impact whilst performing activities. Users such as fishing vessels, commercial transport vessels and military vessels are considered.	
	1.4 High Consequence Events	This sub-criterion relates to any inherent potential for high consequence events i.e. major accident hazard, major environmental incident type events. It applies to all onshore and offshore personnel involved in the project. Considerations such as dropped object concerns, support vessel risks, are considered.	
	1.5 Residual Risk	This sub-criterion addresses residual safety risk to other sea users i.e. fishermen, military vessel crews, commercial vessel crews and passengers, other sea users, that is provided by the option. Issues such as residual snag risk, collision risk, etc. may be considered.	

Criteria	Sub-Criteria	Description	Approach to Assessment
2. Environmental	2.1 Marine Impact (Noise)	Marine environmental impact caused by: Project Vessels, Supply Boats, Survey vessels i.e. Noise generated by vessels, cutting operations, any explosives etc.	Assessment based on quantifying noise generated by decommissioning activities in the short term.
	2.2 Marine Impact (Planned Discharges)	This sub-criterion covers elements such as any planned discharges to environment from vessels and / or activities performed.	Qualitative judgement based on the likely environmental discharges that are inherent in delivering the proposed option and their impact.
	2.3 Marine Impact (Unplanned Releases)	This sub-criterion covers unplanned releases to the environment. It includes risk of spills during bunkering operations, accidental events, both large and small in scale including impact of any Major Environmental Incidents (MEIs).	Qualitative judgement based on the likely accidental spills and releases associated with each option and their impact.
	2.4 Fuel & Emissions	Marine environmental impact caused by: Project Vessels, Supply Boats, Survey vessels • The atmospheric emissions associated with a particular option. It also covers fuel use which is tightly correlated to atmospheric emissions. NOTE: This does not include energy / emissions / resource consumption required to replace materials not recovered for re-use or recycle i.e. indirect.	Assessment based on quantifying the volume of fuel used and the associated emissions.
	2.5 Other Consumptions	Marine environmental impact caused by the amount of resource consumption associated with the option. It covers elements such as environmental burden from processing returned materials, use of quarried rock or other new material and any production of replacement materials.	Assessment based on quantifying the amount of new material or other consumptions associated with an option. A life-cycle emissions assessment has been carried out capturing: > Transport emissions from vessels or trucks > Recycling of materials > Reuse of materials > Production of new materials The output CO_2 figures allow a direct, quantitative comparison between options.
	2.6 Seabed Disturbance	Both direct and indirect seabed disturbance, both permanent and temporary in nature, caused by the operations.	Assessment based on quantifying the area of disturbance by type of disturbance (dredging, rock dump, trenching, backfilling), in combination with an understanding of the baseline environment in the area as shown by the outputs from the environmental surveys.

Criteria	Sub-Criteria	Description	Approach to Assessment
3. Technical	3.1 Technical Risk	This sub-criterion relates to the various technical risks that could result in a major project failure. Concepts such as: Technical Novelty and Potential for Showstoppers can be captured along with impact on the schedule due to overruns from technical issues such as operations being interrupted by the weather. Technical Feasibility and Technical Maturity is also considered.	Assessment based on engineering method statements and considers elements such as novelty, risk of failure and availability of technology.
4. Societal	4.1 Fishing	This sub-criterion addresses the impact of the option on commercial fishing operations. It includes consideration of impacts from both the decommissioning activities any residual impacts post decommissioning such as reinstatement of access to area.	A qualitative judgement that provides a narrative (rather than quantification) regarding the influence of each decommissioning option on the availability of the area of seabed for fisheries or any other commercial impacts.
	4.2 Other Users	This sub-criterion addresses any socio-economic impacts on other users both onshore where the impact may be from dismantling, transporting, treating, recycling and land filling activities relating to the option and offshore. Issues such as impact on the health, well-being, standard of living, structure or coherence of communities or amenities are considered here 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, etc.	Assessment of other users impacts is a qualitative narrative considering both positive and negative impacts on waste disposal, recycling, employment and general community impacts.
5. Economic	5.1 Short-term Costs	This sub-criterion addresses the cost of delivering the option as described. No long-term cost element is considered here. Cost uncertainty (a function of activity maturity) is also recorded.	Quantified in Method Statement Report ref. [3].
	5.2 Long-term Costs	This sub-criterion addresses the costs associated with any long-term liabilities such as on-going monitoring and any potential future remediation costs.	Quantified in Method Statement Report ref. [3].

Table 9.1: Sub-criteria Definition

Appendix A.3 Differentiator Weighting

The 5 differentiating criteria all carry a 20% weighting. That is, all criteria are neutral to each other. Figure 9.1 shows the pairwise comparison matrix. Premier Oil decided that equal weightings offer the most transparency and a balanced view from all perspectives.

Criteria	1. Safety	2. Environmental	3. Technical	4. Societal	5. Economic	Weighting
1. Safety	N	N	N	N	N	20%
2. Environmental	N	N	N	N	N	20%
3. Technical	N	N	N	N	N	20%
4. Societal	N	N	N	N	N	20%
5. Economic	N	N	N	N	N	20%

Figure 9.1: Example Pairwise Comparison Matrix (N = Neutral)

Appendix A.4 Option Attributes

The next step in the CA process was to describe and discuss the attributes of each option with respect to each of the differentiating criteria. In preparation, all relevant data and information developed during the preparation phase were pre-populated into the attributes table for each option. Appendix C to Appendix F contains the completed Attributes Tables.

Any additional discussion around the relative merits of the options was also recorded in the attributes matrix. A summary discussion of why options are considered more or less attractive with respect to each of the differentiating criteria was also recorded. An easy-to-read version of this matrix was supplied to stakeholders as part of the recommendation review process.

Appendix A.5 Option Pair-Wise Comparison

Once the option attributes were compiled and discussed, a pair-wise comparison was performed for each of the differentiating criteria where the proposed options were compared against each other. The pairwise comparison adopted in this case used phrases such as stronger, much stronger, weaker, much weaker, etc. to make qualitative judgements (often based on quantitative data) of the options against each other. Adopting these phrases rather than the more common numerical 'importance scale' from the Analytical Hierarchy Process (AHP) is often more intuitive and representative of the sentiment of a workshop.

One of the challenges of applying the numerical importance scale historically, is that often when scoring a pair of options against each other as a score of 3, delegates implied the comparison was 3 times better, etc. rather than 'slightly better' as the importance scale suggests.

To manage this, Premier Oil chose to apply the principles of the AHP by replacing numbers in the pairwise comparison matrix with a narrative or descriptive approach. This is already programmed into the AHP in the

importance scale explanations (see Table 9.2). It was agreed that three positions from equal (and their reciprocals) would be sufficient for this CA. These positions were:

Title	Scope	Relative Preference Ratio
Neutral	Equal Importance, equivalent to 1 in the AHP importance scale.	50 / 50
Stronger (S) / Weaker (W)	Moderate importance of one criteria / option over the other, equivalent to 1.5 in the AHP importance scale.	60 / 40
Much Stronger (MS) / Much Weaker (MW)	Essential / strong importance of one criteria / option over the other equivalent to 5 or 6 in the AHP importance scale.	75 / 25
Very Much Stronger (VMS) / Very Much Weaker (VMW)	Extreme importance of one criteria / option over the other equivalent to 8 or 9 in the AHP importance scale.	90 / 10

Table 9.2: Explanation of Phrasing Adopted for Pairwise Comparison

Using this transposed scoring system made it simpler and, more importantly, more effective at capturing the mind-set and feeling of the attendees at the workshops. Phrases such as 'what are the relative merits of pipeline removal on a project versus rock dumping from a safety perspective? Are these Neutral to each other? Are they stronger? If so, how much stronger? If you had to prioritise one over the other, which would it be?' This promoted a collaborative dynamic in the workshop and enabled the collective mind-set of the attendees to be captured. Where there was quantitative data to provide back-up and evidence to support the collective assertions, so much the better.

A summary example of the completed pair-wise comparisons for differentiating criteria versus options are shown in Figure 9.2.

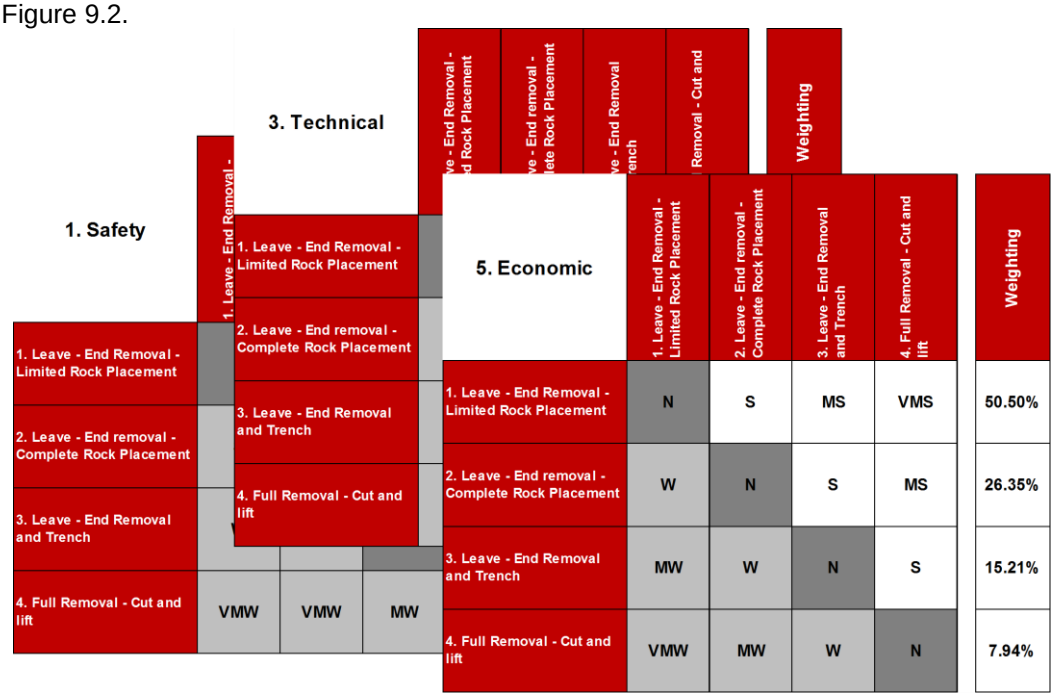


Figure 9.2: Example Option Pair-Wise Comparison

Appendix A.6 Visual Output and Sensitivities

The decision-making tool used the above pairwise comparisons to automatically generate a visual output indicating the highest scoring option i.e. the option which represents the most 'successful' solution in terms of its overall contribution to the set of differentiating criteria. At this stage, opportunity was provided to fine tune the judgements provided, to ensure that all attendees were happy to endorse the outcome. The visual outputs from each decision point are included in Appendix C to Appendix F. An example of the visual output obtained is shown in Figure 9.3.

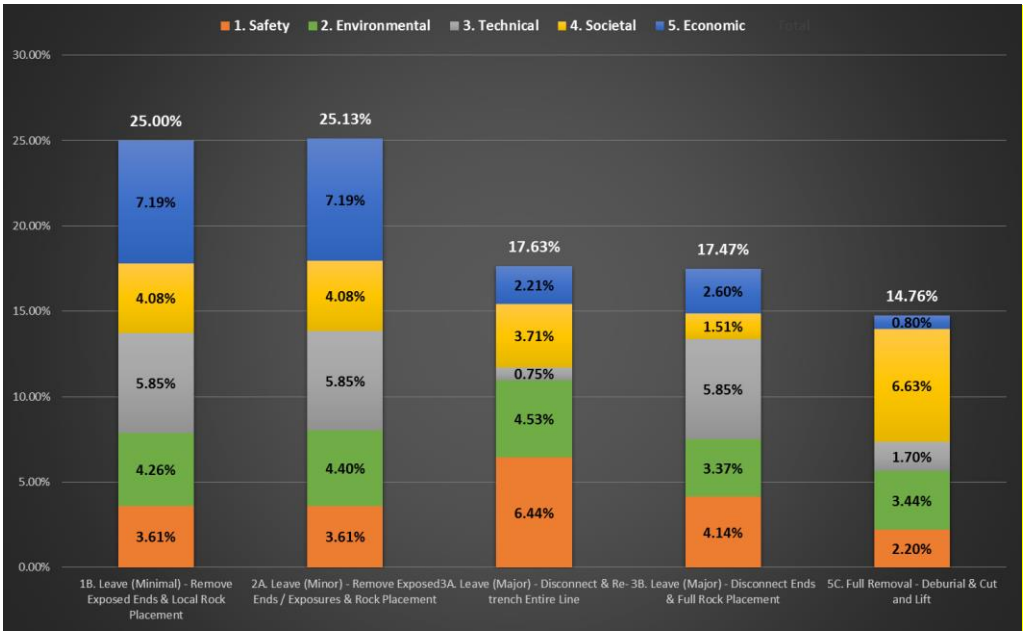


Figure 9.3: CA Visual Output Example

The CA output can then easily be stress tested by the workshop attendees by undertaking a sensitivity analysis:

> By applying a modification to the weighting of the criteria – bearing in mind that the base case for this assessment is to have all criteria equally weighted, and / or

> Modifying the pair-wise comparison of the options against each other within the criteria where appropriate.

These sensitivities will help inform workshop attendees as to whether a particular aspect is driving a preferred option, or indeed if the preferred option remains the same when the sensitivities are applied.

APPENDIX B STAKEHOLDER CA WORKSHOP MINUTES

Subject:	Balmoral Area Subsea Infrastructure Decommissioning - Comparative Assessment Workshop		
Location:	Premier Oil, Prime Four Business Park, Kingswells, Aberdeen		
Date:	16th November 2017		
Assignment:	A301999-S00		
Reference:	A-301999-S00-MINS-001		
Minuted by:	Nic Duncan		
Issued on:			
Attending:	Pieter voor de Poorte	Premier Oil	Subsea Decommissioning Lead
	Paul Newby	Premier Oil	Subsea Engineer
	Charlie Biagioni	Premier Oil	Subsea Engineer
	Dave Goulding	Premier Oil	Subsea Engineer
	Richard Jameson	Premier Oil	Decommissioning Manager
	John Lewis	Premier Oil	Stakeholder Relations Manager
	Margaret Christie	Premier Oil	Environmental Advisor
	Martyn Akers	Premier Oil	Technical Safety Engineer
	Glyn Pritchard	Premier Oil	Subsea Operations Manager
	Kirsty McWilliam	Premier Oil	Environmental Consultant
	Luis Batalla	Repsol Sinopec Resources UK	
	Simon Reid	Repsol Sinopec Resources UK	
	Paul Davis	Conoco Phillips	
	Doug Cowie	OGA	
	Jennie Smith	BEIS OPRED ODU	
	Nicola Abrams	BEIS OPRED EMT	
	Rosanne Dinsdale	JNCC	
	Peter Hayes	Marine Scotland	
	Steven Alexander	SFF	
	Raymond Hall	SFF	
	Nic Duncan	Xodus	Project Manager
	John Foreman	Xodus	Comparative Assessment Lead
	Rob Duncan	Xodus	Senior Subsea Engineer
Distribution:	Attendees +		
	Karen Yorke	Premier Oil	Environmental Team Lead
	David Findlay	Idemitsu	

Item	Issue	Action
1.0	**Purpose of the Meeting**	
1.1	The purpose of the workshop was to engage stakeholders in a comparative assessment (CA) workshop of the options to decommission subsea infrastructure associated with the Balmoral Area Fields. The outputs from the meeting were recommended methodologies for inclusion in the relevant Decommissioning Programmes for public consultation.	
2.0	**Introductions**	
2.1	Premier Oil thanked stakeholders for taking time to attend the workshop and reading the CA recommendations and supporting analysis which had been issued in advance. Each participant was introduced.	
3.0	**Background to the Balmoral Area and the Decommissioning Strategy**	
3.1	Premier Oil provided a background to the Balmoral Area fields and main items of infrastructure. The Balmoral Area includes seven fields, two of which are third party, all of them ultimately tied back to the Balmoral FPV. Production commenced in 1985. The Balmoral Area shall be decommissioned in three main, overlapping, phases. Phase 1 is the flushing and cleaning of all risers and seabed lines; disconnection of the subsea trees; disconnection and removal of the risers; disconnection of the FPV moorings and removal of the FPV from the field. Phase 2 is the decommissioning of the subsea facilities and moorings (the subject of this comparative assessment). Phase 3 is the plugging and abandonment (P&A) of all of the wells. A full survey of the infrastructure was conducted in 2016 in preparation for decommissioning. Pipetracker was able to confirm that all trenched buried pipelines have maintained their design, top of pipe depth of at least 0.45m. A survey of mattresses was conducted and accurate quantities of straightforward to remove versus difficult to remove mattresses was established.	
4.0	**Environmental Overview**	
4.1	Premier Oil provided an environmental overview of the Balmoral Area.	

5.0	**Comparative Assessment Process**	
5.1	Xodus described the CA process undertaken and confirmed that it is aligned to the CA guidelines issued by Oil and Gas UK. It was explained that five key CA recommendations would be made during the workshop. The recommendations will then also be applied to any analogous subsea infrastructure. The Balmoral Template was not going to be assessed on this occasion as the required information was not sufficiently mature to be able to make informed decisions. A summary of the template status would be provided. The evaluation criteria are aligned to the BEIS ODU and OGUK Guidelines, namely Safety, Environmental, Technical, Societal and Economics. The criteria have been assessed using the Xodus "Pairwise" methodology and weighted equally. Xodus made reference to the specific sub-criteria to be considered and the associated descriptions defined by Premier Oil. A summary of the Scoping and Screening process performed to date was provided. It was explained that option super-sets were defined to minimise the effort at the evaluation stage but that this would not prevent similar options being included within the decommissioning programme.	
6.0	**Engineering Summary**	
6.1	Xodus provided a summary of the engineering input to the CA to date and made reference to the pre-read material issued for use during the CA.	
7.0	**Evaluation**	
7.2	Group 1 – Surface Laid Flowlines & Umbilicals	
7.2.1	Xodus provided a summary of the attributes associated with the sub-criteria for each option	
7.2.2	Marine Scotland challenged the validity of data within the attributes table. It was clarified that the data is of a conceptual level (+/- 30%) and that estimates cannot be optimised at this stage. The use of 60/40, 75/25 and 90/10 to calculate Stronger, Much Stronger and Very Much Stronger scores within the MCDA methodology was clarified as a preference metric, and not a probability of an event occurring. In relation to the Offshore Personnel Safety sub-criteria result, the SFF stated their view that everything that can be removed should be removed. However, it was clarified that this is only one sub-criteria and that the whole assessment should be completed before considering the result. A clarification was provided with regard to calculated noise figures, this being that none of the point source noise associated with activities exceeded the injury threshold – results are cumulative over time and represent a comparison of disturbance only.	

	Clarification was provided that sub-criteria 2.5 'Other Consumptions' includes onshore transportation of recovered material. With regard to quantitative data provided for seabed disturbance, it was challenged that indirect disturbance (that from mobilised sediment) would have a significant effect on some flora and fauna, in particular Sea Pens. Xodus was actioned to seek further guidance on extent of indirect disturbance and the associated marine impact, refer to 7.3.1 'post meeting notes' below. Challenge made on the Societal conclusion – the fact that equipment is left in situ is in fact Weaker. The societal benefit from return of materials onshore concludes that leaving equipment / material in situ is Weaker. The economics assessment was unchallenged. The final result remained unchallenged.	
7.3	Group 3 – Buried Rigid Flowlines	
7.3.1	There were no challenges to any of the safety sub-criteria There were no challenges to any of the environmental sub-criteria. However, it was noted by Premier Oil that for Option 3A, which involves re-trenching of entire lines, that seabed recovery could take up to 10 years. For Option 5C, Full Removal, the de-burial operation is assumed to be conducted by mass flow excavation (MFE). Direct disturbance of the seabed from use of MFE had been estimated as a width of 4 metres along the length of the line. An action was raised to understand the extent of indirect disturbance from use of MFE, whereby material is blown into the water column and falls back down on to the seabed. Post Meeting Notes: Advice from Xodus' geotechnical specialist states that "*from a sediment transport standpoint, due to the cohesion of these soils this material will be excavated by the MFE water flow cutting it into gravel and cobble sized blocks. This material will have a limited transportability and will stop just outside the zone of influence of the MFE.*" In response, advice from Xodus' environmental specialist states that "*Whilst there is little quantitative information available on the likely recovery time from the physical disturbance of activities such as trenching using mass flow excavation tools, indications are available from studies carried out into the effects of seabed disturbance by towed fishing gear (as reviewed by Løkkeborg, 2005). These suggest that it is likely that recovery will be evident in the sediments within three to twelve months.*" With respect to Sub-Criteria 4.1, SFF made the point that with any of the leave in situ options it will be important to ensure that decommissioning solutions installed remain as designed. In this case (nephrop fishing) rock placement does not result in less fishing areas – just greater chance of snagging. The working assumption, to support the recommendation, is that any rock placement would be maintained as over-trawlable. Marine Scotland highlighted the capability of FishSAFE. However, it was pointed out that there is a lack of detail provided into FishSAFE. Fishermen do not know the details of what's there. Premier Oil advised that provision of additional data for each line should be quite straightforward.	

	SFF pointed out that the result is heavily correlated to activity duration leading to increased emissions, increased safety metrics and costs, hence typically the options involving more removal of materials / equipment will score more negatively. That said, the result was accepted by the group.	
7.4	Group 4 – Buried Flexible Flowlines & Umbilicals	
7.4.1	There were no challenges raised in relation to Group 4 and the result was accepted by the group.	
7.5	Group 11 – Large Subsea Installations – Balmoral Template	
7.5.1	History and background of the Balmoral Template was provided by Premier Oil. A summary of the structural analysis conducted to date was provided. A summary of the drill cuttings survey conducted to date was provided (13 locations with 2 cores per location across the template). Survey operations have been unable to penetrate through to the seabed so far. Longer cores may be feasible once the FPV is clear. It is known from records that batch drilling was performed, therefore, potentially there will be a layer of cement between water based mud (WBM) top hole material at the bottom and oil based mud (OBM) over the top. At this time there is insufficient data available to be able to comparatively assess the template decommissioning options. Premier Oil advised they are considering the potential to split out the Balmoral Template decommissioning programme (DP) to allow the progression of decommissioning for the remainder of the Balmoral Area infrastructure.	
7.6	Group 14 – Mattresses – Other (including grout bags)	
7.6.1	Where mattresses and grout bags are straightforward to remove they shall be. Group 14 describes mattresses and grout bags which are not straightforward to remove, there are estimated to be 107 of this classification of mattress at mid-line locations across the Balmoral Area. There were no challenges to safety sub-criterion 1.1 – 1.4. With regard to 1.5 Residual Risk, the SFF advised past experience of recovery of mattress blocks within fishing nets. SFF, challenged whether rock placement is a good idea at all. In this case these are single runs of mats which would allow time for the fishing gear to recover. A request was made for a visual representation of Group 14 mats across the field. There were no challenges to environmental sub-criterion 2.1 – 2.3. With regard to 2.4 Fuel and Emissions it was noted that a differential of 5,000te of CO_2 is the point at which a difference is generally identified within the CA, regardless of overall rate. There was some discussion around scoring & SEPA's views on re-use of material that may be proven to be leaching chloride into the environment. There was some discussion around use of mats to infill areas elsewhere instead of rock – should be viewed as an opportunity – otherwise no challenge.	

	A challenge was made to the statement regards total loss of habitat to commercial fishing impact. The associated text within the attributes table was modified. Marine Scotland highlighted that rock placement remediation is being committed to by Premier Oil – the scoring of this sub-criterion was changed accordingly. With regard to 4.2 Societal Other Users, it was agreed that the returned material (concrete) would equate to minor societal benefit. The results for mattress removal are driven by the technological challenge and safety. The SFF stated that they would be concerned by what's left beneath the mattress (i.e. the snagging hazard from pipes left in-situ), and that in balance, rock placement is probably the preference over cutting pipes and leaving cut ends buried. Marine Scotland asked whether SFF would wish to re-appraise societal score based on this. SFF responds that this Group covers mattresses only and shouldn't be confused with pipeline decommissioning solutions.	
7.7	Group 15 – Mooring System including anchor piles	
7.7.1	Xodus provided an overview of the intention for decommissioning of the mooring chains and piles. The chains shall be cut off at the seabed (mud line) and fully removed for re-use or recycling. The piles are buried to 6 metres below seabed and shall be left in situ. This was compare to the alternative full removal case which would involve excavation of more than 2.25 million m^3 of seabed to expose sufficient length of the eight piles to be able to extract them from the seabed.	

APPENDIX C GROUP 1 – DETAILED EVALUATION RESULTS

Appendix C.1 Group 1 Attributes Table

		3A. Leave (Major) - Disconnect & Trench Entire Line	5A. Full Removal - Reverse Reel
		- Flowlines \ umbilicals \ cables will be disconnected **- Trench and backfill entire length to adequate depth to remove snag hazards**	**- Flowlines \ umbilicals \ cables will be disconnected** **- Reverse reel**
1. Safety	1.1 Personnel Offshore	Vessel Type:- PoB / Days / Hours / PLL Trawler:- 5 / 9 / 540 / 4.05E-05 Survey Vessel:- 76 / 17 / 15,504 / 1.16E-03 Trenching Vessel:- 20 / 26 / 6,240 / 4.68E-04 Total offshore hours:- 22,284 hrs Total offshore PLL:- 1.67E-03	Vessel Type:- PoB / Days / Hours / PLL Trawler:- 5 / 9 / 540 / 4.05E-05 Survey Vessel:- 76 / 17 / 15,504 / 1.16E-03 Reel Vessel:- 76 / 21 / 19,152 / 1.44E-03 Total offshore hours:- 35,196 hrs Total offshore PLL:- 2.64E-03
		S	
	Summary	The summary Potential for Loss of Life (PLL) metrics, with respect to Personnel Offshore exposure, for the options are 1.67E-03 and 2.64E-03 respectively. The assessment of the risk exposure for the various offshore worker groups is as follows: Option 3A is assessed as being Stronger than Option 5A as the PLL values and thus the risk exposures are almost 2 time lower than Option 5A. Overall, Option 3A would be preferred from a risk to offshore personnel perspective.	
1. Safety	1.2 Personnel Onshore	Resource Type:- Days / Hours / PLL Engineering & Management:- 141 / 1,129 / 4.52E-06 Project Management:- 612 / 4,896 / 1.96E-05 Onshore Operations (includes Cleaning & Disposal):- 154 / 1,231 / 1.51E-04 Total onshore hours:- 7,256 hrs Total onshore PLL:- 1.76E-04	Resource Type:- Days / Hours / PLL Engineering & Management:- 549 / 4,388 / 1.76E-05 Project Management:- 520 / 4,160 / 1.66E-05 Onshore Operations (includes Cleaning & Disposal):- 131 / 1,044 / 1.28E-04 Total onshore hours:- 9,592 hrs Total onshore PLL:- 1.63E-04
		N	
	Summary	The summary Potential for Loss of Life (PLL) metrics, with respect to Personnel Onshore exposure, for the options are 1.76E-04 and 1.63E-04 respectively. The assessment of the risk exposure for the various onshore worker groups is as follows: Option 3A is assessed as being Neutral to Option 5A as the PLL values and thus the risk exposures are similar.	
1. Safety	1.3 Other Users	Vessel Days:- Trawler:- 9 Survey Vessel:- 17 Trenching Vessel:- 26 Total vessel days:- 52 days	Vessel Days:- Trawler:- 9 Survey Vessel:- 17 Reel Vessel:- 21 Total vessel days:- 47 days
		N	
	Summary	The assessment of the impact of each of the options on Other Users is largely driven by the durations that vessels are located in the area during the decommissioning works. The assessment is as follows: Option 3A is assessed as being Neutral to Option 5A as the number of days on location are similar.	
1. Safety	1.4 High Consequence Events	The potential for High Consequence events is considered low for this option due to no requirement for lifting. Risks associated with these trenching operations are more likely to be technical rather than safety related.	The potential for High Consequence events is considered higher than the trenching option due to small risk of integrity failure whilst reverse reeling.
		S	
	Summary	The assessment of the potential for High Consequence Events associated with each of the options is as follows: Option 3A is assessed as being Stronger than Option 5A due to potential for integrity failure of a line during reverse reel operations. Option 3A would be preferred from a potential for high consequence events perspective.	
1. Safety	1.5 Residual Risk	Vessel Type:- PoB / Days / Hours / PLL Survey Vessel (Legacy):- 76 / 49 / 44,688 / 3.35E-03 Rockdump Vessel (Legacy):- 20 / 5 / 1,200 / 9.00E-05 Total offshore hours:- 45,888 hrs Total offshore PLL:- 3.44E-03 The legacy risk to the fishing industry from trenched pipelines is assessed as having a 'very unlikely' probability of occurrence.	No residual risk from this full removal option.
		MW	
	Summary	The assessment of the Residual Risk associated with each of the options is as follows: Option 3A is assessed as being Much Weaker than Option 5A due to the residual risk associated with the monitoring and remediation of the rock dumped lines. Overall, Option 5A would be preferred from a residual risk perspective.	

		3A. Leave (Major) - Disconnect & Trench Entire Line	5A. Full Removal - Reverse Reel
		- Flowlines \ umbilicals \ cables will be disconnected **- Trench and backfill entire length to adequate depth to remove snag hazards**	**- Flowlines \ umbilicals \ cables will be disconnected** **- Reverse reel**
2. Environmental	2.1 Marine Impact (Noise)	Vessel Noise:- 252 dB re 1mP 15.76 TPa²s Tooling Noise:- 228 dB re 1mP 0.06 TPa²s Under this option, the major sound sources will be the vessels involved with only a very small proportion of noise from trenching equipment. Given the type of vessels, the cumulative noise emissions are quite high. Therefore, the overall impact of noise is anticipated to be moderate.	Vessel Noise:- 251 dB re 1mP 13.07 TPa²s Under this option, the major sound source will be the vessels involved. Given the type of vessels, the cumulative noise emissions are quite high. Therefore, the overall impact of noise is anticipated to be moderate.
		N	
	Summary	The assessment of the Marine Impact (Noise) associated with each of the options is as follows: Whilst there are differences between the cumulative noise exposures of the options, these are assessed as being so minimal that the options are Neutral to each other.	
2. Environmental	2.2 Marine Impact (Planned Discharges)	Pipeline cleaning and flushing operations will use Best Environmental Practice (BEP) and the Best Available Techniques (BAT) to minimise as far as possible both residual Oil in Water (OIW) levels in pipelines post flush and OIW discharges to the marine environment during flushing activities. Discharges of oil bearing fuids from the buried pipleine would occur in small quantities and over a long timeframe. However, given the prior cleaning of the pipelines, the concentration and overall quantity of oil discharged should be low. Therefore, the related impact is also anticipated to be low.	Pipeline cleaning and flushing operations will use Best Environmental Practice (BEP) and the Best Available Techniques (BAT) to minimise as far as possible both residual Oil in Water (OIW) levels in pipelines post flush and OIW discharges to the marine environment during flushing activities. By reeling pipelines onto the vessel, a proportion of fluids within the pipleine will be released into the water column as it is recovered (some fluids will remain in the recovered pipeline and be dealt with as waste). However, given the prior cleaning of the pipelines, the concentration and quantity of oil should be low. The umbilicals will have been cleaned and flushed with the possible exception of the hydraulic fluid lines. However, it would be a goal of the decommissioning option to maintain the contents of these lines during reverse reel. Therefore, the related impact is also anticipated to be low.
		N	
	Summary	The assessment of the Marine Impact (Planned Discharges) associated with each of the options is as follows: Whilst there are differences between the planned discharges with the most onerous being associated with Option 5A, these are assessed as having a minimal impact and as such, the options are Neutral to each other.	
2. Environmental	2.3 Marine Impact (Unplanned Releases)	3 individual vessels 52 combined vessel days The relatively short duration of operations reduces the potential sources of spills but use of sub-sea equipment for longer and the constant nature of hydraulic fluid use for trenching increases risk. The types and maximum possible quantities of oil / chemicals / hydraulic fluid that could be accidentally released at the surface or sub-sea under this option would be expected to disperse quickly and not reach the shore. As such, the impact of an unplanned release to sea should be low.	3 individual vessels 47 combined vessel days The short duration of operations and lack of sub-sea equipment reduce the potential sources of spills. The types and maximum possible quantities of oil that could be accidentally released at the surface or sub-sea under this option would be expected to disperse quickly and not reach the shore. As such, the impact of an unplanned release to sea should be low. Umbilicals will have minimal quantities of chemicals post cleaning however hydraulic fluid could be present. Under reverse reeling, there is the potential for the hydraulic fluid to be released in one area. The quantities released are minimal and hydraulic fluid of this type are released routinely during the operation of subsea facilities. As such, the impact of an unplanned release to sea should be low.
		N	
	Summary	The assessment of the Marine Impact (Unplanned Releases) associated with each of the options is as follows: Whilst there are differences between the potential for unplanned releases with the most onerous being associated with Option 5A, these are assessed as having a minimal impact and as such, the options are Neutral to each other.	
2. Environmental	2.4 Fuel & Emissions	Vessel Emissions (in tonnes):- Fuel:- 2,834 CO2e:- 9,291 NOx:- 167.23 SO2:- 34.01 Vessel Energy Use:- 121,882 GJ The quantity of atmospheric emissions relates to the total fuel usage expected for the operations. The total estimated fuel usage required for this option would only represent a very small proportion of the total annual emissions from industry with respect to contribution to climate change. The impact of atmospheric emissions is therefore anticipated to be low.	Vessel Emissions (in tonnes):- Fuel:- 1,579 CO2e:- 5,175 NOx:- 93.14 SO2:- 18.94 Vessel Energy Use:- 67,885 GJ The quantity of atmospheric emissions relates to the total fuel usage expected for the operations. The total estimated fuel usage required for this option would only represent a very small proportion of the total annual emissions from industry with respect to contribution to climate change. The impact of atmospheric emissions is therefore anticipated to be low.
		W	
	Summary	The assessment of the Fuel & Emissions associated with each of the options is as follows: Whilst the overall impact of each of the options is considered low, Option 3A is assessed as Weaker than Option 5A as the fuel and emissions are around double. Overall, Option 5A would be preferred from a Fuel & Emissions perspective.	

		3A. Leave (Major) - Disconnect & Trench Entire Line	5A. Full Removal - Reverse Reel
		- Flowlines \ umbilicals \ cables will be disconnected **- Trench and backfill entire length to adequate depth to remove snag hazards**	**- Flowlines \ umbilicals \ cables will be disconnected** **- Reverse reel**
2. Environmental	2.5 Other Consumptions	No new material introduced. No material returned to shore / 475 tonnes of CO2 associated with 290 tonnes of remaining material. This option is relatively simple in terms of the expected vessels, equipment and resources required and short in duration. The associated impacts in this context are expected to be low. As the flowlines and umbilicals will be left trenched and buried in the seabed, there will be no waste returned to shore for processing and disposal so there will be no impacts from waste processing. There is however an associated energy consumption that relates to the requirement to replace the remain in-situ materials.	No new material introduced. 290 tonnes of material returned to shore / 230 tonnes of CO2 associated with returned material. This option is relatively simple in terms of the expected vessels, equipment and resources required and short in duration. The associated impacts in this context are expected to be low. As the entire pipelines will be recovered, this will result in materials being transported to shore for treatment, reuse, recycling or disposal which will result in energy and other resource use and atmospheric emissions. There is potential for quantities of hazardous waste, however the potential impact is anticipated as low.
		N	
	Summary	The assessment of the Other Consumptions associated with each of the options is as follows: Whilst there are differences between the consumptions, with the most onerous being associated with Option 3A, these are assessed as having a minimal impact and as such, the options are Neutral to each other.	
2. Environmental	2.6 Seabed Disturbance	Trenching:- 64,581 m2 The area of seabed directly disturbed by these operations is extremely small in the context of the surrounding wider region, with good potential for recovery due to consistent nature of habitats and communities. This option would also leave the seabed in a natural state. Indirect seabed disturbance is considered to have limited impact. Therefore, the level of impact on the seabed and related communities is expected to be low.	There is minimal seabed disturbance associated with this option as the lines are surface laid. This option will not involve direct impact on the seabed but will disturb the seabed sediments as the pipeline is recovered. This disturbance will be felt over a limited area due to the low current energy at the seabed so will be extremely small in the context of the surrounding wider region, with good potential for recovery due to consistent nature of habitats and communities. This option would also leave the seabed in a natural state. Therefore, the level of impact on the seabed and related communities is expected to be low.
		W	
	Summary	The assessment against the Seabed Disturbance criterion for each of the options is as follows: Option 3A is assessed as being Weaker than Option 5A as there is significant area of (albeit temporary) impact. Whilst the overall impact of each of the options is considered low, Option 5A would be preferred from a Seabed Disturbance perspective.	
3. Technical	3.1 Technical Risk	The requirement to trench lines in a very congested area makes this option very technically challenging. Residual torsion in line may mean that trenching to get acceptable burial depth / status may not deliver outcome required i.e. may require spot rock dump anyway, which would constitute technical failure as currently defined. Trenching doesn't present good solution for crossings.	All technical aspects of this option are considered routine operations.
		MW	
	Summary	The assessment against the Technical criterion for each of the options is as follows: Option 3A is assessed as being Much Weaker than Option 5A as there is likely to be significant challenges due to the congested location. Overall, Option 5A would be preferred from a Technical perspective.	
4. Societal	4.1 Fishing	64,581 m2 of disturbance to fishing grounds impacting Nephrops however would recover given time. Short term presence of vessels at Balmoral will exclude fishing activity but not over an area greater than that excluded during production operations. The seabed will be left in a natural state with nothing left exposed on the seabed in the long term that could be a snagging hazard once trenching is complete. Therefore, the overall impact on commercial fisheries is seen to be low.	No impact on fishing. Short term presence of vessels at Balmoral will exclude fishing activity but not over an area greater than that excluded during production operations. The seabed will be left in a natural state with no potential snagging hazards. Therefore, the overall impact on commercial fisheries is seen to be low.
		W	
	Summary	The assessment against the Societal - Fishing criterion for each of the options is as follows: Whilst the overall impact of each of the options is considered low, Option 3A is assessed as Weaker than Option 5A due to the temporary impact on nephrop fishing operations. Overall, Option 5A would be preferred from a Societal - Fishing perspective.	
4. Societal	4.2 Other Users	No material returned to shore.	Around 290 tonnes of returned material - mixture of flowlines, umbilicals and cables. Have been considered difficult to recycle in the past, however these capabilities are improving. Quite a high proportion of copper. Recycling processors performing this function at zero cost.
		W	
	Summary	The assessment against the Societal - Other Users criterion for each of the options is as follows: Option 3A is assessed as being Weaker than Option 5A as whilst the returned material is limited in quantity, in includes copper which is assessed as having a societal benefit. Overall, Option 5A would be preferred from a Societal - Other Users perspective.	
5. Economic	5.1 Short-term Costs	Initial operation cost:- £8.697M Legacy cost:- £2.277M Total cost:- £10.974M	Initial operation cost:- £6.843M Total cost:- £6.843M
		MW	
	Summary	The assessment against the Economic criterion for each of the options is as follows: Option 3A is assessed as being Much Weaker than Option 5A as the costs are almost double and there is an ongoing legacy economic burden. Overall, Option 5A would be preferred from a Economic perspective.	

Appendix C.2 Group 1 Pairwise Comparison Matrices - Safety

1.1 Personnel Offshore	3A. Leave (Major) - Disconnect & Trench Entire Line	5A. Full Removal - Reverse Reel	Weighting
3A. Leave (Major) - Disconnect & Trench Entire Line	N	S	60%
5A. Full Removal - Reverse Reel	W	N	40%

1.2 Personnel Onshore	3A. Leave (Major) - Disconnect & Trench Entire Line	5A. Full Removal - Reverse Reel	Weighting
3A. Leave (Major) - Disconnect & Trench Entire Line	N	N	50%
5A. Full Removal - Reverse Reel	N	N	50%

1.3 Other Users	3A. Leave (Major) - Disconnect & Trench Entire Line	5A. Full Removal - Reverse Reel	Weighting
3A. Leave (Major) - Disconnect & Trench Entire Line	N	N	50%
5A. Full Removal - Reverse Reel	N	N	50%

1.4 High Consequence Events	3A. Leave (Major) - Disconnect & Trench Entire Line	5A. Full Removal - Reverse Reel	Weighting
3A. Leave (Major) - Disconnect & Trench Entire Line	N	S	60%
5A. Full Removal - Reverse Reel	W	N	40%

1.5 Residual Risk	3A. Leave (Major) - Disconnect & Trench Entire Line	5A. Full Removal - Reverse Reel	Weighting
3A. Leave (Major) - Disconnect & Trench Entire Line	N	MW	25%
5A. Full Removal - Reverse Reel	MS	N	75%

Appendix C.3 Group 1 Pairwise Comparison Matrices - Environment

2.1 Marine Impact (Noise)	3A. Leave (Major) - Disconnect & Trench Entire Line	5A. Full Removal - Reverse Reel	Weighting
3A. Leave (Major) - Disconnect & Trench Entire Line	N	N	50%
5A. Full Removal - Reverse Reel	N	N	50%

2.2 Marine Impact (Planned Discharges)	3A. Leave (Major) - Disconnect & Trench Entire Line	5A. Full Removal - Reverse Reel	Weighting
3A. Leave (Major) - Disconnect & Trench Entire Line	N	N	50%
5A. Full Removal - Reverse Reel	N	N	50%

2.3 Marine Impact (Unplanned Releases)	3A. Leave (Major) - Disconnect & Trench Entire Line	5A. Full Removal - Reverse Reel	Weighting
3A. Leave (Major) - Disconnect & Trench Entire Line	N	N	50%
5A. Full Removal - Reverse Reel	N	N	50%

2.4 Fuel & Emissions	3A. Leave (Major) - Disconnect & Trench Entire Line	5A. Full Removal - Reverse Reel	Weighting
3A. Leave (Major) - Disconnect & Trench Entire Line	N	W	40%
5A. Full Removal - Reverse Reel	S	N	60%

2.5 Other Consumptions	3A. Leave (Major) - Disconnect & Trench Entire Line	5A. Full Removal - Reverse Reel	Weighting
3A. Leave (Major) - Disconnect & Trench Entire Line	N	N	50%
5A. Full Removal - Reverse Reel	N	N	50%

2.6 Seabed Disturbance	3A. Leave (Major) - Disconnect & Trench Entire Line	5A. Full Removal - Reverse Reel	Weighting
3A. Leave (Major) - Disconnect & Trench Entire Line	N	W	40%
5A. Full Removal - Reverse Reel	S	N	60%

Appendix C.4 Group 1 Pairwise Comparison Matrices – Technical

3. Technical	3A. Leave (Major) - Disconnect & Trench Entire Line	5A. Full Removal - Reverse Reel	Weighting
3A. Leave (Major) - Disconnect & Trench Entire Line	N	MW	25%
5A. Full Removal - Reverse Reel	MS	N	75%

Appendix C.5 Group 1 Pairwise Comparison Matrices – Societal

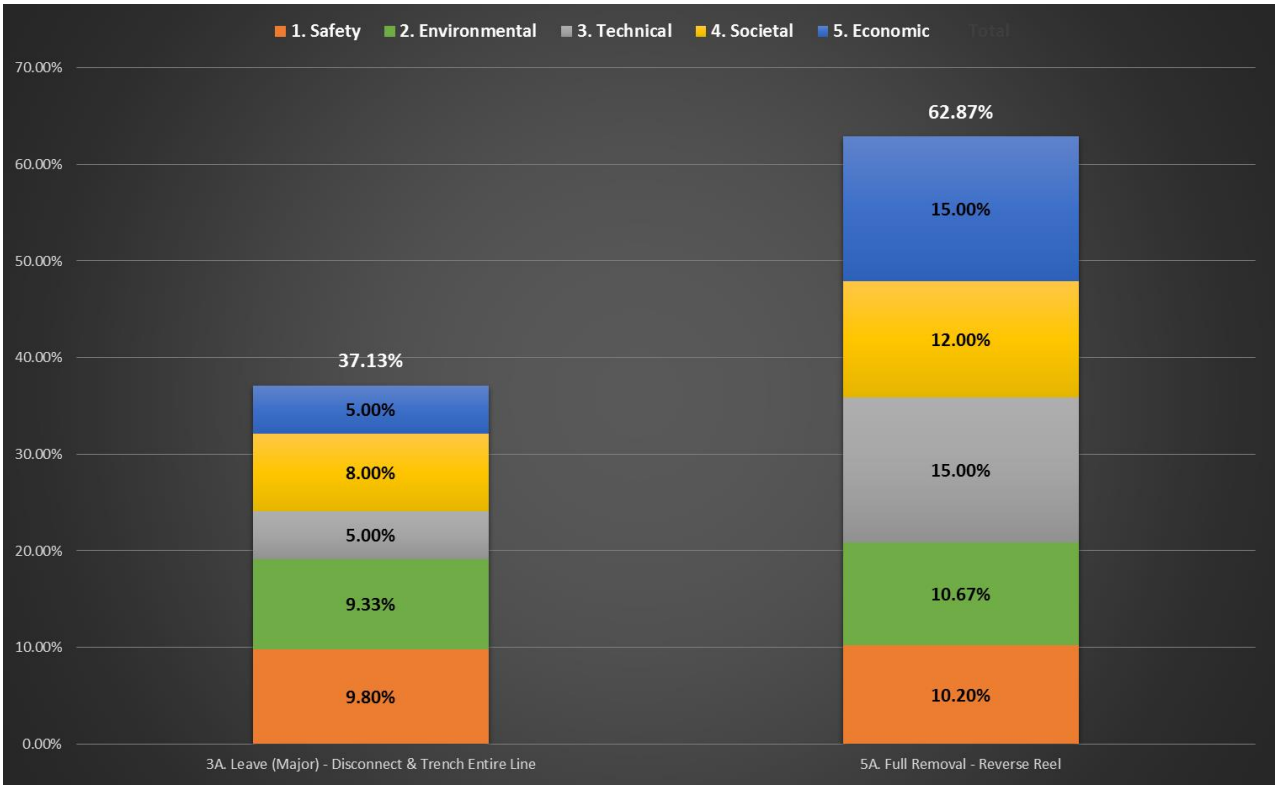
4.1 Fishing	3A. Leave (Major) - Disconnect & Trench Entire Line	5A. Full Removal - Reverse Reel	Weighting
3A. Leave (Major) - Disconnect & Trench Entire Line	N	W	40%
5A. Full Removal - Reverse Reel	S	N	60%

4.2 Other Users	3A. Leave (Major) - Disconnect & Trench Entire Line	5A. Full Removal - Reverse Reel	Weighting
3A. Leave (Major) - Disconnect & Trench Entire Line	N	W	40%
5A. Full Removal - Reverse Reel	S	N	60%

Appendix C.6 Group 1 Pairwise Comparison Matrices – Economic

5. Economic	3A. Leave (Major) - Disconnect & Trench Entire Line	5A. Full Removal - Reverse Reel	Weighting
3A. Leave (Major) - Disconnect & Trench Entire Line	N	MW	25%
5A. Full Removal - Reverse Reel	MS	N	75%

Appendix C.7 Group 1 Results Chart



APPENDIX D GROUP 3 – DETAILED EVALUATION RESULTS

Appendix D.1 Group 3 Attributes Table

		1B. Leave (Minimal) - Remove Exposed Ends & Local Rock Placement	2A. Leave (Minor) - Remove Exposed Ends / Exposures & Rock Placement	3A. Leave (Major) - Disconnect & Re-trench Entire Line	3B. Leave (Major) - Disconnect Ends & Full Rock Placement	5C. Full Removal - Deburial & Cut and Lift
		- Flowlines will be disconnected **- Removal and recovery of exposed section** **- Rock placement to remediate seabed at cut location (small area very local) and over sections where trench and burial depth is considered unacceptable.**	**- Flowlines will be disconnected** **- Removal and recovery of exposed section** **- Removal and recovery of all spans and exposures** **- Rock placement at all areas of removal to appropriate level of burial depth.**	**- Flowlines will be disconnected** **- Re-trench and backfill entire length to remove snag hazards** **- No recovery of flowlines** **- No introduction of material.**	**- Flowlines will be disconnected** **- Rock placement over entire length to acceptable level of depth** **- No recovery of flowlines.**	**- Flowlines will be disconnected** **- Deburial along entire length and recover by cutting into sections and removal**
1. Safety	1.1 Personnel Offshore	Vessel Type:- PoB / Days / Hours / PLL DSV:- 76 / 34 / 31,008 / 2.33E-03 Barge / Pipehaul:- 20 / 35 / 8,400 / 4.62E-04 Divers:- 3 / 34 / 2,448 / 2.37E-03 Trawler:- 5 / 9 / 540 / 4.05E-05 Survey Vessel:- 76 / 22 / 20,064 / 1.50E-03 Rockdump Vessel:- 20 / 10 / 2,400 / 1.80E-04 Total offshore hours:- 64,860 hrs Total offshore PLL:- 6.89E-03	Vessel Type:- PoB / Days / Hours / PLL DSV:- 76 / 40 / 36,480 / 2.74E-03 Barge / Pipehaul:- 20 / 41 / 9,840 / 5.41E-04 Divers:- 3 / 40 / 2,880 / 2.79E-03 Trawler:- 5 / 9 / 540 / 4.05E-05 Survey Vessel:- 76 / 22 / 20,064 / 1.50E-03 Rockdump Vessel:- 20 / 12 / 2,880 / 2.16E-04 Total offshore hours:- 72,684 hrs Total offshore PLL:- 7.83E-03	Vessel Type:- PoB / Days / Hours / PLL Trawler:- 5 / 9 / 540 / 4.05E-05 Survey Vessel:- 76 / 22 / 20,064 / 1.50E-03 Trenching Vessel:- 20 / 42 / 10,080 / 7.56E-04 Total offshore hours:- 30,684 hrs Total offshore PLL:- 2.30E-03	Vessel Type:- PoB / Days / Hours / PLL Trawler:- 5 / 9 / 540 / 4.05E-05 Survey Vessel:- 76 / 22 / 20,064 / 1.50E-03 Rockdump Vessel:- 20 / 76 / 18,240 / 1.37E-03 Total offshore hours:- 38,844 hrs Total offshore PLL:- 2.91E-03	Vessel Type:- PoB / Days / Hours / PLL DSV:- 76 / 128 / 116,736 / 8.76E-03 Barge / Pipehaul:- 20 / 63 / 15,120 / 8.32E-04 Divers:- 3 / 128 / 9,216 / 8.94E-03 Trawler:- 5 / 9 / 540 / 4.05E-05 Survey Vessel:- 76 / 22 / 20,064 / 1.50E-03 CSV:- 76 / 102 / 93,024 / 5.12E-03 Total offshore hours:- 254,700 hrs Total offshore PLL:- 2.52E-02
		N / **MW** / **MW** / **MS**	**MW** / **MW** / **MS**	**N** / **VMS**	**VMS**	
	Summary	The summary Potential for Loss of Life (PLL) metrics, with respect to Personnel Offshore exposure, for the options are 6.89E-03, 7.83E-03, 2.30E-03, 2.91E-03 and 2.52E-02 respectively. The assessment of the risk exposure for the various offshore worker groups is as follows: Option 1B is assessed as being Neutral to Option 2A as the PLL values and thus the risk exposures are very close. Option 1B is assessed as being Much Weaker than Option 3A as the risk exposure is around 3 times higher. Option 1B is assessed as being Much Weaker than Option 3B as the risk exposure is around double. Option 1B is assessed as being Much Stronger than Option 5C as the risk exposure is more than 3 times lower. Option 2A is assessed as being Much Weaker than Option 3A and 3B as the risk exposure is around 3 times higher. Option 2A is assessed as being Much Stronger than Option 5C as the risk exposure is around 3 times lower. Option 3A is assessed as being Neutral to Option 3B as the risk exposures are very similar. Option 3A is assessed as being Very Much Stronger than Option 5C as the risk exposure is around 11 times lower. Option 3B is assessed as being Very Much Stronger than Option 5C as the risk exposure is around 9 times lower. Overall, Options 3A and 3B would be preferred from a risk to offshore personnel perspective.				
1. Safety	1.2 Personnel Onshore	Resource Type:- Days / Hours / PLL Engineering & Management:- 963 / 7,706 / 3.08E-05 Project Management:- 901 / 7,208 / 2.88E-05 Onshore Operations (inc. Cleaning & Disposal):- 219 / 1,755 / 2.16E-04 Total onshore hours:- 16,668 hrs Total onshore PLL:- 2.75E-04	Resource Type:- Days / Hours / PLL Engineering & Management:- 1106 / 8,847 / 3.54E-05 Project Management:- 1033 / 8,264 / 3.31E-05 Onshore Operations (inc. Cleaning & Disposal):- 262 / 2,092 / 2.57E-04 Total onshore hours:- 19,203 hrs Total onshore PLL:- 3.26E-04	Resource Type:- Days / Hours / PLL Engineering & Management:- 1109 / 8,871 / 3.55E-05 Project Management:- 1027 / 8,216 / 3.29E-05 Onshore Operations (inc. Cleaning & Disposal):- 246 / 1,971 / 2.42E-04 Total onshore hours:- 19,058 hrs Total onshore PLL:- 3.11E-04	Resource Type:- Days / Hours / PLL Engineering & Management:- 275 / 2,200 / 8.80E-06 Project Management:- 264 / 2,112 / 8.45E-06 Onshore Operations (inc. Cleaning & Disposal):- 66 / 528 / 6.49E-05 Total onshore hours:- 4,840 hrs Total onshore PLL:- 8.22E-05	Resource Type:- Days / Hours / PLL Engineering & Management:- 4213 / 33,706 / 1.35E-04 Project Management:- 3882 / 31,056 / 1.24E-04 Onshore Operations (inc. Cleaning & Disposal):- 985 / 7,881 / 9.69E-04 Total onshore hours:- 72,643 hrs Total onshore PLL:- 1.23E-03
		N / **N** / **MW** / **MS**	**N** / **MW** / **MS**	**MW** / **MS**	**VMS**	
	Summary	The summary Potential for Loss of Life (PLL) metrics, with respect to Personnel Onshore exposure, for the options are 2.75E-04, 3.26E-04, 3.11E-04, 8.22E-05 and 1.23E-03 respectively. The assessment of the risk exposure for the various onshore worker groups is as follows: Option 1B is assessed as being Neutral to Option 2A and 3A as the PLL values and thus the risk exposures are very close. Option 1B is assessed as being Much Weaker than Option 3B as the risk exposure is around three times higher. Option 1B is assessed as being Much Stronger than Option 5C as the risk exposure is around 4 times lower. Option 2A is assessed as being Neutral to Option 3A as the risk exposure is similar. Option 2A is assessed as being Much Weaker than Option 3B as the risk exposure is around four times higher. Option 2A is assessed as being Much Stronger than Option 5C as the risk exposure is around 4 times lower. Option 3A is assessed as being Much Weaker than to Option 3B as the risk exposure is around 4 times higher. Option 3A is assessed as being Much Stronger than Option 5C as the risk exposure is around 4 times lower. Option 3B is assessed as being Very Much Stronger than Option 5C as the risk exposure is around 15 times lower. Overall, Option 3B would be preferred from a risk to onshore personnel perspective.				
1. Safety	1.3 Other Users	Vessel Days:- DSV:- 34 Barge / Pipehaul:- 35 Trawler:- 9 Survey Vessel:- 22 Rockdump Vessel:- 10 Total vessel days:- 110 days	Vessel Days:- DSV:- 40 Barge / Pipehaul:- 41 Trawler:- 9 Survey Vessel:- 22 Rockdump Vessel:- 12 Total vessel days:- 124 days	Vessel Days:- Trawler:- 9 Survey Vessel:- 22 Trenching Vessel:- 42 Total vessel days:- 73 days	Vessel Days:- Trawler:- 9 Survey Vessel:- 22 Rockdump Vessel:- 76 Total vessel days:- 107 days	Vessel Days:- DSV:- 128 Barge / Pipehaul:- 63 Trawler:- 9 Survey Vessel:- 22 CSV:- 102 Total vessel days:- 324 days
		N / **W** / **N** / **MS**	**W** / **N** / **MS**	**S** / **VMS**	**MS**	
	Summary	The assessment of the impact of each of the options on Other Users is largely driven by the durations that vessels are located in the area during the decommissioning works. The assessment is as follows: Option 1B is assessed as being Neutral to Option 2A as the number of days of vessel operations is similar. Option 1B is assessed as being Weaker than Option 3A as the number of days of vessel operations is a little under double. Option 1B is assessed as being Neutral to Option 3B as the number of days of vessel operations is similar. Option 1B is assessed as being Much Stronger than Option 5C as the number of days of vessel operations is around 3 times lower and option 5C operations are spread out over a larger area and duration. Option 2A is assessed as being Weaker than Option 3A as the number of days of vessel operations is a little under double. Option 2A is assessed as being Neutral to Option 3B as the number of days of vessel operations is similar. Option 2A is assessed as being Much Stronger than Option 5C as the number of days of vessel operations is around 3 times lower and option 5C operations are spread out over a larger area and duration. Option 3A is assessed as being Stronger than Option 3B as the number of days of vessel operations is a little under half. Option 3A is assessed as being Very Much Stronger than Option 5C as the number of days of vessel operations around 4 times lower. Option 3B is assessed as being Much Stronger than Option 5C as the number of days of vessel operations is around 3 times lower and option 5C operations are spread out over a larger area and duration. Overall, Option 3A would be preferred from a risk to other users perspective.				
1. Safety	1.4 High Consequence Events	The potential for High Consequence events is considered low for this option and relates to the potential for dropped object during lifting operations. Number of lifts through water column / splash zone is 96.	The potential for High Consequence events is considered low for this option and relates to the potential for dropped object during lifting operations. Number of lifts through water column / splash zone is 167.	The potential for High Consequence events is considered low for this option. It is considered lower again than Option 1B and 2A due to no requirement for lifting. Risks associated with these trenching operations are more likely to be technical rather than safety related.	The potential for High Consequence events is considered low for this option. It is considered lower again than Option 1B and 2A due to no requirement for lifting.	The potential for High Consequence events is considered higher than the other options but not particularly high in absolute terms. This is a function of the number of lifts required, through the splash zone and onto deck / transfers to barges. Number of lifts through water column / splash zone is 970.
		S / **W** / **W** / **MS**	**W** / **W** / **MS**	**N** / **VMS**	**VMS**	
	Summary	The assessment of the potential for High Consequence Events for each of the options is as follows: Option 1B is assessed as being Stronger than Option 2A in terms of potential for High Consequence Events due to the dropped object hazard associated with lifting operations through the splashzone and onto vessels and there being more lifting operations associated with Option 2A. Option 1B is assessed as being Weaker than Options 3A and 3B as there are no lifting operations associated with those options. Option 1B is assessed as being Much Stronger than Option 5C as there are many more lifts associated with Option 5C including inter-vessel transfers. Option 2A is assessed as being Weaker than Options 3A and 3B as there are no lifting operations associated with those options. Option 2A is assessed as being Much Stronger than Option 5C as there are many more lifts associated with Option 5C. Option 3A is assessed as being Neutral to Option 3B as there are no lifts associated with these options. Option 3A is assessed as being Very Much Stronger than Option 5C as there are no lifts versus a high number of lifts. Option 3B is assessed as being Very Much Stronger than Option 5C for similar reasons. Overall, Options 3A and 3B would be preferred from a potential for High Consequence Events perspective.				

		1B. Leave (Minimal) - Remove Exposed Ends & Local Rock Placement				2A. Leave (Minor) - Remove Exposed Ends / Exposures & Rock Placement			3A. Leave (Major) - Disconnect & Re-trench Entire Line		3B. Leave (Major) - Disconnect Ends & Full Rock Placement	5C. Full Removal - Deburial & Cut and Lift
		- Flowlines will be disconnected **- Removal and recovery of exposed section** **- Rock placement to remediate seabed at cut location (small area very local) and over sections where trench and burial depth is considered unacceptable.**				**- Flowlines will be disconnected** **- Removal and recovery of exposed section** **- Removal and recovery of all spans and exposures** **- Rock placement at all areas of removal to appropriate level of burial depth.**			**- Flowlines will be disconnected** **- Re-trench and backfill entire length to remove snag hazards** **- No recovery of flowlines** **- No introduction of material.**		**- Flowlines will be disconnected** **- Rock placement over entire length to acceptable level of depth** **- No recovery of flowlines.**	**- Flowlines will be disconnected** **- Deburial along entire length and recover by cutting into sections and removal**
1. Safety	**1.5 Residual Risk**	Vessel Type:- PoB / Days / Hours / PLL Survey Vessel (Legacy):- 76 / 66 / 60,192 / 4.51E-03 Rockdump Vessel (Legacy):- 20 / 5 / 1,200 / 9.00E-05 Total offshore hours:- 61,392 hrs Total offshore PLL:- 4.60E-03 The legacy risk to the fishing industry from rock dumped, monitored / remediated pipelines is assessed as having a 'very unlikely' probability of occurrence.				Vessel Type:- PoB / Days / Hours / PLL Survey Vessel (Legacy):- 76 / 66 / 60,192 / 4.51E-03 Rockdump Vessel (Legacy):- 20 / 5 / 1,200 / 9.00E-05 Total offshore hours:- 61,392 hrs Total offshore PLL:- 4.60E-03 The legacy risk to the fishing industry from rock dumped, monitored / remediated pipelines is assessed as having a 'very unlikely' probability of occurrence.			Vessel Type:- PoB / Days / Hours / PLL Survey Vessel (Legacy):- 76 / 66 / 60,192 / 4.51E-03 Rockdump Vessel (Legacy):- 20 / 5 / 1,200 / 9.00E-05 Total offshore hours:- 61,392 hrs Total offshore PLL:- 4.60E-03 The legacy risk to the fishing industry from trenched pipelines is assessed as having a 'very unlikely' probability of occurrence.		Vessel Type:- PoB / Days / Hours / PLL Survey Vessel (Legacy):- 76 / 66 / 60,192 / 4.51E-03 Rockdump Vessel (Legacy):- 20 / 5 / 1,200 / 9.00E-05 Total offshore hours:- 61,392 hrs Total offshore PLL:- 4.60E-03 The legacy risk to the fishing industry from rock dumped, monitored / remediated pipelines is assessed as having a 'unlikely' probability of occurrence.	No residual risk from this full removal option.
		N	**N**	**N**	**MW**	**N**	**N**	**MW**	**N**	**MW**	**MW**	
	Summary	The assessment of the Residual Risk for each of the options is as follows: Option 1B, 2A, 3A and 3B are assessed as being Neutral to each other due to the impact from monitoring and remediation being the same and the potential for snag hazard to the fishing community being assessed as the same i.e. very unlikely. All options are assessed as being Much Weaker than Option 5C as there is no residual risk associated with the Full Removal option. Overall, Option 5C would be preferred from a Residual Risk perspective.										
2. Environmental	**2.1 Marine Impact (Noise)**	Vessel Noise:- 244 dB re 1mP 2.61 TPa²s Tooling Noise:- 218 dB re 1mP 0.01 TPa²s Under this option, the major sound source will be the vessels involved with noise from equipment negligible. Although a rock dump vessel, which is notably noisier than other vessels types, will be used its proportion of the overall duration is small. The estimated total sound exposure over the operations is also small. Therefore, the overall impact of noise is anticipated to be low.				Vessel Noise:- 250 dB re 1mP 10.28 TPa²s Tooling Noise:- 219 dB re 1mP 0.01 TPa²s Under this option, the major sound source will be the vessels involved with noise from equipment negligible. A rock dump vessel, would be required but its proportion of the overall vessel duration is small. The estimated total sound exposure over the operations is also small. Therefore, the overall impact of noise is anticipated to be low.			Vessel Noise:- 240 dB re 1mP 0.94 TPa²s Tooling Noise:- 230 dB re 1mP 0.1 TPa²s Under this option, the major sound source will be the vessels involved with a very small proportion of noise from extensive use of trenching equipment. A small number of vessels is required with no use of the noisiest rock dump vessel necessary. This leads to a very small estimated total sound exposure and therefore, overall impact of noise is anticipated to be low.		Vessel Noise:- 257 dB re 1mP 45.29 TPa²s Under this option, the major sound source will be the vessels involved. The extensive use of the rock dumping vessel and the overall duration of operations result in a high cumulative sound exposure. Based on this, the overall impact of noise is anticipated to be moderate.	Vessel Noise:- 256 dB re 1mP 37.05 TPa²s Tooling Noise:- 225 dB re 1mP 0.034 TPa²s Under this option, the major sound sources will be the vessels involved with a very small amount of noise from frequent use of cutting and MFE equipment. The number of vessels and duration of their use, especially the use of dynamically positioned CSV and DSV lead to a high estimated total sound exposure. As such the potential impact is anticipated to be moderate.
		N	**N**	**S**	**S**	**N**	**S**	**S**	**S**	**S**	**N**	
	Summary	The assessment of the Marine Impact (Noise) for each of the options is as follows: Option 1B is assessed as being Neutral to Option 2A and 3A as, whilst there are differences in the cumulative noise metrics, these are assessed as similar in impact terms. Option 1B is assessed as being Stronger than Option 3B and 5C as the impact from the cumulative noise is considered to have a moderate impact. Option 2A is assessed as being Neutral to Option 3A and Stronger than Option 3B and 5C for similar reasons. Option 3A is assessed as being Stronger than Option 3B and Option 5C, again for similar reasons as already described. Option 3B is assessed as being Neutral to Option 5C as the cumulative noise impact is similar. Overall, Options 1B, 2A and 3A would be preferred from a Marine Impact (Noise) perspective.										
2. Environmental	**2.2 Marine Impact (Planned Discharges)**	Pipeline cleaning and flushing operations will use Best Environmental Practice (BEP) and the Best Available Techniques (BAT) to minimise as far as possible both residual Oil in Water (OIW) levels in pipelines post flush and OIW discharges to the marine environment during flushing activities. Cutting of exposed pipeline ends would lead to a discharge of fluids containing residual oil from within the pipelines. However, given the prior cleaning of the pipelines, the concentration and quantity of oil should be low. Therefore, the related impact is also anticipated to be low.				Pipeline cleaning and flushing operations will use Best Environmental Practice (BEP) and the Best Available Techniques (BAT) to minimise as far as possible both residual Oil in Water (OIW) levels in pipelines post flush and OIW discharges to the marine environment during flushing activities. Cutting of both pipeline ends and exposed midline sections would lead to an elevated discharge of fluids containing residual oil from within the pipelines. However, given the prior cleaning of the pipelines, the concentration and quantity of oil should still be low overall. Therefore, the related impact is also anticipated to be low.			Pipeline cleaning and flushing operations will use Best Environmental Practice (BEP) and the Best Available Techniques (BAT) to minimise as far as possible both residual Oil in Water (OIW) levels in pipelines post flush and OIW discharges to the marine environment during flushing activities. Discharges of oil bearing fluids from the buried pipeline would occur in small quantities and over a long timeframe. However, given the prior cleaning of the pipelines, the concentration and quantity of oil should be low. Therefore, the related impact is also anticipated to be low.		Pipeline cleaning and flushing operations will use Best Environmental Practice (BEP) and the Best Available Techniques (BAT) to minimise as far as possible both residual Oil in Water (OIW) levels in pipelines post flush and OIW discharges to the marine environment during flushing activities. Discharges of oil bearing fluids from the rock dumped pipeline would occur in small quantities and over a long timeframe. However, given the cleaning of the pipelines, the concentration and quantity of oil should be low. Therefore, the related impact is also anticipated to be low.	Pipeline cleaning and flushing operations will use Best Environmental Practice (BEP) and the Best Available Techniques (BAT) to minimise as far as possible both residual Oil in Water (OIW) levels in pipelines post flush and OIW discharges to the marine environment during flushing activities. Cutting of the pipelines into individual sections would result in noticeably increased volumes of oil contaminated fluids being discharged over a short time frame. However, given the cleaning of the pipelines, the concentration and quantity of oil should still be low overall. Therefore, the related impact is also anticipated to be low.
		N	**N**	**N**	**S**	**N**	**N**	**S**	**N**	**S**	**S**	
	Summary	The assessment of the Marine Impact (Planned Discharges) for each of the options is as follows: Option 1B is assessed as being Neutral to Options 2A, 3A and 3B as any differences in any planned discharges are assessed as minimal and all are assessed to have low impact. All options are assessed as being Stronger than Option 5C as the, whilst the impact is still assessed as being low overall, there would be more planned discharges associated with cutting the pipelines in 20m sections in-situ. Overall, Options 1B, 2A, 3A and 3B would be preferred from a Marine Impact (Planned Discharges) perspective.										
2. Environmental	**2.3 Marine Impact (Unplanned Releases)**	5 individual vessels 107 combined vessel days The relatively short duration of operations and limited use of sub-sea equipment reduce the potential sources of spills. The types and maximum possible quantities of oil that could be accidentally released at the surface or sub-sea under this option would be expected to disperse quickly and not reach the shore. As such, the impact of an unplanned release to sea should be low.				5 individual vessels 125 combined vessel days The relatively short duration of operations and limited use of sub-sea equipment reduce the potential sources of spills. The types and maximum possible quantities of oil that could be accidentally released at the surface or sub-sea under this option would be expected to disperse quickly and not reach the shore. As such, the impact of an unplanned release to sea should be low.			3 individual vessels 73 combined vessel days The relatively short duration of operations reduces the potential sources of spills but use of sub-sea equipment for longer and the constant nature of hydraulic fluid use for trenching increases risk. The types and maximum possible quantities of oil that could be accidentally released at the surface or sub-sea under this option would be expected to disperse quickly and not reach the shore. As such, the impact of an unplanned release to sea should be low.		3 individual vessels 107 combined vessel days The relatively short duration of operations and limited use of sub-sea equipment reduce the potential sources of spills. The types and maximum possible quantities of oil that could be accidentally released at the surface or sub-sea under this option would be expected to disperse quickly and not reach the shore. As such, the impact of an unplanned release to sea should be low.	5 individual vessels 324 combined vessel days This option would involve considerable vessel time at sea and extensive use of hydraulic cutting equipment sub-sea, increasing the duration and related risk of potential oil spill sources. However, the types and maximum possible quantities of oil that could be accidentally released at the surface or sub-sea under this option would still be expected to disperse quickly and not reach the shore. Therefore, the impact of an unplanned release to sea should still be low.
		N	**N**	**N**	**S**	**N**	**N**	**S**	**N**	**S**	**S**	
	Summary	The assessment of the Marine Impact (Unplanned Releases) for each of the options is as follows: Option 1B is assessed as being Neutral to Options 2A, 3A and 3B as any differences in any unplanned releases, either from vessel operations or subsea operations are assessed as minimal and all are assessed to have low impact. All options are assessed as being Stronger than Option 5C as the, whilst the impact is still assessed as being low overall, there would be a higher potential for unplanned releases from the longer operational durations. Overall, Options 1B, 2A, 3A and 3B would be preferred from a Marine Impact (Unplanned Releases) perspective.										

		1B. Leave (Minimal) - Remove Exposed Ends & Local Rock Placement	2A. Leave (Minor) - Remove Exposed Ends / Exposures & Rock Placement	3A. Leave (Major) - Disconnect & Re-trench Entire Line	3B. Leave (Major) - Disconnect Ends & Full Rock Placement	5C. Full Removal - Deburial & Cut and Lift
		- Flowlines will be disconnected **- Removal and recovery of exposed section** **- Rock placement to remediate seabed at cut location (small area very local) and over sections where trench and burial depth is considered unacceptable.**	**- Flowlines will be disconnected** **- Removal and recovery of exposed section** **- Removal and recovery of all spans and exposures** **- Rock placement at all areas of removal to appropriate level of burial depth.**	**- Flowlines will be disconnected** **- Re-trench and backfill entire length to remove snag hazards** **- No recovery of flowlines** **- No introduction of material.**	**- Flowlines will be disconnected** **- Rock placement over entire length to acceptable level of depth** **- No recovery of flowlines.**	**- Flowlines will be disconnected** **- Deburial along entire length and recover by cutting into sections and removal**
2. Environmental	2.4 Fuel & Emissions	Vessel Emissions (in tonnes):- Fuel:- 5,186 CO2e:- 16,998 NOx:- 305.97 SO2:- 62.23 Vessel Energy Use:- 222,995 GJ The total estimated fuel usage required for this option would only represent a very small proportion of the total annual emissions from industry with respect to contribution to climate change. The impact of atmospheric emissions is therefore anticipated to be low.	Vessel Emissions (in tonnes):- Fuel:- 5,535 CO2e:- 18,141 NOx:- 326.54 SO2:- 66.41 Vessel Energy Use:- 237,985 GJ The total estimated fuel usage required for this option would only represent a very small proportion of the total annual emissions from industry with respect to contribution to climate change. The impact of atmospheric emissions is therefore anticipated to be low.	Vessel Emissions (in tonnes):- Fuel:- 3,820 CO2e:- 12,521 NOx:- 225.38 SO2:- 12,109.32 Vessel Energy Use:- 164,259 GJ The total estimated fuel usage required for this option would only represent a very small proportion of the total annual emissions from industry with respect to contribution to climate change. The impact of atmospheric emissions is therefore anticipated to be low.	Vessel Emissions (in tonnes):- Fuel:- 4,406 CO2e:- 14,443 NOx:- 259.98 SO2:- 52.88 Vessel Energy Use:- 189,478 GJ The total estimated fuel usage required for this option would only represent a very small proportion of the total annual emissions from industry with respect to contribution to climate change. The impact of atmospheric emissions is therefore anticipated to be low.	Vessel Emissions (in tonnes):- Fuel:- 8,410 CO2e:- 27,566 NOx:- 496.19 SO2:- 100.92 Vessel Energy Use:- 361,633 GJ The length of time required for this option will result in correspondingly high quantities of fuel use and atmospheric emissions. However, this will still represent only a small proportion of the total annual emissions from industry with respect to contribution to climate change. The impact of atmospheric emissions is therefore anticipated to be low.
		N **N** **N** **S**	**N** **N** **S**	**N** **S**	**S**	
	Summary	The assessment of the impact of Fuel & Emissions for each of the options is as follows: Option 1B is assessed as being Neutral to Options 2A, 3A and 3B as, whilst there are differences in the fuel use and emissions, these differences are not considered significant in impact terms. All options are assessed as being Stronger than Option 5C as the, whilst the impact is still assessed as being low overall, there is significantly higher fuel use and atmospheric emissions associated with this option. Overall, Options 1B, 2A, 3A and 3B would be preferred from a Fuel & Emissions perspective.				
2. Environmental	2.5 Other Consumptions	New material introduced:- Rockdump:- 4,902 tonnes Material returned for onshore processing:- Recovered:- 491 tonnes / 495 tonnes CO2 Remaining:- 6,131 tonnes / 11,635 tonnes CO2 Given the amount of rock dump required, this option is seen as moderate in scale in terms of resource use. As the flowlines will mostly be left in-situ (trenched and buried) with only the ends cut and recovered, there will be a relatively small amount of waste returned to shore for processing and disposal. There will be an associated burden for production of replacement material. The associated impacts are anticipated to be low in scale.	New material introduced:- Rockdump:- 4,350 tonnes Material returned for onshore processing:- Recovered:- 547 tonnes / 551 tonnes CO2 Remaining:- 6,076 tonnes / 11,530 tonnes CO2 Given the amount of rock dump required, this option is seen as moderate in scale in terms of resource use. As the flowlines will mostly be left in-situ (trenched and buried) with only the pipeline ends and exposed sections cut and recovered, there will be a relatively small amount of waste returned to shore for processing and disposal. There will be an associated burden for production of replacement material. The associated impacts are anticipated to be low in scale.	New material introduced:- None Material returned for onshore processing:- Recovered:- None Remaining:- 6,623 tonnes / 12,563 tonnes CO2 This option is relatively simple in terms of the expected vessels, equipment and resources required and short in duration. The associated impacts in this context are expected to be low. As the flowlines will be left trenched and buried in the seabed, there will be no waste returned to shore for processing and disposal so there will be no impacts from waste processing. There will be an associated burden for production of replacement material.	New material introduced:- Rockdump:- 399,901 tonnes Material returned for onshore processing:- Recovered:- None Remaining:- 6,623 tonnes / 12,563 tonnes CO2 Given the sheer quantity of rock dump material required and associated energy and resources used in procuring this material, the use of natural resources is seen to be moderate in this case. As the flowlines will be left rock dumped on the seabed, there will be no waste returned to shore for processing and disposal so there will be no impacts from waste processing. There will be an associated burden for production of replacement material.	New material introduced:- None Material returned for onshore processing:- Recovered:- 6,623 tonnes / 6,695 tonnes CO2 Remaining:- None Although no rock dump material is required, the duration of the operations and number of vessels under this option suggests that resource use may be moderate in scale. As the pipelines will be recovered, materials will be returned to shore for treatment, reuse, recycling or disposal which will result in energy and other resource use and atmospheric emissions. There is however, the associated benefit of no requirement to produce replacement material. Overall, impact is anticipated as low.
		N **W** **VMS** **W**	**W** **VMS** **W**	**VMS** **W**	**VMW**	
	Summary	The assessment of the Other Consumptions for each of the options is as follows: Option 1B is assessed as being Neutral to Option 2A as, whilst there are minor differences in the amount of new material required for rock dump and the amount of energy consumption used to address the amount of material being recovered / remaining, these differences are considered minor overall and that the impact of these consumptions will be low in scale. Option 1B is assessed as being Weaker than Option 3A and 5C, mainly due to there being no requirement for new material with these options. Option 1B is assessed as being Very Much Stronger than Option 3B due to the large amount of new material required with that option. Option 2A is assessed as being Weaker than Option 3A and 5C, mainly due to there being no requirement for new material with these options. Option 2A is assessed as being Very Much Stronger than Option 3B due to the large amount of new material required with that option. Option 3A is assessed as being Very Much Stronger than Option 3B due to the large amount of new material required with that option and Weaker than Option 5C as there is reasonable additional consumption associated with the remaining material under Option 3A. Option 3B is assessed as being Very Much Weaker than all options due to the large amount of new material required with that option. Overall, Option 5C would be preferred from a Other Consumptions perspective.				
2. Environmental	2.6 Seabed Disturbance	Rockdumping:- 6,925 m2 The area of seabed directly disturbed by these operations is extremely small in the context of the surrounding wider region. Although the rock dumping will leave an area of seabed different from the surrounding natural sediments (mud), this area will also be very small. Indirect seabed disturbance is also considered to have limited impact. Therefore, the level of impact on the seabed and related communities is expected to be low.	Rockdumping:- 6,475 m2 The area of seabed directly disturbed by these operations is extremely small in the context of the surrounding wider region Although the rock dumping will leave an area of seabed different from the surrounding natural sediments (mud), this area will also be very small. Indirect seabed disturbance is also considered to have limited impact. Therefore, the level of impact on the seabed and related communities is expected to be low.	Trenching:- 116,339 m2 The area of seabed directly disturbed by these operations is roughly equivalent to that incurred by the mooring of an anchored drilling rig. This is still small in the context of the surrounding wider region, with good potential for recovery due to the consistent nature of habitats and communities. This option would also leave the seabed in a natural state. Indirect seabed disturbance is also considered to have limited impact. Therefore, the level of impact on the seabed and related communities is expected to be low.	Rockdumping:- 581,695 m2 Although physical impacts will be felt over a relatively small area, given that the rock dumping will alter the habitat in the area covered, the overall impact is concluded to be moderate. Indirect seabed disturbance is considered to have limited impact.	MFE:- 465,356 m2 The area of seabed directly disturbed by these operations is roughly equivalent to that incurred by the mooring of four anchored drilling rigs. Mass flow excavation is likely to cause wider sediment resuspension and disturbance. However, this is still a small area in the context of the surrounding wider region, with good potential for recovery due to the consistent nature of habitats and communities. This option would also leave the seabed in a natural state. Whilst indirect seabed disturbance is over a significant area, its impact is considered limited. Therefore, the level of impact on the seabed and related communities is expected to be low.
		N **N** **VMS** **S**	**N** **VMS** **S**	**VMS** **S**	**VMW**	
	Summary	The assessment of the Seabed Disturbance for each of the options is as follows: Option 1B is assessed as being Neutral to Options 2A and 3A as the impact of a small area of rock dump versus the larger area of trenching are considered largely comparable in terms of impact. Option 1B is assessed as being Very Much Stronger than Option 3B due to the large area of rock dump associated with that option. Option 1B is assessed as being Stronger than Option 5C with the key difference being the larger area of impact and the additional sediment disturbance component associated with the Mass Flow Excavator under Option 5C. Option 2A is assessed against Options 3A, 3B and 5C in the same way as Option 1B for similar reasons. Option 3A is assessed as being Very Much Stronger than Option 3B, again due to impact of the large area of rock dump. Option 3A is assessed as being Stronger than Option 5C due to the smaller area of impact and the additional sediment disturbance component associated with the Mass Flow Excavator under Option 5C. Option 3B is assessed as being Very Much Weaker than all options due to the large area of rock dump associated with that option. Overall, Options 1B, 2A and 3A would be preferred from a Seabed Disturbance perspective.				

		1B. Leave (Minimal) - Remove Exposed Ends & Local Rock Placement				2A. Leave (Minor) - Remove Exposed Ends / Exposures & Rock Placement			3A. Leave (Major) - Disconnect & Re-trench Entire Line		3B. Leave (Major) - Disconnect Ends & Full Rock Placement	5C. Full Removal - Deburial & Cut and Lift
		- Flowlines will be disconnected - Removal and recovery of exposed section - Rock placement to remediate seabed at cut location (small area very local) and over sections where trench and burial depth is considered unacceptable.				**- Flowlines will be disconnected - Removal and recovery of exposed section - Removal and recovery of all spans and exposures - Rock placement at all areas of removal to appropriate level of burial depth.**			**- Flowlines will be disconnected - Re-trench and backfill entire length to remove snag hazards - No recovery of flowlines - No introduction of material.**		**- Flowlines will be disconnected - Rock placement over entire length to acceptable level of depth - No recovery of flowlines.**	**- Flowlines will be disconnected - Deburial along entire length and recover by cutting into sections and removal**
3. Technical	3.1 Technical Risk	All technical aspects of this option are considered routine operations.				All technical aspects of this option are considered routine operations.			The requirement to trench lines in a very congested area along with the lines already being in a trench make this option very technically challenging. Residual torsion in line may mean that trenching to get acceptable burial depth / status may not deliver outcome required i.e. may require spot rock dump anyway, which would constitute technical failure as currently defined.		All technical aspects of this option are considered routine operations.	Whilst technical aspects are considered routine, potential for schedule over run from technical issues associated with extended operations and number of subsea cuts increases technical challenges associated with this option.
		N	**VMS**	**N**	**MS**	**VMS**	**N**	**MS**	**VMW**	**W**	**MS**	
	Summary	The assessment of the Technical aspects for each of the options is as follows: Option 1B, 2A and 3B are assessed as being Neutral to each other as the operations are routine. Option 1B is assessed as being Very Much Stronger than Option 3A due to the significant technical challenges associated with trenching in a congested area and to an acceptable level identified with Option 3A. Option 1B is assessed as being Much Stronger than Option 5C due to the potential technical challenges associated with the numerous subsea cuts and the extended operational durations for Option 5C. Option 2A is assessed as being Very Much Stronger than Option 3A due to the significant technical challenges already described. Option 2A is assessed as being Much Stronger than Option 5C for similar reasons as Option 1B. Option 3A is assessed as being Very Much Weaker than Option 3B due to the significant technical challenges already described. Option 3A is assessed as being Weaker than Option 5C as the significant technical challenges associated with Option 3A are offset somewhat by the potential technical challenges associated with the numerous subsea cuts and the extended operational durations for Option 5C. Option 3B is assessed as being Much Stronger than Option 5C due to the routine operations versus potential technical challenges associated with the numerous subsea cuts and the extended operational durations for Option 5C. Overall, Options 1B, 2A and 3B would be preferred from a Technical perspective.										
4. Societal	4.1 Fishing	Area of potential fishing ground impact from commercial fishing perspective (nephrops) due to decommissioning option is equivalent to the area of rock dump i.e. 6,925 m2. Short term presence of vessels at Balmoral will exclude fishing activity but not over an area greater than that excluded during production operations. Nothing will be left exposed on the seabed in the long term that could be a snagging hazard once rock dumping is complete and the rock dump will be designed to be overtrawlable in the long term. The rock dumping will also cover a very small area of potential fishing grounds. Therefore, the overall impact on commercial fisheries is seen to be low.				Area of potential fishing ground impact from commercial fishing perspective (nephrops) due to decommissioning option is equivalent to the area of rock dump i.e. 6,475 m2. Short term presence of vessels at Balmoral will exclude fishing activity but not over an area greater than that excluded during production operations. Nothing will be left exposed on the seabed in the long term that could be a snagging hazard once rock dumping is complete and the rock dump will be designed to be overtrawlable in the long term. The rock dumping will also cover a very small area of potential fishing grounds. Therefore, the overall impact on commercial fisheries is seen to be low.			Area of potential fishing ground impact from commercial fishing perspective (nephrops) due to decommissioning option is equivalent to the area of trenching operations i.e. 116,339 m2. Believe area impacted would recover relatively quickly. Ultimately, no commercial fishing ground loss. Short term presence of vessels at Balmoral will exclude fishing activity but not over an area greater than that excluded during production operations. The seabed will be left in a natural state with nothing will be left exposed on the seabed in the long term that could be a snagging hazard once trenching is complete. Therefore, the overall impact on commercial fisheries is seen to be low.		Area of potential fishing ground impact from commercial fishing perspective (nephrops) due to decommissioning option is equivalent to the area of rock dump i.e. 581,695 m2. Short term presence of vessels at Balmoral will exclude fishing activity but not over an area greater than that excluded during production operations. Nothing will be left exposed on the seabed in the long term that could be a snagging hazard once rock dumping is complete and the rock dump will be designed to be overtrawlable in the long term. Therefore, the overall impact on commercial fisheries is seen to be low.	Area of potential fishing ground impact from commercial fishing perspective (nephrops) due to decommissioning option is equivalent to the area of deburial operations i.e. 456,356 m2. Believe area impacted would recover relatively quickly. Ultimately, no commercial fishing ground loss. Short term presence of vessels at Balmoral will exclude fishing activity but not over an area greater than that excluded during production operations. The seabed will be left in a natural state with nothing will be left on the seabed in the long term that could be a snagging hazard once removal is complete. Therefore, the overall impact on commercial fisheries is seen to be low.
		N	**N**	**S**	**N**	**N**	**S**	**N**	**S**	**N**	**W**	
	Summary	The assessment against the Societal - Fishing criterion is as follows: Option 1B, 2A, 3B and 5C are assessed as being Neutral to each other from a Societal - Fishing perspective as, whilst there are areas lost to fishing under Option 1B and Option 2A, these are very small and the larger area of nephrop fishing impacted by Option 3A and 5C would be expected to recover relatively quickly in commercial fishing terms. All options are assessed as Stronger than 3B from a Societal - Fishing perspective due to the area permanently lost to nephrop fishing, which whilst large is small in overall fishing grounds terms. Overall, Options 1B, 2A, 3A and 5C would be preferred from a Societal - Fishing perspective.										
4. Societal	4.2 Other Users	Some minor societal benefit associated with the 491 tonnes of returned steel.				Some minor societal benefit associated with the 547 tonnes of returned steel.			No perceived societal benefits.		Minor societal benefit of job protection / creation associated with requirement for almost 400,000 tonnes of rock. This is more than outweighed by, potentially hundreds of lorry journeys associated with getting that rock from quarry to quayside and the impact on communities.	Some minor societal benefit associated with the 6,623 tonnes of returned steel.
		N	**S**	**MS**	**W**	**S**	**MS**	**W**	**MS**	**W**	**VMW**	
	Summary	The assessment against the Societal - Other Users criterion for each of the options is as follows: Option 1B is assessed as being Neutral to Option 2A as the impact is similar. Option 1B is assessed as being Stronger than Option 3A due to the minor benefits associated with the material returned with Option 1A. Option 1B is assessed as being Much Stronger than Option 3B due the impact of transporting the large amount of quarried rock on communities. Option 1B is assessed as being Weaker than Option 5C due to the benefit associated with returning much more material with Option 5C. Option 2A is assessed as being Stronger than Option 3A, Much Stronger than Option 3B and Weaker than Option 5C for similar reasons as Option 1B. Option 3A is assessed as being Much Stronger than Option 3B due the impact of transporting the large amount of quarried rock on communities. Option 3A is assessed as being Weaker than Option 5C due to the benefit associated with returning much more material with Option 5C. Option 3B is assessed as being Very Much Weaker than Option 5C due to a combination of the impact of transporting the large amount of quarried rock on communities and the benefit associated with returning much more material with Option 5C. Overall, Option 5C would be preferred from a Societal - Other Users perspective.										
5. Economic	5.1 Short-term Costs	Initial operation cost:- £12.839M Legacy cost:- £3.234M Total cost:- £16.074M				Initial operation cost:- £14.493M Legacy cost:- £3.234M Total cost:- £17.727M			Initial operation cost:- £14.238M Legacy cost:- £3.234M Total cost:- £17.473M		Initial operation cost:- £20.950M Legacy cost:- £3.234M Total cost:- £24.184M	Initial operation cost:- £49.457M Total cost:- £49.457M
		N	**N**	**MS**	**VMS**	**N**	**MS**	**VMS**	**MS**	**VMS**	**MS**	
	Summary	The assessment of the Economics for each of the options is as follows: Option 1B is assessed as being Neutral to Options 2A and 3A as the total costs are largely similar. Option 1B is assessed as being Much Stronger than Option 3B due to the total costs being more than £10M lower. Option 1B is assessed as being Very Much Stronger than Option 5C as the costs are around a third of those for Option 5C. Option 2A is assessed as being Neutral to Option 3A as the total costs are similar. Option 2A is assessed as being Much Stronger than Option 3B due to the total costs being more than £10M lower. Option 2A is assessed as being Very Much Stronger than Option 5C as the costs are around a third of those for Option 5C. Option 3A is assessed as being Much Stronger than Option 3B due to the total costs being more than £10M lower. Option 3A is assessed as being Very Much Stronger than Option 5C as the costs are around a third of those for Option 5C. Option 3B is assessed as being Much Stronger than Option 5C as the costs are aroud half. Overall, Options 1B, 2A and 3A would be preferred from an Economic perspective.										

Appendix D.2 Group 3 Pairwise Comparison Matrices – Safety

1.1 Personnel Offshore

	1B. Leave (Minimal) - Remove Exposed Ends & Local Rock Placement	2A. Leave (Minor) - Remove Exposed Ends / Exposures & Rock Placement	3A. Leave (Major) - Disconnect & Re-trench Entire Line	3B. Leave (Major) - Disconnect Ends & Full Rock Placement	5C. Full Removal - Deburial & Cut and Lift	Weighting
1B. Leave (Minimal) - Remove Exposed Ends & Local Rock Placement	N	N	MW	MW	MS	12%
2A. Leave (Minor) - Remove Exposed Ends / Exposures & Rock Placement	N	N	MW	MW	MS	12%
3A. Leave (Major) - Disconnect & Re-trench Entire Line	MS	MS	N	N	VMS	36%
3B. Leave (Major) - Disconnect Ends & Full Rock Placement	MS	MS	N	N	VMS	36%
5C. Full Removal - Deburial & Cut and Lift	MW	MW	VMW	VMW	N	4%

1.2 Personnel Onshore

	1B. Leave (Minimal) - Remove Exposed Ends & Local Rock Placement	2A. Leave (Minor) - Remove Exposed Ends / Exposures & Rock Placement	3A. Leave (Major) - Disconnect & Re-trench Entire Line	3B. Leave (Major) - Disconnect Ends & Full Rock Placement	5C. Full Removal - Deburial & Cut and Lift	Weighting
1B. Leave (Minimal) - Remove Exposed Ends & Local Rock Placement	N	N	N	MW	MS	16%
2A. Leave (Minor) - Remove Exposed Ends / Exposures & Rock Placement	N	N	N	MW	MS	16%
3A. Leave (Major) - Disconnect & Re-trench Entire Line	N	N	N	MW	MS	16%
3B. Leave (Major) - Disconnect Ends & Full Rock Placement	MS	MS	MS	N	VMS	47%
5C. Full Removal - Deburial & Cut and Lift	MW	MW	MW	VMW	N	5%

1.3 Other Users

	1B. Leave (Minimal) - Remove Exposed Ends & Local Rock Placement	2A. Leave (Minor) - Remove Exposed Ends / Exposures & Rock Placement	3A. Leave (Major) - Disconnect & Re-trench Entire Line	3B. Leave (Major) - Disconnect Ends & Full Rock Placement	5C. Full Removal - Deburial & Cut and Lift	Weighting
1B. Leave (Minimal) - Remove Exposed Ends & Local Rock Placement	N	N	W	N	MS	20%
2A. Leave (Minor) - Remove Exposed Ends / Exposures & Rock Placement	N	N	W	N	MS	20%
3A. Leave (Major) - Disconnect & Re-trench Entire Line	S	S	N	S	VMS	34%
3B. Leave (Major) - Disconnect Ends & Full Rock Placement	N	N	W	N	MS	20%
5C. Full Removal - Deburial & Cut and Lift	MW	MW	VMW	MW	N	6%

1.4 High Consequence Events

	1B. Leave (Minimal) - Remove Exposed Ends & Local Rock Placement	2A. Leave (Minor) - Remove Exposed Ends / Exposures & Rock Placement	3A. Leave (Major) - Disconnect & Re-trench Entire Line	3B. Leave (Major) - Disconnect Ends & Full Rock Placement	5C. Full Removal - Deburial & Cut and Lift	Weighting
1B. Leave (Minimal) - Remove Exposed Ends & Local Rock Placement	N	S	W	W	MS	19%
2A. Leave (Minor) - Remove Exposed Ends / Exposures & Rock Placement	W	N	W	W	MS	16%
3A. Leave (Major) - Disconnect & Re-trench Entire Line	S	S	N	N	VMS	30%
3B. Leave (Major) - Disconnect Ends & Full Rock Placement	S	S	N	N	VMS	30%
5C. Full Removal - Deburial & Cut and Lift	MW	MW	VMW	VMW	N	4%

1.5 Residual Risk

	1B. Leave (Minimal) - Remove Exposed Ends & Local Rock Placement	2A. Leave (Minor) - Remove Exposed Ends / Exposures & Rock Placement	3A. Leave (Major) - Disconnect & Re-trench Entire Line	3B. Leave (Major) - Disconnect Ends & Full Rock Placement	5C. Full Removal - Deburial & Cut and Lift	Weighting
1B. Leave (Minimal) - Remove Exposed Ends & Local Rock Placement	N	N	N	N	MW	14%
2A. Leave (Minor) - Remove Exposed Ends / Exposures & Rock Placement	N	N	N	N	MW	14%
3A. Leave (Major) - Disconnect & Re-trench Entire Line	N	N	N	N	MW	14%
3B. Leave (Major) - Disconnect Ends & Full Rock Placement	N	N	N	N	MW	14%
5C. Full Removal - Deburial & Cut and Lift	MS	MS	MS	MS	N	43%

Appendix D.3 Group 3 Pairwise Comparison Matrices – Environment

2.1 Marine Impact (Noise)	1B. Leave (Minimal) - Remove Exposed Ends & Local Rock Placement	2A. Leave (Minor) - Remove Exposed Ends / Exposures & Rock Placement	3A. Leave (Major) - Disconnect & Re-trench Entire Line	3B. Leave (Major) - Disconnect Ends & Full Rock Placement	5C. Full Removal - Deburial & Cut and Lift	Weighting
1B. Leave (Minimal) - Remove Exposed Ends & Local Rock Placement	N	N	N	S	S	23%
2A. Leave (Minor) - Remove Exposed Ends / Exposures & Rock Placement	N	N	N	S	S	23%
3A. Leave (Major) - Disconnect & Re-trench Entire Line	N	N	N	S	S	23%
3B. Leave (Major) - Disconnect Ends & Full Rock Placement	W	W	W	N	N	15%
5C. Full Removal - Deburial & Cut and Lift	W	W	W	N	N	15%

2.2 Marine Impact (Planned Discharges)	1B. Leave (Minimal) - Remove Exposed Ends & Local Rock Placement	2A. Leave (Minor) - Remove Exposed Ends / Exposures & Rock Placement	3A. Leave (Major) - Disconnect & Re-trench Entire Line	3B. Leave (Major) - Disconnect Ends & Full Rock Placement	5C. Full Removal - Deburial & Cut and Lift	Weighting
1B. Leave (Minimal) - Remove Exposed Ends & Local Rock Placement	N	N	N	N	S	21%
2A. Leave (Minor) - Remove Exposed Ends / Exposures & Rock Placement	N	N	N	N	S	21%
3A. Leave (Major) - Disconnect & Re-trench Entire Line	N	N	N	N	S	21%
3B. Leave (Major) - Disconnect Ends & Full Rock Placement	N	N	N	N	S	21%
5C. Full Removal - Deburial & Cut and Lift	W	W	W	W	N	14%

2.3 Marine Impact (Unplanned Releases)	1B. Leave (Minimal) - Remove Exposed Ends & Local Rock Placement	2A. Leave (Minor) - Remove Exposed Ends / Exposures & Rock Placement	3A. Leave (Major) - Disconnect & Re-trench Entire Line	3B. Leave (Major) - Disconnect Ends & Full Rock Placement	5C. Full Removal - Deburial & Cut and Lift	Weighting
1B. Leave (Minimal) - Remove Exposed Ends & Local Rock Placement	N	N	N	N	S	21%
2A. Leave (Minor) - Remove Exposed Ends / Exposures & Rock Placement	N	N	N	N	S	21%
3A. Leave (Major) - Disconnect & Re-trench Entire Line	N	N	N	N	S	21%
3B. Leave (Major) - Disconnect Ends & Full Rock Placement	N	N	N	N	S	21%
5C. Full Removal - Deburial & Cut and Lift	W	W	W	W	N	14%

2.4 Fuel & Emissions	1B. Leave (Minimal) - Remove Exposed Ends & Local Rock Placement	2A. Leave (Minor) - Remove Exposed Ends / Exposures & Rock Placement	3A. Leave (Major) - Disconnect & Re-trench Entire Line	3B. Leave (Major) - Disconnect Ends & Full Rock Placement	5C. Full Removal - Deburial & Cut and Lift	Weighting
1B. Leave (Minimal) - Remove Exposed Ends & Local Rock Placement	N	N	N	N	S	21%
2A. Leave (Minor) - Remove Exposed Ends / Exposures & Rock Placement	N	N	N	N	S	21%
3A. Leave (Major) - Disconnect & Re-trench Entire Line	N	N	N	N	S	21%
3B. Leave (Major) - Disconnect Ends & Full Rock Placement	N	N	N	N	S	21%
5C. Full Removal - Deburial & Cut and Lift	W	W	W	W	N	14%

2.5 Other Consumptions	1B. Leave (Minimal) - Remove Exposed Ends & Local Rock Placement	2A. Leave (Minor) - Remove Exposed Ends / Exposures & Rock Placement	3A. Leave (Major) - Disconnect & Re-trench Entire Line	3B. Leave (Major) - Disconnect Ends & Full Rock Placement	5C. Full Removal - Deburial & Cut and Lift	Weighting
1B. Leave (Minimal) - Remove Exposed Ends & Local Rock Placement	N	N	W	VMS	W	20%
2A. Leave (Minor) - Remove Exposed Ends / Exposures & Rock Placement	N	N	W	VMS	W	20%
3A. Leave (Major) - Disconnect & Re-trench Entire Line	S	S	N	VMS	W	26%
3B. Leave (Major) - Disconnect Ends & Full Rock Placement	VMW	VMW	VMW	N	VMW	3%
5C. Full Removal - Deburial & Cut and Lift	S	S	S	VMS	N	31%

2.6 Seabed Disturbance	1B. Leave (Minimal) - Remove Exposed Ends & Local Rock Placement	2A. Leave (Minor) - Remove Exposed Ends / Exposures & Rock Placement	3A. Leave (Major) - Disconnect & Re-trench Entire Line	3B. Leave (Major) - Disconnect Ends & Full Rock Placement	5C. Full Removal - Deburial & Cut and Lift	Weighting
1B. Leave (Minimal) - Remove Exposed Ends & Local Rock Placement	N	N	N	VMS	S	26%
2A. Leave (Minor) - Remove Exposed Ends / Exposures & Rock Placement	N	N	N	VMS	S	26%
3A. Leave (Major) - Disconnect & Re-trench Entire Line	N	N	N	VMS	S	26%
3B. Leave (Major) - Disconnect Ends & Full Rock Placement	VMW	VMW	VMW	N	VMW	3%
5C. Full Removal - Deburial & Cut and Lift	W	W	W	VMS	N	19%

Appendix D.4 Group 3 Pairwise Comparison Matrices – Technical

3. Technical	1B. Leave (Minimal) - Remove Exposed Ends & Local Rock Placement	2A. Leave (Minor) - Remove Exposed Ends / Exposures & Rock Placement	3A. Leave (Major) - Disconnect & Re-trench Entire Line	3B. Leave (Major) - Disconnect Ends & Full Rock Placement	5C. Full Removal - Deburial & Cut and Lift	Weighting
1B. Leave (Minimal) - Remove Exposed Ends & Local Rock Placement	N	N	VMS	N	MS	29%
2A. Leave (Minor) - Remove Exposed Ends / Exposures & Rock Placement	N	N	VMS	N	MS	29%
3A. Leave (Major) - Disconnect & Re-trench Entire Line	VMW	VMW	N	VMW	W	4%
3B. Leave (Major) - Disconnect Ends & Full Rock Placement	N	N	VMS	N	MS	29%
5C. Full Removal - Deburial & Cut and Lift	MW	MW	S	MW	N	8%

Appendix D.5 Group 3 Pairwise Comparison Matrices – Societal

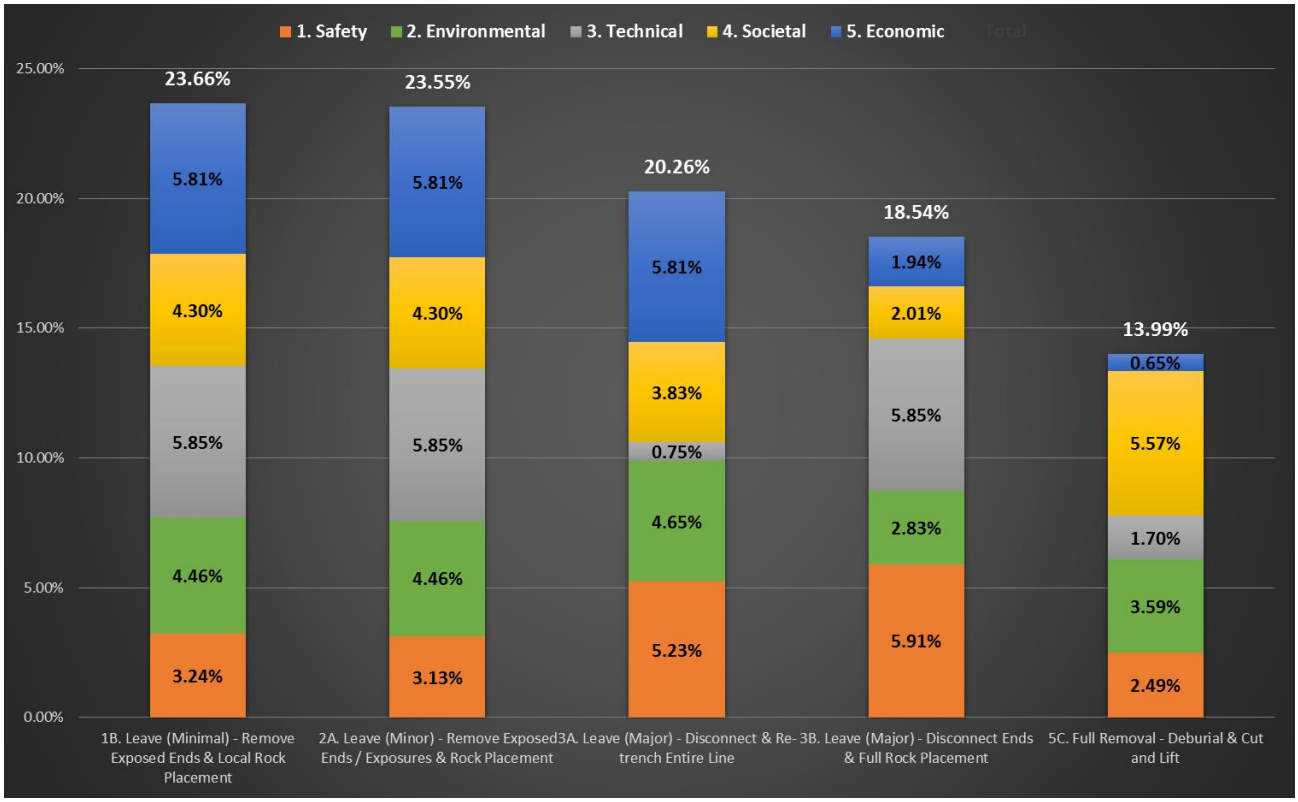
4.1 Fishing	1B. Leave (Minimal) - Remove Exposed Ends & Local Rock Placement	2A. Leave (Minor) - Remove Exposed Ends / Exposures & Rock Placement	3A. Leave (Major) - Disconnect & Re-trench Entire Line	3B. Leave (Major) - Disconnect Ends & Full Rock Placement	5C. Full Removal - Deburial & Cut and Lift	Weighting
1B. Leave (Minimal) - Remove Exposed Ends & Local Rock Placement	N	N	N	S	N	21%
2A. Leave (Minor) - Remove Exposed Ends / Exposures & Rock Placement	N	N	N	S	N	21%
3A. Leave (Major) - Disconnect & Re-trench Entire Line	N	N	N	S	N	21%
3B. Leave (Major) - Disconnect Ends & Full Rock Placement	W	W	W	N	W	14%
5C. Full Removal - Deburial & Cut and Lift	N	N	N	S	N	21%

4.2 Other Users	1B. Leave (Minimal) - Remove Exposed Ends & Local Rock Placement	2A. Leave (Minor) - Remove Exposed Ends / Exposures & Rock Placement	3A. Leave (Major) - Disconnect & Re-trench Entire Line	3B. Leave (Major) - Disconnect Ends & Full Rock Placement	5C. Full Removal - Deburial & Cut and Lift	Weighting
1B. Leave (Minimal) - Remove Exposed Ends & Local Rock Placement	N	N	S	MS	W	22%
2A. Leave (Minor) - Remove Exposed Ends / Exposures & Rock Placement	N	N	S	MS	W	22%
3A. Leave (Major) - Disconnect & Re-trench Entire Line	W	W	N	MS	W	17%
3B. Leave (Major) - Disconnect Ends & Full Rock Placement	MW	MW	MW	N	VMW	6%
5C. Full Removal - Deburial & Cut and Lift	S	S	S	VMS	N	34%

Appendix D.6 Group 3 Pairwise Comparison Matrices – Economic

5. Economic	1B. Leave (Minimal) - Remove Exposed Ends & Local Rock Placement	2A. Leave (Minor) - Remove Exposed Ends / Exposures & Rock Placement	3A. Leave (Major) - Disconnect & Re-trench Entire Line	3B. Leave (Major) - Disconnect Ends & Full Rock Placement	5C. Full Removal - Deburial & Cut and Lift	Weighting
1B. Leave (Minimal) - Remove Exposed Ends & Local Rock Placement	N	N	N	MS	VMS	29%
2A. Leave (Minor) - Remove Exposed Ends / Exposures & Rock Placement	N	N	N	MS	VMS	29%
3A. Leave (Major) - Disconnect & Re-trench Entire Line	N	N	N	MS	VMS	29%
3B. Leave (Major) - Disconnect Ends & Full Rock Placement	MW	MW	MW	N	MS	10%
5C. Full Removal - Deburial & Cut and Lift	VMW	VMW	VMW	MW	N	3%

Appendix D.7 Group 3 Results Chart



APPENDIX E GROUP 4 – DETAILED EVALUATION RESULTS

Appendix E.1 Group 4 Attributes Table

		1B. Leave (Minimal) - Remove Exposed Ends / Exposures & Local Rock Placement					2A. Leave (Minor) - Remove Exposed Ends & Rock Placement				3A. Leave (Major) - Disconnect & Re-trench Entire Line			3B. Leave (Major) - Disconnect Ends & Full Rock Placement		5A. Full Removal - Deburial & Reverse Reel	5C. Full Removal - Deburial & Cut and Lift
		- Flowlines / Umbilicals will be disconnected **- Removal and recovery of exposed ends** **- Rock placement to remediate seabed at cut location (small area very local) and over sections where trench and burial depth is considered unacceptable.**					**- Flowlines / Umbilicals will be disconnected** **- Removal and recovery of exposed ends** **- Removal and recovery of all spans and exposures** **- Rock placement at all areas of removal to appropriate level of burial depth.**				**- Flowlines / Umbilicals will be disconnected** **- Re-trench and backfill entire length to remove snag hazards** **- No recovery of Flowlines / Umbilicals** **- No introduction of material.**			**- Flowlines / Umbilicals will be disconnected** **- Rock placement over entire length to acceptable level of depth** **- No recovery of Flowlines / Umbilicals.**		**- Flowlines / Umbilicals will be disconnected** **- Deburial along entire length and reverse reel**	**- Flowlines / Umbilicals will be disconnected** **- Deburial along entire length and recover by cutting into sections and removal**
1. Safety	**1.1 Personnel Offshore**	Vessel Type:- PoB / Days / Hours / PLL DSV:- 76 / 22 / 20,064 / 1.50E-03 Barge / Pipehaul:- 20 / 21 / 5,040 / 2.77E-04 Divers:- 3 / 22 / 1,584 / 1.54E-03 Trawler:- 5 / 8 / 480 / 3.60E-05 Survey Vessel:- 76 / 15 / 13,680 / 1.03E-03 Rockdump Vessel:- 20 / 7 / 1,680 / 1.26E-04 Total offshore hours:- 42,528 hrs Total offshore PLL:- 4.51E-03					Vessel Type:- PoB / Days / Hours / PLL DSV:- 76 / 25 / 22,800 / 1.71E-03 Barge / Pipehaul:- 20 / 24 / 5,760 / 3.17E-04 Divers:- 3 / 25 / 1,800 / 1.75E-03 Trawler:- 5 / 8 / 480 / 3.60E-05 Survey Vessel:- 76 / 15 / 13,680 / 1.03E-03 Rockdump Vessel:- 20 / 8 / 1,920 / 1.44E-04 Total offshore hours:- 46,440 hrs Total offshore PLL:- 4.98E-03				Vessel Type:- PoB / Days / Hours / PLL Trawler:- 5 / 8 / 480 / 3.60E-05 Survey Vessel:- 76 / 15 / 13,680 / 1.03E-03 Trenching Vessel:- 20 / 25 / 6,000 / 4.50E-04 Total offshore hours:- 20,160 hrs Total offshore PLL:- 1.51E-03			Vessel Type:- PoB / Days / Hours / PLL Trawler:- 5 / 8 / 480 / 3.60E-05 Survey Vessel:- 76 / 15 / 13,680 / 1.03E-03 Rockdump Vessel:- 20 / 46 / 11,040 / 8.28E-04 Total offshore hours:- 25,200 hrs Total offshore PLL:- 1.89E-03		Vessel Type:- PoB / Days / Hours / PLL Trawler:- 5 / 8 / 480 / 3.60E-05 Survey Vessel:- 76 / 15 / 13,680 / 1.03E-03 CSV:- 76 / 34 / 31,008 / 1.71E-03 Reel Vessel:- 76 / 23 / 20,976 / 1.57E-03 Total offshore hours:- 66,144 hrs Total offshore PLL:- 4.34E-03	Vessel Type:- PoB / Days / Hours / PLL DSV:- 76 / 76 / 69,312 / 5.20E-03 Barge / Pipehaul:- 20 / 38 / 9,120 / 5.02E-04 Divers:- 3 / 76 / 5,472 / 5.31E-03 Trawler:- 5 / 8 / 480 / 3.60E-05 Survey Vessel:- 76 / 15 / 13,680 / 1.03E-03 CSV:- 76 / 63 / 57,456 / 3.16E-03 Total offshore hours:- 155,520 hrs Total offshore PLL:- 1.52E-02
		N	**MW**	**W**	**N**	**MS**	**MW**	**MW**	**N**	**MS**	**N**	**MS**	**VMS**	**MS**	**VMS**	**MS**	
	Summary	The summary Potential for Loss of Life (PLL) metrics, with respect to Personnel Offshore exposure, for the options are 4.51E-03, 4.98E-03, 1.51E-03, 1.89E-03, 4.34E-03 and 2.52E-02 respectively. The assessment of the risk exposure for the various offshore worker groups is as follows: Option 1B is assessed as being Neutral to Options 2A and 5A as the PLL values and thus the risk exposures are very close. Option 1B is assessed as being Much Weaker than Option 3A as the risk exposure is around 3 times higher and also Much Weaker than Option 3B as the risk exposure is around double. Option 1B is assessed as being Much Stronger than Option 5C as the risk exposure is more than 3 times lower. Option 2A is assessed as being Much Weaker than Options 3A and 3B as the risk exposure is around 3 times higher. Option 2A is assessed as being Neutral to Option 5A as the risk exposure is similar. Option 2A is assessed as being Much Stronger than Option 5C as the risk exposure is around 3 times lower. Option 3A is assessed as being Neutral to Option 3B as the risk exposures are similar. Option 3A is assessed as being Much Stronger than Option 5A as the risk exposure is around 3 times lower. Option 3A is assessed as being Very Much Stronger than Option 5C as the risk exposure is around 10 times lower. Option 3B is assessed as being Much Stronger than Option 5C as the risk exposure is more than 2 times lower. Option 3B is assessed as being Very Much Stronger than Option 5C as the risk exposure is around 8 times lower. Option 5A is assessed as being Much Stronger than Option 5C as the risk exposure is more than 3 times lower. Overall, Option 3A would be preferred from a risk to offshore personnel perspective.															
1. Safety	**1.2 Personnel Onshore**	Resource Type:- Days / Hours / PLL Engineering & Management:- 637 / 5,094 / 2.04E-05 Project Management:- 602 / 4,816 / 1.93E-05 Onshore Operations (inc. Cleaning & Disposal):- 131 / 1,049 / 1.29E-04 Total onshore hours:- 10,959 hrs Total onshore PLL:- 1.69E-04					Resource Type:- Days / Hours / PLL Engineering & Management:- 712 / 5,694 / 2.28E-05 Project Management:- 670 / 5,360 / 2.14E-05 Onshore Operations (inc. Cleaning & Disposal):- 148 / 1,185 / 1.46E-04 Total onshore hours:- 12,239 hrs Total onshore PLL:- 1.90E-04				Resource Type:- Days / Hours / PLL Engineering & Management:- 699 / 5,588 / 2.24E-05 Project Management:- 651 / 5,208 / 2.08E-05 Onshore Operations (inc. Cleaning & Disposal):- 145 / 1,158 / 1.42E-04 Total onshore hours:- 11,954 hrs Total onshore PLL:- 1.86E-04			Resource Type:- Days / Hours / PLL Engineering & Management:- 254.411764705882 / 2,035 / 8.14E-06 Project Management:- 263 / 2,104 / 8.42E-06 Onshore Operations (inc. Cleaning & Disposal):- 274.095 / 2,193 / 2.70E-04 Total onshore hours:- 6,332 hrs Total onshore PLL:- 2.86E-04		Resource Type:- Days / Hours / PLL Engineering & Management:- 1003 / 8,024 / 3.21E-05 Project Management:- 900 / 7,200 / 2.88E-05 Onshore Operations (inc. Cleaning & Disposal):- 240 / 1,922 / 2.36E-04 Total onshore hours:- 17,146 hrs Total onshore PLL:- 2.97E-04	Resource Type:- Days / Hours / PLL Engineering & Management:- 2668 / 21,341 / 8.54E-05 Project Management:- 2465 / 19,720 / 7.89E-05 Onshore Operations (inc. Cleaning & Disposal):- 490 / 3,919 / 4.82E-04 Total onshore hours:- 44,980 hrs Total onshore PLL:- 6.46E-04
		N	**N**	**S**	**S**	**MS**	**N**	**S**	**S**	**MS**	**S**	**S**	**MS**	**N**	**MS**	**MS**	
	Summary	The summary Potential for Loss of Life (PLL) metrics, with respect to Personnel Onshore exposure, for the options are 1.69E-04, 1.90E-04, 1.86E-04, 2.86E-04, 2.97E-04 and 6.46E-04 respectively. The assessment of the risk exposure for the various onshore worker groups is as follows: Option 1B is assessed as being Neutral to Options 2A and 3A as the PLL values and thus the risk exposures are similar. Option 1B is assessed as being Stronger than Options 3B and 5A as the risk exposures are around 2 times lower. Option 1B is assessed as being Much Stronger than Option 5C as the risk exposure is around 4 times lower. Option 2A is assessed as being Neutral to Option 3A as the risk exposure is similar. Option 2A is assessed as being Stronger than Options 3B and 5A as the risk exposures are around 1.5 times lower. Option 2A is assessed as being Much Stronger than Option 5C as the risk exposure is around 3.5 times lower. Option 3A is assessed as being Stronger than Options 3B and 5A as the risk exposures are around 1.5 times lower. Option 3A is assessed as being Much Stronger than Option 5C as the risk exposure is around 3.5 times lower. Option 3B is assessed as being Neutral to Option 5A as the risk exposure is similar. Option 3B is assessed as being Much Stronger than Option 5C as the risk exposure is more than 2 times lower. Option 5A is assessed as being Much Stronger than Option 5C as the risk exposure is just over 2 times lower. Overall, Options 1B, 2A and 3A would be preferred from a risk to onshore personnel perspective.															
1. Safety	**1.3 Other Users**	Vessel Days:- DSV:- 22 Barge / Pipehaul:- 21 Trawler:- 8 Survey Vessel:- 15 Rockdump Vessel:- 7 Total vessel days:- 73 days					Vessel Days:- DSV:- 25 Barge / Pipehaul:- 24 Trawler:- 8 Survey Vessel:- 15 Rockdump Vessel:- 8 Total vessel days:- 80 days				Vessel Days:- Trawler:- 8 Survey Vessel:- 15 Trenching Vessel:- 25 Total vessel days:- 48 days			Vessel Days:- Trawler:- 8 Survey Vessel:- 15 Rockdump Vessel:- 46 Total vessel days:- 69 days		Vessel Days:- Trawler:- 8 Survey Vessel:- 15 CSV:- 34 Reel Vessel:- 23 Total vessel days:- 80 days	Vessel Days:- DSV:- 76 Barge / Pipehaul:- 38 Trawler:- 8 Survey Vessel:- 15 CSV:- 63 Total vessel days:- 200 days
		N	**W**	**N**	**N**	**MS**	**W**	**N**	**N**	**MS**	**S**	**S**	**MS**	**N**	**MS**	**MS**	
	Summary	The assessment of the impact of each of the options on Other Users is largely driven by the durations that vessels are located in the area during the decommissioning works. The assessment is as follows: Option 1B is assessed as being Neutral to Options 2A, 3B and 5A as the number of days of vessel operations is similar. Option 1B is assessed as being Weaker than Option 3A as the number of days of vessel operations is a little under double. Option 1B is assessed as being Much Stronger than Option 5C as the number of days of vessel operations is around 3 times lower and option 5C operations are spread out over a larger area and duration. Option 2A is assessed as being Weaker than Option 3A as the number of days of vessel operations is a little under double. Option 2A is assessed as being Neutral to Options 3B and 5A as the number of days of vessel operations is similar. Option 2A is assessed as being Much Stronger than Option 5C as the number of days of vessel operations is around 3 times lower and option 5C operations are spread out over a larger area and duration. Option 3A is assessed as being Stronger than Options 3B and 5A as the number of days of vessel operations is a little under half. Option 3A is assessed as being Much Stronger than Option 5C as the number of days of vessel operations around 4 times lower. Option 3B is assessed as being Neutral to Option 5A as the number of days of vessel operations is similar. Option 3B is assessed as being Much Stronger than Option 5C as the number of days of vessel operations is around 3 times lower and option 5C operations are spread out over a larger area and duration. Option 5A is assessed as being Much Stronger than Option 5C for similar reasons. Overall, Option 3A would be preferred from a risk to other users perspective.															
1. Safety	**1.4 High Consequence Events**	The potential for High Consequence events is considered low for this option and relates to the potential for dropped object during lifting operations. Number of lifts through water column / splash zone is 84.					The potential for High Consequence events is considered low for this option and relates to the potential for dropped object during lifting operations. Number of lifts through water column / splash zone is 118. Whilst there are more lifts than Option 2A, these are not considered significant enough to move from Neutral.				The potential for High Consequence events is considered low for this option. It is considered lower again than Option 1B and 2A due to no requirement for lifting. Risks associated with these trenching operations are more likely to be technical rather than safety related.			The potential for High Consequence events is considered low for this option. It is considered lower again than Option 1B and 2A due to no requirement for lifting.		The potential for High Consequence events is considered lower than the lifting options and higher than options 3A and 3B due to small risk of integrity failure whilst reverse reeling.	The potential for High Consequence events is considered higher than the other options but not particularly high in absolute terms. This is a function of the number of lifts required, through the splash zone and onto deck / transfers to barges. Number of lifts through water column / splash zone is 549.
		N	**W**	**W**	**W**	**MS**	**W**	**W**	**W**	**MS**	**N**	**S**	**VMS**	**S**	**VMS**	**MS**	
	Summary	The assessment of the potential for High Consequence Events for each of the options is as follows: Option 1B is assessed as being Neutral to Option 2A in terms of potential for High Consequence Events due to the dropped object hazard associated with lifting operations through the splashzone and onto vessels and there being more lifting operations associated with Option 2A. Option 1B is assessed as being Weaker than Options 3A, 3B and 5A as there are no lifting operations associated with those options. Option 1B is assessed as being Much Stronger than Option 5C as there are many more lifts associated with Option 5C including inter-vessel transfers. Option 2A is assessed as being Weaker than Options 3A, 3B and 5A as there are no lifting operations associated with those options. Option 2A is assessed as being Much Stronger than Option 5C as there are many more lifts associated with Option 5C. Option 3A is assessed as being Neutral to Option 3B as there are no lifts associated with these options. Option 3A is assessed as being Stronger than Option 5A due to the potential for integrity failure associated with reverse reeling. Option 3A is assessed as being Very Much Stronger than Option 5C as there are no lifts versus a high number of lifts. Option 3B is assessed as being Stronger than Option 5A and Very Much Stronger than Option 5C for similar reasons. Option 5A is assessed as being Much Stronger than Option 5C as there are no lifts versus a high number of lifts. Overall, Options 3A and 3B would be preferred from a potential for High Consequence Events perspective.															

		1B. Leave (Minimal) - Remove Exposed Ends / Exposures & Local Rock Placement	2A. Leave (Minor) - Remove Exposed Ends & Rock Placement	3A. Leave (Major) - Disconnect & Re-trench Entire Line	3B. Leave (Major) - Disconnect Ends & Full Rock Placement	5A. Full Removal - Deburial & Reverse Reel	5C. Full Removal - Deburial & Cut and Lift
		- Flowlines / Umbilicals will be disconnected **- Removal and recovery of exposed ends** **- Rock placement to remediate seabed at cut location (small area very local) and over sections where trench and burial depth is considered unacceptable.**	**- Flowlines / Umbilicals will be disconnected** **- Removal and recovery of exposed ends** **- Removal and recovery of all spans and exposures** **- Rock placement at all areas of removal to appropriate level of burial depth.**	**- Flowlines / Umbilicals will be disconnected** **- Re-trench and backfill entire length to remove snag hazards** **- No recovery of Flowlines / Umbilicals** **- No introduction of material.**	**- Flowlines / Umbilicals will be disconnected** **- Rock placement over entire length to acceptable level of depth** **- No recovery of Flowlines / Umbilicals.**	**- Flowlines / Umbilicals will be disconnected** **- Deburial along entire length and reverse reel**	**- Flowlines / Umbilicals will be disconnected** **- Deburial along entire length and recover by cutting into sections and removal**
1. Safety	**1.5 Residual Risk**	Vessel Type:- PoB / Days / Hours / PLL Survey Vessel (Legacy):- 76 / 45 / 41,040 / 3.08E-03 Rockdump Vessel (Legacy):- 20 / 5 / 1,200 / 9.00E-05 Total offshore hours:- 42,240 hrs Total offshore PLL:- 3.17E-03 The legacy risk to the fishing industry from rock dumped, monitored / remediated pipelines is assessed as having a 'very unlikely' probability of occurrence.	Vessel Type:- PoB / Days / Hours / PLL Survey Vessel (Legacy):- 76 / 45 / 41,040 / 3.08E-03 Rockdump Vessel (Legacy):- 20 / 5 / 1,200 / 9.00E-05 Total offshore hours:- 42,240 hrs Total offshore PLL:- 3.17E-03 The legacy risk to the fishing industry from rock dumped, monitored / remediated pipelines is assessed as having a 'very unlikely' probability of occurrence.	Vessel Type:- PoB / Days / Hours / PLL Survey Vessel (Legacy):- 76 / 45 / 41,040 / 3.08E-03 Rockdump Vessel (Legacy):- 20 / 5 / 1,200 / 9.00E-05 Total offshore hours:- 42,240 hrs Total offshore PLL:- 3.17E-03 The legacy risk to the fishing industry from trenched pipelines is assessed as having a 'very unlikely' probability of occurrence.	Vessel Type:- PoB / Days / Hours / PLL Survey Vessel (Legacy):- 76 / 45 / 41,040 / 3.08E-03 Rockdump Vessel (Legacy):- 20 / 5 / 1,200 / 9.00E-05 Total offshore hours:- 42,240 hrs Total offshore PLL:- 3.17E-03 The legacy risk to the fishing industry from rock dumped, monitored / remediated pipelines is assessed as having a 'very unlikely' probability of occurrence.	No residual risk from this full removal option.	No residual risk from this full removal option.
		N N N MW MW	**N N MW MW**	**N MW MW**	**MW MW**	**N**	
	Summary	The assessment of the Residual Risk for each of the options is as follows: Option 1B, 2A, 3A and 3B are assessed as being Neutral to each other due to the impact from monitoring and remediation being the same and the potential for snag hazard to the fishing community being assessed as the same i.e. very unlikely. All options are assessed as being Much Weaker than Options 5A and 5C as there is no residual risk associated with the Full Removal options. Overall, Options 5A and 5C would be preferred from a Residual Risk perspective.					
2. Environmental	**2.1 Marine Impact (Noise)**	Vessel Noise:- 247 dB re 1mP 5.06 TPa²s Tooling Noise:- 215 dB re 1mP 0.001 TPa²s Under this option, the major sound source will be the vessels involved with only a very small proportion of noise from equipment. Although a rock dump vessel, which is notably noisier than other vessels types, will be used its proportion of the overall duration is small. A DSV vessel will be used for quite a large part of the operations. However, the estimated total sound exposure over the operations is small. Therefore, the overall impact of noise is anticipated to be low.	Vessel Noise:- 248 dB re 1mP 6.05 TPa²s Tooling Noise:- 216 dB re 1mP 0.001 TPa²s Under this option, vessel noise will be the most prominent source of underwater sound input with only with only a very small proportion of noise from cutting. Although a rock dump vessel, which is notably noisier than other vessels types, will be used its proportion of the overall duration is small. A DSV vessel will also be used for quite a large part of the operations. However, the estimated total sound exposure over the operations is small. Therefore, the overall impact of noise is anticipated to be low.	Vessel Noise:- 251 dB re 1mP 11.66 TPa²s Tooling Noise:- 227 dB re 1mP 0.05 TPa²s Under this option, the major sound sources will be the vessels involved with only a very small amount of noise from jet trenching equipment. Given the short duration and limited number of different vessel types, the total sound exposure is relatively low. Therefore, the overall impact of noise is also anticipated to be low.	Vessel Noise:- 253 dB re 1mP 20.59 TPa²s Under this option, the major sound source will be the vessels involved, particularly the rock dumping vessel as the entire pipeline lengths will be rock dumped . Although only a small number of vessels would be used overall, the duration of rock dumping vessel use makes the cumulative sound exposure quite high. Therefore, the overall impact of noise is anticipated to be moderate.	Vessel Noise:- 252 dB re 1mP 15.52 TPa²s Tooling Noise:- 226 dB re 1mP 0.04 TPa²s Under this option, the major sound sources will be the vessels involved with some noise from mass flow excavation. A number of different types of vessels will be used, creating relatively high noise emissions. Therefore, the overall impact of noise is anticipated to be moderate.	Vessel Noise:- 252 dB re 1mP 16.93 TPa²s Tooling Noise:- 228 dB re 1mP 0.056 TPa²s Under this option, the major sound sources will be the vessels involved with a small proportion of noise from mass flow excavation and cutting equipment. Given the lengthy duration of operations, overall number of vessels including the extensive use of a DSV and a CSV, the overall noise exposure is quite high. Therefore, the impact of noise is anticipated to be moderate.
		N N S S S	**N S S S**	**N N N**	**N N**	**N**	
	Summary	The assessment of the Marine Impact (Noise) for each of the options is as follows: Option 1B is assessed as being Neutral to Options 2A and 3A as, whilst there are differences in the cumulative noise metrics, these are assessed as similar in impact terms. Option 1B is assessed as being Stronger than Options 3B, 5A and 5C as the impact from the cumulative noise is considered to have a moderate impact. Option 2A is assessed as being Neutral to Option 3A and Stronger than Options 3B, 5A and 5C for similar reasons. Option 3A is assessed as being Neutral to Options 3B, 5A and Option 5C as, whilst there are differences in the cumulative noise metrics, these are assessed as similar in impact terms. Option 3B is assessed as being Neutral to Options 5A and 5C and Option 5A is assessed as being Neutral to Option 5C for similar reasons. Overall, Options 1B and 2A would be preferred from a Marine Impact (Noise) perspective.					
2. Environmental	**2.2 Marine Impact (Planned Discharges)**	Pipeline cleaning and flushing operations will use Best Environmental Practice (BEP) and the Best Available Techniques (BAT) to minimise as far as possible both residual Oil in Water (OIW) levels in pipelines post flush and OIW discharges to the marine environment during flushing activities. Cutting of flowline ends would lead to a discharge of fluids containing residual oil from within the pipelines. However, given the prior cleaning of the pipelines, the concentration and quantity of oil should be low. Therefore, the related impact is also anticipated to be low. The umbilicals will have been cleaned and flushed with the possible exception of the hydraulic fluid lines. There would be minor discharge from cutting the exposed sections of the umbilical however the quantities released are minimal and hydraulic fluid of this type is released routinely during the operation of subsea facilities. Therefore, the related impact is also anticipated to be low.	Pipeline cleaning and flushing operations will use Best Environmental Practice (BEP) and the Best Available Techniques (BAT) to minimise as far as possible both residual Oil in Water (OIW) levels in pipelines post flush and OIW discharges to the marine environment during flushing activities. Cutting of both flowline ends and exposed midline sections would lead to an elevated discharge of fluids containing residual oil from within the pipelines. However, given the prior cleaning of the pipelines, the concentration and quantity of oil should still be low overall. Therefore, the related impact is also anticipated to be low. The umbilicals will have been cleaned and flushed with the possible exception of the hydraulic fluid lines. There would be minor discharge from cutting the exposed sections of the umbilical however the quantities released are minimal and hydraulic fluid of this type is released routinely during the operation of subsea facilities. Therefore, the related impact is also anticipated to be low.	Pipeline cleaning and flushing operations will use Best Environmental Practice (BEP) and the Best Available Techniques (BAT) to minimise as far as possible both residual Oil in Water (OIW) levels in pipelines post flush and OIW discharges to the marine environment during flushing activities. Discharges of oil bearing fluids from the buried pipeline would occur in small quantities and over a long timeframe. However, given the prior cleaning of the pipelines, the concentration and quantity of oil should be low. Therefore, the related impact is also anticipated to be low. The umbilicals will have been cleaned and flushed with the possible exception of the hydraulic fluid lines. However, it would be a goal of the decommissioning option to maintain the contents of these lines. Therefore, the related impact is also anticipated to be low.	Pipeline cleaning and flushing operations will use Best Environmental Practice (BEP) and the Best Available Techniques (BAT) to minimise as far as possible both residual Oil in Water (OIW) levels in pipelines post flush and OIW discharges to the marine environment during flushing activities. Discharges of oil bearing fluids from the rock dumped pipeline would occur in small quantities and over a long timeframe. However, given the prior cleaning of the pipelines, the concentration and quantity of oil should be low. Therefore, the related impact is also anticipated to be low. The umbilicals will have been cleaned and flushed with the possible exception of the hydraulic fluid lines. However, it would be a goal of the decommissioning option to maintain the contents of these lines. Therefore, the related impact is also anticipated to be low.	Pipeline cleaning and flushing operations will use Best Environmental Practice (BEP) and the Best Available Techniques (BAT) to minimise as far as possible both residual Oil in Water (OIW) levels in pipelines post flush and OIW discharges to the marine environment during flushing activities. By reeling pipelines onto the vessel, a proportion of fluids within the pipeline will be released into the water column as it is recovered (some fluids will remain in the recovered pipeline and be dealt with as waste). However, given the prior cleaning of the pipelines, the concentration and quantity of oil should be low. Therefore, the related impact is also anticipated to be low. The umbilicals will have been cleaned and flushed with the possible exception of the hydraulic fluid lines. However, it would be a goal of the decommissioning option to maintain the contents of these lines during reverse reel. Therefore, the related impact is also anticipated to be low.	Pipeline cleaning and flushing operations will use Best Environmental Practice (BEP) and the Best Available Techniques (BAT) to minimise as far as possible both residual Oil in Water (OIW) levels in pipelines post flush and OIW discharges to the marine environment during flushing activities. Cutting of the flexible flowlines into individual sections would result in noticeably increased volumes of oil contaminated fluids being discharged over a short timeframe. However, given the prior cleaning of the pipelines, the concentration and quantity of oil should still be low overall. Therefore, the related impact is also anticipated to be low. The umbilicals will have been cleaned and flushed with the possible exception of the hydraulic fluid lines. There would be minor discharge from cutting the umbilical for removal however the quantities released are minimal and hydraulic fluid of this type is released routinely during the operation of subsea facilities. Therefore, the related impact is also anticipated to be low.
		N N N N S	**N N N S**	**N N S**	**N S**	**S**	
	Summary	The assessment of the Marine Impact (Planned Discharges) for each of the options is as follows: Option 1B is assessed as being Neutral to Options 2A, 3A, 3B and 5A as any differences in any planned discharges are assessed as minimal and all are assessed to have low impact. All options are assessed as being Stronger than Option 5C as the, whilst the impact is still assessed as being low overall, there would be more planned discharges associated with cutting the pipelines in 20m sections in-situ.					

		1B. Leave (Minimal) - Remove Exposed Ends / Exposures & Local Rock Placement					2A. Leave (Minor) - Remove Exposed Ends & Rock Placement				3A. Leave (Major) - Disconnect & Re-trench Entire Line			3B. Leave (Major) - Disconnect Ends & Full Rock Placement		5A. Full Removal - Deburial & Reverse Reel	5C. Full Removal - Deburial & Cut and Lift
		- Flowlines / Umbilicals will be disconnected **- Removal and recovery of exposed ends** **- Rock placement to remediate seabed at cut location (small area very local) and over sections where trench and burial depth is considered unacceptable.**					**- Flowlines / Umbilicals will be disconnected** **- Removal and recovery of exposed ends** **- Removal and recovery of all spans and exposures** **- Rock placement at all areas of removal to appropriate level of burial depth.**				**- Flowlines / Umbilicals will be disconnected** **- Re-trench and backfill entire length to remove snag hazards** **- No recovery of Flowlines / Umbilicals** **- No introduction of material.**			**- Flowlines / Umbilicals will be disconnected** **- Rock placement over entire length to acceptable level of depth** **- No recovery of Flowlines / Umbilicals.**		**- Flowlines / Umbilicals will be disconnected** **- Deburial along entire length and reverse reel**	**- Flowlines / Umbilicals will be disconnected** **- Deburial along entire length and recover by cutting into sections and removal**
2. Environmental	**2.3 Marine Impact (Unplanned Releases)**	5 individual vessels 73 combined vessel days The relatively short duration of operations and limited use of sub-sea equipment reduce the potential sources of spills. The types and maximum possible quantities of oil that could be accidentally released at the surface or sub-sea under this option would be expected to disperse quickly and not reach the shore. As such, the impact of an unplanned release to sea should be low. Umbilicals will have minimal quantities of chemicals post cleaning however hydraulic fluid could be present. The quantities released are minimal and hydraulic fluid of this type are released routinely during the operation of subsea facilities. As such, the impact of an unplanned release to sea should be low.					5 individual vessels 80 combined vessel days The relatively short duration of operations and limited use of sub-sea equipment reduce the potential sources of spills. The types and maximum possible quantities of oil that could be accidentally released at the surface or sub-sea under this option would be expected to disperse quickly and not reach the shore. As such, the impact of an unplanned release to sea should be low. Umbilicals will have minimal quantities of chemicals post cleaning however hydraulic fluid could be present. The quantities released are minimal and hydraulic fluid of this type are released routinely during the operation of subsea facilities. As such, the impact of an unplanned release to sea should be low.				3 individual vessels 48 combined vessel days The relatively short duration of operations reduces the potential sources of spills but use of sub-sea equipment for longer and the constant nature of hydraulic fluid use for trenching increases risk. The types and maximum possible quantities of oil that could be accidentally released at the surface or sub-sea under this option would be expected to disperse quickly and not reach the shore. As such, the impact of an unplanned release to sea should be low. Umbilicals will have minimal quantities of chemicals post cleaning however hydraulic fluid could be present. The quantities released are minimal and hydraulic fluid of this type are released routinely during the operation of subsea facilities. As such, the impact of an unplanned release to sea should be low.			3 individual vessels 69 combined vessel days The relatively short duration of operations and absence of sub-sea equipment reduce the potential sources of spills. The types and maximum possible quantities of oil that could be accidentally released at the surface or sub-sea under this option would be expected to disperse quickly and not reach the shore. As such, the impact of an unplanned release to sea should be low. Umbilicals will have minimal quantities of chemicals post cleaning however hydraulic fluid could be present. The quantities released are minimal and hydraulic fluid of this type are released routinely during the operation of subsea facilities. As such, the impact of an unplanned release to sea should be low.		4 individual vessels 80 combined vessel days The short duration of operations and lack of sub-sea equipment reduce the potential sources of spills. The types and maximum possible quantities of oil that could be accidentally released at the surface or sub-sea under this option would be expected to disperse quickly and not reach the shore. As such, the impact of an unplanned release to sea should be low. Umbilicals will have minimal quantities of chemicals post cleaning however hydraulic fluid could be present. The quantities released are minimal and hydraulic fluid of this type are released routinely during the operation of subsea facilities. As such, the impact of an unplanned release to sea should be low.	5 individual vessels 200 combined vessel days This option would involve considerable vessel time at sea and extensive use of hydraulic cutting equipment sub-sea, increasing the duration and related risk of potential oil spill sources. However, the types and maximum possible quantities of oil that could be accidentally released at the surface or sub-sea under this option would still be expected to disperse quickly and not reach the shore. Therefore, the impact of an unplanned release to sea should still be low. Umbilicals will have minimal quantities of chemicals post cleaning however hydraulic fluid could be present. The quantities released are minimal and hydraulic fluid of this type are released routinely during the operation of subsea facilities. As such, the impact of an unplanned release to sea should be low.
		N	**N**	**N**	**N**	**S**	**N**	**N**	**N**	**S**	**N**	**N**	**S**	**N**	**S**	**S**	
Summary		The assessment of the Marine Impact (Unplanned Releases) for each of the options is as follows: Option 1B is assessed as being Neutral to Options 2A, 3A, 3B and 5A as any differences in any unplanned releases, either from vessel operations or subsea operations are assessed as minimal and all are assessed to have low impact. All options are assessed as being Stronger than Option 5C as the, whilst the impact is still assessed as being low overall, there would be a higher potential for unplanned releases from the longer operational durations. Overall, Options 1B, 2A, 3A, 3B and 5A would be preferred from a Marine Impact (Unplanned Releases) perspective.															
2. Environmental	**2.4 Fuel & Emissions**	Vessel Emissions (in tonnes):- Fuel:- 3,537 CO2e:- 11,593 NOx:- 208.68 SO2:- 42.44 Vessel Energy Use:- 152,089 GJ The total estimated fuel usage required for this option would only represent a very small proportion of the total annual emissions from industry with respect to contribution to climate change. The impact of atmospheric emissions is therefore anticipated to be low.					Vessel Emissions (in tonnes):- Fuel:- 3,711 CO2e:- 12,165 NOx:- 218.96 SO2:- 44.54 Vessel Energy Use:- 159,584 GJ The total estimated fuel usage required for this option would only represent a very small proportion of the total annual emissions from industry with respect to contribution to climate change. The impact of atmospheric emissions is therefore anticipated to be low.				Vessel Emissions (in tonnes):- Fuel:- 2,622 CO2e:- 8,595 NOx:- 154.71 SO2:- 8,312.37 Vessel Energy Use:- 112,755 GJ The total estimated fuel usage required for this option would only represent a very small proportion of the total annual emissions from industry with respect to contribution to climate change. The impact of atmospheric emissions is therefore anticipated to be low.			Vessel Emissions (in tonnes):- Fuel:- 2,984 CO2e:- 9,782 NOx:- 176.08 SO2:- 35.81 Vessel Energy Use:- 128,331 GJ The total estimated fuel usage required for this option would only represent a very small proportion of the total annual emissions from industry with respect to contribution to climate change. The impact of atmospheric emissions is therefore anticipated to be low.		Vessel Emissions (in tonnes):- Fuel:- 2,615 CO2e:- 8,572 NOx:- 154.30 SO2:- 31.38 Vessel Energy Use:- 112,454 GJ The total estimated fuel usage required for this option would only represent a very small proportion of the total annual emissions from industry with respect to contribution to climate change. The impact of atmospheric emissions is therefore anticipated to be low.	Vessel Emissions (in tonnes):- Fuel:- 5,239 CO2e:- 17,173 NOx:- 309.12 SO2:- 62.87 Vessel Energy Use:- 225,292 GJ The total estimated fuel usage required for this option would only represent a very small proportion of the total annual emissions from industry with respect to contribution to climate change. The impact of atmospheric emissions is therefore anticipated to be low.
		N	**N**	**N**	**N**	**S**	**N**	**N**	**N**	**S**	**N**	**N**	**S**	**N**	**S**	**S**	
Summary		The assessment of the impact of Fuel & Emissions for each of the options is as follows: Option 1B is assessed as being Neutral to Options 2A, 3A, 3B and 5A as, whilst there are differences in the fuel use and emissions, these differences are not considered significant in impact terms. All options are assessed as being Stronger than Option 5C as the, whilst the impact is still assessed as being low overall, there is significantly higher fuel use and atmospheric emissions associated with this option. Overall, Options 1B, 2A, 3A, 3B and 5A would be preferred from a Fuel & Emissions perspective.															
2. Environmental	**2.5 Other Consumptions**	New material introduced:- Rockdump:- 2,037 tonnes Given the small amount of rock dump required, this option is seen as low in scale in terms of resource use. Material returned for onshore processing:- Recovered:- 112 tonnes / 90 tonnes CO2 Remaining:- 1,029 tonnes / 1,571 tonnes CO2 As the flowlines / umbilicals will mostly be left on the in-situ (trenched and buried) with only the ends cut and recovered, there will be a relatively small amount of waste returned to shore for processing and disposal. There will be an associated burden for production of replacement material. The associated impacts are anticipated to be low in scale.					New material introduced:- Rockdump:- 1,700 tonnes Given the small amount of rock dump required, this option is seen as low in scale in terms of resource use. Material returned for onshore processing:- Recovered:- 118 tonnes / 90 tonnes CO2 Remaining:- 1,023 tonnes / 1,561 tonnes CO2 As the flowlines / umbilicals will mostly be left on the in-situ (trenched and buried) with only the ends and exposed sections cut and recovered, there will be a relatively small amount of waste returned to shore for processing and disposal. There will be an associated burden for production of replacement material. The associated impacts are anticipated to be low in scale.				No new material introduced. This option is relatively simple in terms of the expected vessels, equipment and resources required and short in duration. The associated impacts in this context are expected to be low. Material returned for onshore processing:- Remaining:- 1,141 tonnes / 1,741 tonnes CO2 As the flowlines / umbilicals will be left trenched and buried in the seabed, there will be no waste returned to shore for processing and disposal so there will be no impacts from waste processing. There will be an associated burden for production of replacement material.			New material introduced:- Rockdump:- 232,380 tonnes Given the sheer quantity of rock dump material required and associated energy and resources used in procuring this material, the use of natural resources is seen to be moderate in this case. Material returned for onshore processing:- Remaining:- 1,141 tonnes / 1,741 tonnes CO2 As the flowlines / umbilicals will be left rock dumped on the seabed, there will be no waste returned to shore for processing and disposal so there will be no impacts from waste processing. There will be an associated burden for production of replacement material.		No new material introduced. This option is relatively simple in terms of the expected vessels, equipment and resources required and short in duration. The associated impacts in this context are expected to be low. Material returned for onshore processing:- Recovered:- 1,141 tonnes / 913 tonnes CO2 As the flowlines / umbilicals will be recovered, materials will be returned to shore for treatment, reuse, recycling or disposal which will result in energy and other resource use and atmospheric emissions. There is however, the associated benefit of no requirement to produce replacement material. Overall, impact is anticipated as low.	No new material introduced. This option is relatively simple in terms of the expected vessels, equipment and resources required and short in duration. The associated impacts in this context are expected to be low. Material returned for onshore processing:- Recovered:- 1,141 tonnes / 913 tonnes CO2 As the flowlines / umbilicals will be recovered, materials will be returned to shore for treatment, reuse, recycling or disposal which will result in energy and other resource use and atmospheric emissions. There is however, the associated benefit of no requirement to produce replacement material. Overall, impact is anticipated as low.
		N	**W**	**MS**	**W**	**W**	**W**	**MS**	**W**	**W**	**MS**	**N**	**N**	**MW**	**MW**	**N**	
Summary		The assessment of the Other Consumptions for each of the options is as follows: Option 1B is assessed as being Neutral to Option 2A as, whilst there are minor differences in the amount of new material required for rock dump and the amount of energy consumption used to address the amount of material being recovered / remaining, these differences are considered minor overall and that the impact of these consumptions will be low in scale. Option 1B is assessed as being Weaker than Option 3A, 5A and 5C, mainly due to there being no requirement for new material with these options. Option 1B is assessed as being Much Stronger than Option 3B due to the large amount of new material required with that option. Option 2A is assessed as being Weaker than Option 3A, 5A and 5C, mainly due to there being no requirement for new material with these options. Option 2A is assessed as being Much Stronger than Option 3B due to the large amount of new material required with that option. Option 3A is assessed as being Much Stronger than Option 3B due to the large amount of new material required with that option and Neutral to Option 5A and 5C as there is only minor differences in the consumption associated with the recovered versus remaining material under these options. Option 3B is assessed as being Much Weaker than all options due to the large amount of new material required with that option. Option 5A is assessed as being Neutral to Option 5C as the consumptions are the same. Overall, Options 3A, 5A and 5C would be preferred from a Other Consumptions perspective.															

		1B. Leave (Minimal) - Remove Exposed Ends / Exposures & Local Rock Placement	2A. Leave (Minor) - Remove Exposed Ends & Rock Placement	3A. Leave (Major) - Disconnect & Re-trench Entire Line	3B. Leave (Major) - Disconnect Ends & Full Rock Placement	5A. Full Removal - Deburial & Reverse Reel	5C. Full Removal - Deburial & Cut and Lift
		- Flowlines / Umbilicals will be disconnected **- Removal and recovery of exposed ends** **- Rock placement to remediate seabed at cut location (small area very local) and over sections where trench and burial depth is considered unacceptable.**	**- Flowlines / Umbilicals will be disconnected** **- Removal and recovery of exposed ends** **- Removal and recovery of all spans and exposures** **- Rock placement at all areas of removal to appropriate level of burial depth.**	**- Flowlines / Umbilicals will be disconnected** **- Re-trench and backfill entire length to remove snag hazards** **- No recovery of Flowlines / Umbilicals** **- No introduction of material.**	**- Flowlines / Umbilicals will be disconnected** **- Rock placement over entire length to acceptable level of depth** **- No recovery of Flowlines / Umbilicals.**	**- Flowlines / Umbilicals will be disconnected** **- Deburial along entire length and reverse reel**	**- Flowlines / Umbilicals will be disconnected** **- Deburial along entire length and recover by cutting into sections and removal**
2. Environmental	**2.6 Seabed Disturbance**	Rockdumping:- 2,875 m2 The area of seabed directly disturbed by these operations is extremely small in the context of the surrounding wider region,. Although the rock dumping will leave an area of seabed different from the surrounding natural sediments (mud), this area will also be very small. Therefore, the level of impact on the seabed and related communities is expected to be low.	Rockdumping:- 2,380 m2 The area of seabed directly disturbed by these operations is extremely small in the context of the surrounding wider region. Although the rock dumping will leave an area of seabed different from the surrounding natural sediments (mud), this area will also be very small. Therefore, the level of impact on the seabed and related communities is expected to be low.	Trenching:- 65,830 m2 Disturbance effects will only be felt along the area trenched and the seabed will begin to recover as soon as operations are complete. There is good recovery potential since the operations will return the seabed to its natural state and it is surrounded by wide expanses of similar, homogenous habitats. Indirect seabed disturbance is also considered to have limited impact. Therefore, the level of impact on the seabed and related communities is expected to be low.	Rockdumping:- 329,150 m2 The area of seabed directly disturbed by these operations is roughly equivalent to that incurred by the mooring of three anchored drilling rigs. Even though the area will be altered compared to surrounding sediments, it is still small compared to the wide areas of surrounding homogenous natural seabed. Therefore, the level of impact on the seabed and related communities is expected to be low.	MFE:- 263,320 m2 The area of seabed directly disturbed by these operations is roughly equivalent to that incurred by the mooring two anchored drilling rigs. Mass flow excavation is likely to cause wider sediment resuspension and disturbance. However, this is still a small area in the context of the surrounding wider region, with good potential for recovery due to the consistent nature of habitats and communities. This option would also leave the seabed in a natural state. Whilst indirect seabed disturbance is over a significant area, its impact is considered limited. Therefore, the level of impact on the seabed and related communities is expected to be low.	MFE:- 263,320 m2 The area of seabed directly disturbed by these operations is roughly equivalent to that incurred by the mooring of two anchored drilling rigs. Mass flow excavation is likely to cause wider sediment resuspension and disturbance. However, this is still a small area in the context of the surrounding wider region, with good potential for recovery due to the consistent nature of habitats and communities. This option would also leave the seabed in a natural state. Whilst indirect seabed disturbance is over a significant area, its impact is considered limited. Therefore, the level of impact on the seabed and related communities is expected to be low.
		N N VMS S S	**N VMS S S**	**VMS S S**	**VMW VMW**	**N**	
	Summary	The assessment of the Seabed Disturbance for each of the options is as follows: Option 1B is assessed as being Neutral to Options 2A and 3A as the impact of a small area of rock dump versus the larger area of trenching are considered largely comparable in terms of impact. Option 1B is assessed as being Very Much Stronger than Option 3B due to the large area of rock dump associated with that option. Option 1B is assessed as being Stronger than Option 5A and 5C with the key difference being the larger area of impact and the additional sediment disturbance component associated with the Mass Flow Excavator under these options. Option 2A is assessed against Options 3A, 3B, 5A and 5C in the same way as Option 1B for similar reasons. Option 3A is assessed as being Very Much Stronger than Option 3B, again due to impact of the large area of rock dump. Option 3A is assessed as being Stronger than Option 5A and 5C due to the smaller area of impact and the likely greater impact associated with Mass Flow Excavation. Option 3B is assessed as being Very Much Weaker than all options due to the large area of rock dump associated with that option. Option 5A is assessed as being Neutral to Option 5C as the impacts are expected to be similar. Overall, Options 1B and 2A would be preferred from a Seabed Disturbance perspective.					
3. Technical	**3.1 Technical Risk**	All technical aspects of this option are considered routine operations.	All technical aspects of this option are considered routine operations.	The requirement to trench lines in a very congested area along with the lines already being in a trench make this option very technically challenging. Residual torsion in line may mean that trenching to get acceptable burial depth / status may not deliver outcome required i.e. may require spot rock dump anyway, which would constitute technical failure as currently defined. Trenching doesn't present good solution for crossings.	All technical aspects of this option are considered routine operations.	All technical aspects of this option are considered routine operations.	Whilst technical aspects are considered routine, potential for schedule over run from technical issues associated with extended operations and number of subsea cuts increases technical challenges associated with this option.
		N VMS N N MS	**VMS N N MS**	**VMW VMW MW**	**N MS**	**MS**	
	Summary	The assessment of the Technical aspects for each of the options is as follows: Option 1B, 2A, 3B and 5A are assessed as being Neutral to each other as the operations are routine. Option 1B is assessed as being Very Much Stronger than Option 3A due to the significant technical challenges associated with trenching in a congested area and to an acceptable level identified with Option 3A. Option 1B is assessed as being Much Stronger than Option 5C due to the potential technical challenges associated with the numerous subsea cuts and the extended operational durations for Option 5C. Option 2A is assessed as being Very Much Stronger than Option 3A due to the significant technical challenges already described. Option 2A is assessed as being Much Stronger than Option 5C for similar reasons as Option 1B. Option 3A is assessed as being Very Much Weaker than Option 3B and 5A due to the significant technical challenges already described. Option 3A is assessed as being Much Weaker than Option 5C as the significant technical challenges associated with Option 3A are offset somewhat by the potential technical challenges associated with the numerous subsea cuts and the extended operational durations for Option 5C. Option 3B is assessed as being Much Stronger than Option 5C due to the routine operations versus potential technical challenges associated with the numerous subsea cuts and the extended operational durations for Option 5C. Option 5A is assessed as being Much Stronger than Option 5C for similar reasons. Overall, Options 1B, 2A, 3B and 5A would be preferred from a Technical perspective.					
4. Societal	**4.1 Fishing**	Area of potential fishing ground impact from commercial fishing perspective (nephrops) due to decommissioning option is equivalent to the area of rock dump i.e. 2,875 m2. Short term presence of vessels at Balmoral will exclude fishing activity but not over an area greater than that excluded during production operations. Nothing will be left exposed on the seabed in the long term that could be a snagging hazard once rock dumping is complete and the rock dump will be designed to be overtrawlable in the long term. The rock dumping will also cover a very small area of potential fishing grounds. Therefore, the overall impact on commercial fisheries is seen to be low.	Area of potential fishing ground impact from commercial fishing perspective (nephrops) due to decommissioning option is equivalent to the area of rock dump i.e. 2,380 m2. Short term presence of vessels at Balmoral will exclude fishing activity but not over an area greater than that excluded during production operations. Nothing will be left exposed on the seabed in the long term that could be a snagging hazard once rock dumping is complete and the rock dump will be designed to be overtrawlable in the long term. The rock dumping will also cover a very small area of potential fishing grounds. Therefore, the overall impact on commercial fisheries is seen to be low.	Area of potential fishing ground impact from commercial fishing perspective (nephrops) due to decommissioning option is equivalent to the area of trenching operations i.e. 65,830 m2. Believe area impacted would recover relatively quickly. Ultimately, no commercial fishing ground loss. Short term presence of vessels at Balmoral will exclude fishing activity but not over an area greater than that excluded during production operations. The seabed will be left in a natural state with nothing will be left exposed on the seabed in the long term that could be a snagging hazard once trenching is complete. Therefore, the overall impact on commercial fisheries is seen to be low.	Area of potential fishing ground impact from commercial fishing perspective (nephrops) due to decommissioning option is equivalent to the area of rock dump i.e. 329,150 m2. Short term presence of vessels at Balmoral will exclude fishing activity but not over an area greater than that excluded during production operations. Nothing will be left exposed on the seabed in the long term that could be a snagging hazard once rock dumping is complete and the rock dump will be designed to be overtrawlable in the long term. Therefore, the overall impact on commercial fisheries is seen to be low.	Area of potential fishing ground impact from commercial fishing perspective (nephrops) due to decommissioning option is equivalent to the area of deburial operations i.e. 263,320 m2. Believe area impacted would recover relatively quickly. Ultimately, no commercial fishing ground loss. Short term presence of vessels at Balmoral will exclude fishing activity but not over an area greater than that excluded during production operations. The seabed will be left in a natural state with nothing will be left on the seabed in the long term that could be a snagging hazard once removal is complete. Therefore, the overall impact on commercial fisheries is seen to be low.	Area of potential fishing ground impact from commercial fishing perspective (nephrops) due to decommissioning option is equivalent to the area of deburial operations i.e. 263,320 m2. Believe area impacted would recover relatively quickly. Ultimately, no commercial fishing ground loss. Short term presence of vessels at Balmoral will exclude fishing activity but not over an area greater than that excluded during production operations. The seabed will be left in a natural state with nothing will be left on the seabed in the long term that could be a snagging hazard once removal is complete. Therefore, the overall impact on commercial fisheries is seen to be low.
		N N S N N	**N S N N**	**S N N**	**W W**	**N**	
	Summary	The assessment against the Societal - Fishing criterion is as follows: Option 1B, 2A, 3A, 5A and 5C are assessed as being Neutral to each other from a Societal - Fishing perspective as, whilst there are areas lost to fishing under Option 1B and Option 2A, these are very small and the larger area of nephrop fishing impacted by Option 3A, 5A and 5C would be expected to recover relatively quickly in commercial fishing terms. All options are assessed as Stronger than 3B from a Societal - Fishing perspective due to the area permanently lost to nephrop fishing, which whilst large is small in overall fishing grounds terms. Overall, Options 1B, 2A, 3A, 5A and 5C would be preferred from a Societal - Fishing perspective.					

		1B. Leave (Minimal) - Remove Exposed Ends / Exposures & Local Rock Placement					2A. Leave (Minor) - Remove Exposed Ends & Rock Placement				3A. Leave (Major) - Disconnect & Re-trench Entire Line			3B. Leave (Major) - Disconnect Ends & Full Rock Placement		5A. Full Removal - Deburial & Reverse Reel	5C. Full Removal - Deburial & Cut and Lift
		- Flowlines / Umbilicals will be disconnected **- Removal and recovery of exposed ends** **- Rock placement to remediate seabed at cut location (small area very local) and over sections where trench and burial depth is considered unacceptable.**					**- Flowlines / Umbilicals will be disconnected** **- Removal and recovery of exposed ends** **- Removal and recovery of all spans and exposures** **- Rock placement at all areas of removal to appropriate level of burial depth.**				**- Flowlines / Umbilicals will be disconnected** **- Re-trench and backfill entire length to remove snag hazards** **- No recovery of Flowlines / Umbilicals** **- No introduction of material.**			**- Flowlines / Umbilicals will be disconnected** **- Rock placement over entire length to acceptable level of depth** **- No recovery of Flowlines / Umbilicals.**		**- Flowlines / Umbilicals will be disconnected** **- Deburial along entire length and reverse reel**	**- Flowlines / Umbilicals will be disconnected** **- Deburial along entire length and recover by cutting into sections and removal**
4. Societal	**4.2 Other Users**	Material returned for onshore processing:- Recovered:- 112 tonnes Remaining:- 1,029 tonnes New Material:- Rockdump:- 2,037 tonnes					Material returned for onshore processing:- Recovered:- 118 tonnes Remaining:- 1,023 tonnes New Material:- Rockdump:- 1,700 tonnes				Material returned for onshore processing:- Remaining:- 1,141 tonnes No New Material			Material returned for onshore processing:- Remaining:- 1,141 tonnes New Material:- Rockdump:- 232,380 tonnes		Material returned for onshore processing:- Recovered:- 1,141 tonnes New New Material	Material returned for onshore processing:- Recovered:- 1,141 tonnes No New Material
		N	**N**	**S**	**W**	**W**	**N**	**S**	**W**	**W**	**S**	**W**	**W**	**MW**	**MW**	**N**	
	Summary	The assessment against the Societal - Other Users criterion for each of the options is as follows: Option 1B is assessed as being Neutral to Option 2A and 3A as the differences in the materials recovered / remaining are minimal in societal terms. Option 1B is assessed as being Stronger than Option 3B due to the impact of transporting the large amount of quarried rock on communities. Option 1B is assessed as being Weaker than Option 5A and 5C due to the benefit associated with returning much more material with these options. Option 2A is assessed as being Neutral to Option 3A, Stronger than Option 3B and Weaker than Option 5A and 5C for similar reasons as Option 1B. Option 3A is assessed as being Stronger than Option 3B due the impact of transporting the large amount of quarried rock on communities. Option 3A is assessed as being Weaker than Option 5A and 5C due to the benefit associated with returning these options. Option 5A is assessed as being Neutral to Option 5C as the societal impact from the returned material is the same. Overall, Option 5A and 5C would be preferred from a Societal - Other Users perspective.															
5. Economic	**5.1 Short-term Costs**	Initial operation cost:- £10.865M Legacy cost:- £2.033M Total cost:- £12.898M					Initial operation cost:- £11.720M Legacy cost:- £2.033M Total cost:- £13.753M				Initial operation cost:- £11.459M Legacy cost:- £2.033M Total cost:- £13.492M			Initial operation cost:- £16.048M Legacy cost:- £2.033M Total cost:- £18.081M		Initial operation cost:- £14.414M Total cost:- £14.414M	Initial operation cost:- £33.835M Total cost:- £33.835M
		N	**N**	**S**	**N**	**MS**	**N**	**S**	**N**	**MS**	**S**	**N**	**MS**	**W**	**S**	**MS**	
	Summary	The assessment of the Economics for each of the options is as follows: Option 1B is assessed as being Neutral to Options 2A, 3A and 5A as the total costs are largely similar. Option 1B is assessed as being Stronger than Option 3B due to the total costs being around £7M lower. Option 1B is assessed as being Much Stronger than Option 5C as the costs are almost a third of those for Option 5C. Option 2A is assessed as being Neutral to Option 3A and 5A as the total costs are similar. Option 2A is assessed as being Stronger than Option 3B due to the total costs being around £7M lower. Option 2A is assessed as being Much Stronger than Option 5C as the costs are around 2.5 times lower. Option 3A is assessed as being Stronger than Option 3B due to the total costs being around £7M lower. Option 3A is assessed as being Neutral to Option 5A as the costs are similar. Option 3A is assessed as being Much Stronger than Option 5C as the costs are around 2.5 times lower. Option 3B is assessed as being Weaker than Option 5A as the costs are around £6M higher. Option 3B is assessed as being Much Stronger than Option 5C as the costs are close to half. Option 5A is assessed as being Much Stronger than Option 5C as the costs are almost 2.5 times lower. Overall, Options 1B, 2A, 3A and 5A would be preferred from an Economic perspective.															

Appendix E.2 Group 4 Pairwise Comparison Matrices – Safety

1.1 Personnel Offshore

	1B. Leave (Minimal) - Remove Exposed Ends / Exposures & Local Rock Placement	2A. Leave (Minor) - Remove Exposed Ends & Rock Placement	3A. Leave (Major) - Disconnect & Re-trench Entire Line	3B. Leave (Major) - Disconnect Ends & Full Rock Placement	5A. Full Removal - Deburial & Reverse Reel	5C. Full Removal - Deburial & Cut and Lift	Weighting
1B. Leave (Minimal) - Remove Exposed Ends / Exposures & Local Rock Placement	N	N	MW	W	N	MS	12%
2A. Leave (Minor) - Remove Exposed Ends & Rock Placement	N	N	MW	MW	N	MS	11%
3A. Leave (Major) - Disconnect & Re-trench Entire Line	MS	MS	N	N	MS	VMS	33%
3B. Leave (Major) - Disconnect Ends & Full Rock Placement	S	MS	N	N	MS	VMS	29%
5A. Full Removal - Deburial & Reverse Reel	N	N	MW	MW	N	MS	11%
5C. Full Removal - Deburial & Cut and Lift	MW	MW	VMW	VMW	MW	N	4%

1.2 Personnel Onshore

	1B. Leave (Minimal) - Remove Exposed Ends / Exposures & Local Rock Placement	2A. Leave (Minor) - Remove Exposed Ends & Rock Placement	3A. Leave (Major) - Disconnect & Re-trench Entire Line	3B. Leave (Major) - Disconnect Ends & Full Rock Placement	5A. Full Removal - Deburial & Reverse Reel	5C. Full Removal - Deburial & Cut and Lift	Weighting
1B. Leave (Minimal) - Remove Exposed Ends / Exposures & Local Rock Placement	N	N	N	S	S	MS	21%
2A. Leave (Minor) - Remove Exposed Ends & Rock Placement	N	N	N	S	S	MS	21%
3A. Leave (Major) - Disconnect & Re-trench Entire Line	N	N	N	S	S	MS	21%
3B. Leave (Major) - Disconnect Ends & Full Rock Placement	W	W	W	N	N	MS	15%
5A. Full Removal - Deburial & Reverse Reel	W	W	W	N	N	MS	15%
5C. Full Removal - Deburial & Cut and Lift	MW	MW	MW	MW	MW	N	6%

1.3 Other Users

	1B. Leave (Minimal) - Remove Exposed Ends / Exposures & Local Rock Placement	2A. Leave (Minor) - Remove Exposed Ends & Rock Placement	3A. Leave (Major) - Disconnect & Re-trench Entire Line	3B. Leave (Major) - Disconnect Ends & Full Rock Placement	5A. Full Removal - Deburial & Reverse Reel	5C. Full Removal - Deburial & Cut and Lift	Weighting
1B. Leave (Minimal) - Remove Exposed Ends / Exposures & Local Rock Placement	N	N	W	N	N	MS	17%
2A. Leave (Minor) - Remove Exposed Ends & Rock Placement	N	N	W	N	N	MS	17%
3A. Leave (Major) - Disconnect & Re-trench Entire Line	S	S	N	S	S	MS	24%
3B. Leave (Major) - Disconnect Ends & Full Rock Placement	N	N	W	N	N	MS	17%
5A. Full Removal - Deburial & Reverse Reel	N	N	W	N	N	MS	17%
5C. Full Removal - Deburial & Cut and Lift	MW	MW	MW	MW	MW	N	6%

1.4 High Consequence Events

	1B. Leave (Minimal) - Remove Exposed Ends / Exposures & Local Rock Placement	2A. Leave (Minor) - Remove Exposed Ends & Rock Placement	3A. Leave (Major) - Disconnect & Re-trench Entire Line	3B. Leave (Major) - Disconnect Ends & Full Rock Placement	5A. Full Removal - Deburial & Reverse Reel	5C. Full Removal - Deburial & Cut and Lift	Weighting
1B. Leave (Minimal) - Remove Exposed Ends / Exposures & Local Rock Placement	N	N	W	W	W	MS	14%
2A. Leave (Minor) - Remove Exposed Ends & Rock Placement	N	N	W	W	W	MS	14%
3A. Leave (Major) - Disconnect & Re-trench Entire Line	S	S	N	N	S	VMS	25%
3B. Leave (Major) - Disconnect Ends & Full Rock Placement	S	S	N	N	S	VMS	25%
5A. Full Removal - Deburial & Reverse Reel	S	S	W	W	N	MS	17%
5C. Full Removal - Deburial & Cut and Lift	MW	MW	VMW	VMW	MW	N	4%

1.5 Residual Risk

	1B. Leave (Minimal) - Remove Exposed Ends / Exposures & Local Rock Placement	2A. Leave (Minor) - Remove Exposed Ends & Rock Placement	3A. Leave (Major) - Disconnect & Re-trench Entire Line	3B. Leave (Major) - Disconnect Ends & Full Rock Placement	5A. Full Removal - Deburial & Reverse Reel	5C. Full Removal - Deburial & Cut and Lift	Weighting
1B. Leave (Minimal) - Remove Exposed Ends / Exposures & Local Rock Placement	N	N	N	N	MW	MW	10%
2A. Leave (Minor) - Remove Exposed Ends & Rock Placement	N	N	N	N	MW	MW	10%
3A. Leave (Major) - Disconnect & Re-trench Entire Line	N	N	N	N	MW	MW	10%
3B. Leave (Major) - Disconnect Ends & Full Rock Placement	N	N	N	N	MW	MW	10%
5A. Full Removal - Deburial & Reverse Reel	MS	MS	MS	MS	N	N	30%
5C. Full Removal - Deburial & Cut and Lift	MS	MS	MS	MS	N	N	30%

Appendix E.3 Group 4 Pairwise Comparison Matrices – Environment

2.1 Marine Impact (Noise)

	1B. Leave (Minimal) - Remove Exposed Ends / Exposures & Local Rock Placement	2A. Leave (Minor) - Remove Exposed Ends & Rock Placement	3A. Leave (Major) - Disconnect & Re-trench Entire Line	3B. Leave (Major) - Disconnect Ends & Full Rock Placement	5A. Full Removal - Deburial & Reverse Reel	5C. Full Removal - Deburial & Cut and Lift	Weighting
1B. Leave (Minimal) - Remove Exposed Ends / Exposures & Local Rock Placement	N	N	N	S	S	S	20%
2A. Leave (Minor) - Remove Exposed Ends & Rock Placement	N	N	N	S	S	S	20%
3A. Leave (Major) - Disconnect & Re-trench Entire Line	N	N	N	N	N	N	16%
3B. Leave (Major) - Disconnect Ends & Full Rock Placement	W	W	N	N	N	N	14%
5A. Full Removal - Deburial & Reverse Reel	W	W	N	N	N	N	14%
5C. Full Removal - Deburial & Cut and Lift	W	W	N	N	N	N	14%

2.2 Marine Impact (Planned Discharges)

	1B. Leave (Minimal) - Remove Exposed Ends / Exposures & Local Rock Placement	2A. Leave (Minor) - Remove Exposed Ends & Rock Placement	3A. Leave (Major) - Disconnect & Re-trench Entire Line	3B. Leave (Major) - Disconnect Ends & Full Rock Placement	5A. Full Removal - Deburial & Reverse Reel	5C. Full Removal - Deburial & Cut and Lift	Weighting
1B. Leave (Minimal) - Remove Exposed Ends / Exposures & Local Rock Placement	N	N	N	N	N	S	18%
2A. Leave (Minor) - Remove Exposed Ends & Rock Placement	N	N	N	N	N	S	18%
3A. Leave (Major) - Disconnect & Re-trench Entire Line	N	N	N	N	N	S	18%
3B. Leave (Major) - Disconnect Ends & Full Rock Placement	N	N	N	N	N	S	18%
5A. Full Removal - Deburial & Reverse Reel	N	N	N	N	N	S	18%
5C. Full Removal - Deburial & Cut and Lift	W	W	W	W	W	N	12%

2.3 Marine Impact (Unplanned Releases)

	1B. Leave (Minimal) - Remove Exposed Ends / Exposures & Local Rock Placement	2A. Leave (Minor) - Remove Exposed Ends & Rock Placement	3A. Leave (Major) - Disconnect & Re-trench Entire Line	3B. Leave (Major) - Disconnect Ends & Full Rock Placement	5A. Full Removal - Deburial & Reverse Reel	5C. Full Removal - Deburial & Cut and Lift	Weighting
1B. Leave (Minimal) - Remove Exposed Ends / Exposures & Local Rock Placement	N	N	N	N	N	S	18%
2A. Leave (Minor) - Remove Exposed Ends & Rock Placement	N	N	N	N	N	S	18%
3A. Leave (Major) - Disconnect & Re-trench Entire Line	N	N	N	N	N	S	18%
3B. Leave (Major) - Disconnect Ends & Full Rock Placement	N	N	N	N	N	S	18%
5A. Full Removal - Deburial & Reverse Reel	N	N	N	N	N	S	18%
5C. Full Removal - Deburial & Cut and Lift	W	W	W	W	W	N	12%

2.4 Fuel & Emissions

	1B. Leave (Minimal) - Remove Exposed Ends / Exposures & Local Rock Placement	2A. Leave (Minor) - Remove Exposed Ends & Rock Placement	3A. Leave (Major) - Disconnect & Re-trench Entire Line	3B. Leave (Major) - Disconnect Ends & Full Rock Placement	5A. Full Removal - Deburial & Reverse Reel	5C. Full Removal - Deburial & Cut and Lift	Weighting
1B. Leave (Minimal) - Remove Exposed Ends / Exposures & Local Rock Placement	N	N	N	N	N	S	18%
2A. Leave (Minor) - Remove Exposed Ends & Rock Placement	N	N	N	N	N	S	18%
3A. Leave (Major) - Disconnect & Re-trench Entire Line	N	N	N	N	N	S	18%
3B. Leave (Major) - Disconnect Ends & Full Rock Placement	N	N	N	N	N	S	18%
5A. Full Removal - Deburial & Reverse Reel	N	N	N	N	N	S	18%
5C. Full Removal - Deburial & Cut and Lift	W	W	W	W	W	N	12%

2.5 Other Consumptions

	1B. Leave (Minimal) - Remove Exposed Ends / Exposures & Local Rock Placement	2A. Leave (Minor) - Remove Exposed Ends & Rock Placement	3A. Leave (Major) - Disconnect & Re-trench Entire Line	3B. Leave (Major) - Disconnect Ends & Full Rock Placement	5A. Full Removal - Deburial & Reverse Reel	5C. Full Removal - Deburial & Cut and Lift	Weighting
1B. Leave (Minimal) - Remove Exposed Ends / Exposures & Local Rock Placement	N	N	W	MS	W	W	15%
2A. Leave (Minor) - Remove Exposed Ends & Rock Placement	N	N	W	MS	W	W	15%
3A. Leave (Major) - Disconnect & Re-trench Entire Line	S	S	N	MS	N	N	21%
3B. Leave (Major) - Disconnect Ends & Full Rock Placement	MW	MW	MW	N	MW	MW	6%
5A. Full Removal - Deburial & Reverse Reel	S	S	N	MS	N	N	21%
5C. Full Removal - Deburial & Cut and Lift	S	S	N	MS	N	N	21%

2.6 Seabed Disturbance

	1B. Leave (Minimal) - Remove Exposed Ends / Exposures & Local Rock Placement	2A. Leave (Minor) - Remove Exposed Ends & Rock Placement	3A. Leave (Major) - Disconnect & Re-trench Entire Line	3B. Leave (Major) - Disconnect Ends & Full Rock Placement	5A. Full Removal - Deburial & Reverse Reel	5C. Full Removal - Deburial & Cut and Lift	Weighting
1B. Leave (Minimal) - Remove Exposed Ends / Exposures & Local Rock Placement	N	N	N	VMS	S	S	22%
2A. Leave (Minor) - Remove Exposed Ends & Rock Placement	N	N	N	VMS	S	S	22%
3A. Leave (Major) - Disconnect & Re-trench Entire Line	N	N	N	VMS	S	S	22%
3B. Leave (Major) - Disconnect Ends & Full Rock Placement	VMW	VMW	VMW	N	VMW	VMW	2%
5A. Full Removal - Deburial & Reverse Reel	W	W	W	VMS	N	N	16%
5C. Full Removal - Deburial & Cut and Lift	W	W	W	VMS	N	N	16%

Appendix E.4 Group 4 Pairwise Comparison Matrices – Technical

3. Technical	1B. Leave (Minimal) - Remove Exposed Ends / Exposures & Local Rock Placement	2A. Leave (Minor) - Remove Exposed Ends & Rock Placement	3A. Leave (Major) - Disconnect & Re-trench Entire Line	3B. Leave (Major) - Disconnect Ends & Full Rock Placement	5A. Full Removal - Deburial & Reverse Reel	5C. Full Removal - Deburial & Cut and Lift	Weighting
1B. Leave (Minimal) - Remove Exposed Ends / Exposures & Local Rock Placement	N	N	VMS	N	N	MS	23%
2A. Leave (Minor) - Remove Exposed Ends & Rock Placement	N	N	VMS	N	N	MS	23%
3A. Leave (Major) - Disconnect & Re-trench Entire Line	VMW	VMW	N	VMW	VMW	MW	3%
3B. Leave (Major) - Disconnect Ends & Full Rock Placement	N	N	VMS	N	N	MS	23%
5A. Full Removal - Deburial & Reverse Reel	N	N	VMS	N	N	MS	23%
5C. Full Removal - Deburial & Cut and Lift	MW	MW	MS	MW	MW	N	8%

Appendix E.5 Group 4 Pairwise Comparison Matrices – Societal

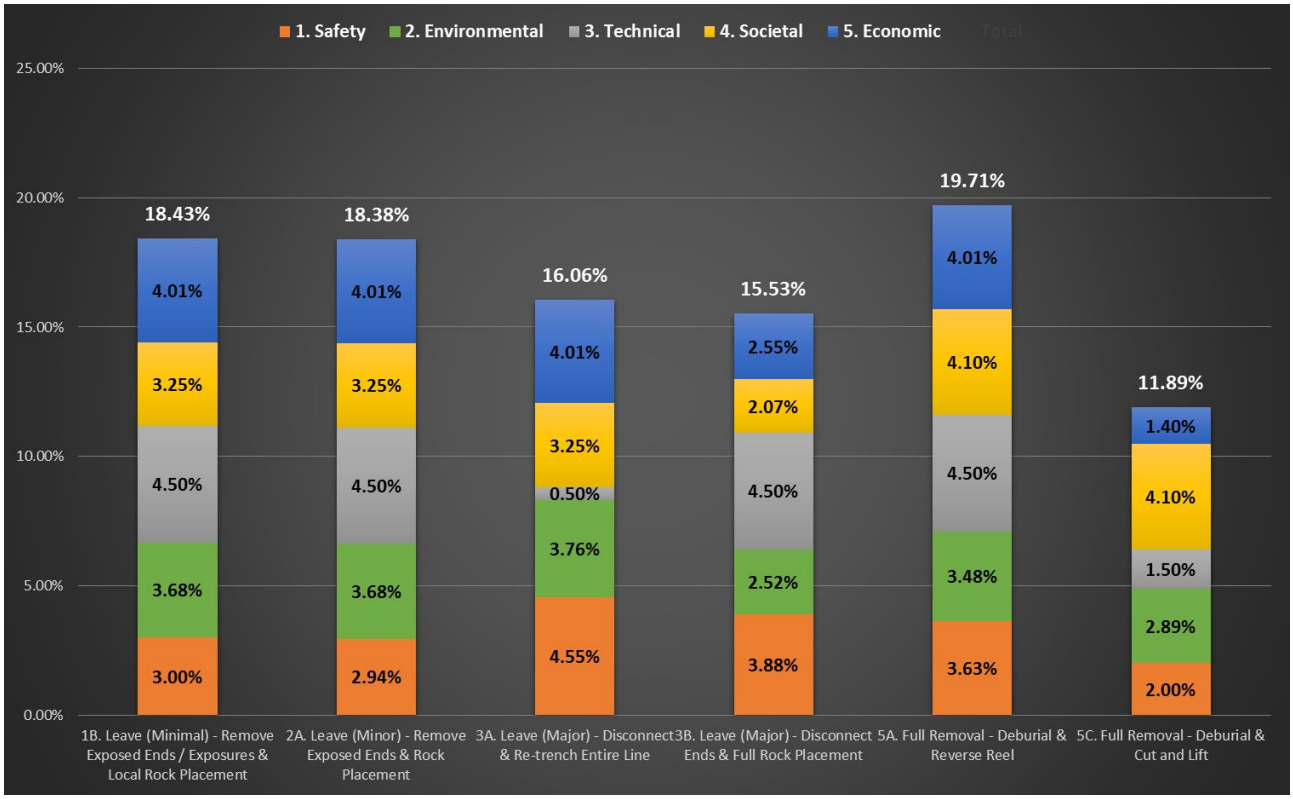
4.1 Fishing	1B. Leave (Minimal) - Remove Exposed Ends / Exposures & Local Rock Placement	2A. Leave (Minor) - Remove Exposed Ends & Rock Placement	3A. Leave (Major) - Disconnect & Re-trench Entire Line	3B. Leave (Major) - Disconnect Ends & Full Rock Placement	5A. Full Removal - Deburial & Reverse Reel	5C. Full Removal - Deburial & Cut and Lift	Weighting
1B. Leave (Minimal) - Remove Exposed Ends / Exposures & Local Rock Placement	N	N	N	S	N	N	18%
2A. Leave (Minor) - Remove Exposed Ends & Rock Placement	N	N	N	S	N	N	18%
3A. Leave (Major) - Disconnect & Re-trench Entire Line	N	N	N	S	N	N	18%
3B. Leave (Major) - Disconnect Ends & Full Rock Placement	W	W	W	N	W	W	12%
5A. Full Removal - Deburial & Reverse Reel	N	N	N	S	N	N	18%
5C. Full Removal - Deburial & Cut and Lift	N	N	N	S	N	N	18%

4.2 Other Users	1B. Leave (Minimal) - Remove Exposed Ends / Exposures & Local Rock Placement	2A. Leave (Minor) - Remove Exposed Ends & Rock Placement	3A. Leave (Major) - Disconnect & Re-trench Entire Line	3B. Leave (Major) - Disconnect Ends & Full Rock Placement	5A. Full Removal - Deburial & Reverse Reel	5C. Full Removal - Deburial & Cut and Lift	Weighting
1B. Leave (Minimal) - Remove Exposed Ends / Exposures & Local Rock Placement	N	N	N	S	W	W	15%
2A. Leave (Minor) - Remove Exposed Ends & Rock Placement	N	N	N	S	W	W	15%
3A. Leave (Major) - Disconnect & Re-trench Entire Line	N	N	N	S	W	W	15%
3B. Leave (Major) - Disconnect Ends & Full Rock Placement	W	W	W	N	MW	MW	9%
5A. Full Removal - Deburial & Reverse Reel	S	S	S	MS	N	N	23%
5C. Full Removal - Deburial & Cut and Lift	S	S	S	MS	N	N	23%

Appendix E.6 Group 4 Pairwise Comparison Matrices – Economic

5. Economic	1B. Leave (Minimal) - Remove Exposed Ends / Exposures & Local Rock Placement	2A. Leave (Minor) - Remove Exposed Ends & Rock Placement	3A. Leave (Major) - Disconnect & Re-trench Entire Line	3B. Leave (Major) - Disconnect Ends & Full Rock Placement	5A. Full Removal - Deburial & Reverse Reel	5C. Full Removal - Deburial & Cut and Lift	Weighting
1B. Leave (Minimal) - Remove Exposed Ends / Exposures & Local Rock Placement	N	N	N	S	N	MS	20%
2A. Leave (Minor) - Remove Exposed Ends & Rock Placement	N	N	N	S	N	MS	20%
3A. Leave (Major) - Disconnect & Re-trench Entire Line	N	N	N	S	N	MS	20%
3B. Leave (Major) - Disconnect Ends & Full Rock Placement	W	W	W	N	W	S	13%
5A. Full Removal - Deburial & Reverse Reel	N	N	N	S	N	MS	20%
5C. Full Removal - Deburial & Cut and Lift	MW	MW	MW	W	MW	N	7%

Appendix E.7 Group 4 Results Chart



APPENDIX F GROUP 14 – DETAILED EVALUATION RESULTS

Appendix F.1 Group 14 Attributes Table

		2A. Leave (Minor) - Rock Placement		3A. Leave (Major) - Burial	5B. Full Removal - ROV Removal
		- Rock placement to eliminate hazard - Base case: - 78 mats, 5,450 grout bags - Some mattresses partially buried, bitumen mats, wire mats, hexagonal blocks (wire), grout bags, concrete marbles.		**- Perform in-situ burial of mattresses - Base case: - 78 mats, 5,450 grout bags - Some mattresses partially buried, bitumen mats, wire mats, hexagonal blocks (wire), grout bags, concrete marbles.**	**- Removal and recovery of mattresses using ROV with diver support as required. - Includes grout bags.**
1. Safety	1.1 Personnel Offshore	Vessel Type:- PoB / Days / Hours / PLL Trawler:- 5 / 9 / 540 / 4.05E-05 Rockdump Vessel:- 20 / 6 / 1,440 / 1.08E-04 Total offshore hours:- 1,980 hrs Total offshore PLL:- 1.49E-04		Vessel Type:- PoB / Days / Hours / PLL DSV:- 76 / 16 / 14,592 / 1.09E-03 Divers:- 3 / 16 / 1,152 / 1.12E-03 Trawler:- 5 / 9 / 540 / 4.05E-05 Total offshore hours:- 16,284 hrs Total offshore PLL:- 2.25E-03	Vessel Type:- PoB / Days / Hours / PLL DSV:- 76 / 35 / 31,920 / 2.39E-03 Divers:- 3 / 17.5 / 1,260 / 1.22E-03 Trawler:- 5 / 9 / 540 / 4.05E-05 Total offshore hours:- 33,720 hrs Total offshore PLL:- 3.66E-03
		VMS	**VMS**	**N**	
	Summary	The summary Potential for Loss of Life (PLL) metrics, with respect to Personnel Offshore exposure, for the options are 1.49E-04, 2.25E-03 and 3.66E-03 respectively. The assessment of the risk exposure for the various offshore worker groups is as follows: Option 2A is assessed as being Very Much Stronger than both Option 3A and Option 5B as the PLL value and thus the risk exposure is around 15 / 25 times lower respectively. Option 3A is assessed as being Neutral to Option 5B as the risk exposure is similar. Overall, Option 2A would be preferred from a risk to offshore personnel perspective.			
1. Safety	1.2 Personnel Onshore	Resource Type:- Days / Hours / PLL Engineering & Management:- 9 / 71 / 2.82E-07 Project Management:- 24 / 192 / 7.68E-07 Onshore Operations (includes Cleaning & Disposal):- 54 / 432 / 5.31E-05 Total onshore hours:- 695 hrs Total onshore PLL:- 5.42E-05		Resource Type:- Days / Hours / PLL Engineering & Management:- 350 / 2,800 / 1.12E-05 Project Management:- 335 / 2,680 / 1.07E-05 Onshore Operations (includes Cleaning & Disposal):- 95 / 759 / 9.34E-05 Total onshore hours:- 6,239 hrs Total onshore PLL:- 1.15E-04	Resource Type:- Days / Hours / PLL Engineering & Management:- 774 / 6,188 / 2.48E-05 Project Management:- 741 / 5,928 / 2.37E-05 Onshore Operations (includes Cleaning & Disposal):- 225 / 1,799 / 2.21E-04 Total onshore hours:- 13,915 hrs Total onshore PLL:- 2.70E-04
		S	**MS**	**S**	
	Summary	The summary Potential for Loss of Life (PLL) metrics, with respect to Personnel Onshore exposure, for the options are 5.42E-05, 1.15E-04 and 2.70E-04 respectively. The assessment of the risk exposure for the various onshore worker groups is as follows: Option 2A is assessed as being Stronger than Option 3A as the PLL value and thus the risk exposure is around 2 times lower. Option 2A is assessed as being Much Stronger than Option 5B as the PLL value and thus the risk exposure is just over 5 times lower. Option 3A is assessed as being Stronger than Option 5B as the PLL value and thus risk exposure is around 2 times lower. Overall, Option 2A would be preferred from a risk to offshore personnel perspective.			
1. Safety	1.3 Other Users	Vessel Days:- Trawler:- 9 Rockdump Vessel:- 6 Total vessel days:- 15 days		Vessel Days:- DSV:- 16 Trawler:- 9 Total vessel days:- 25 days	Vessel Days:- DSV:- 35 Trawler:- 9 Total vessel days:- 44 days
		S	**S**	**S**	
	Summary	The assessment of the impact of each of the options on Other Users is largely driven by the durations that vessels are located in the area during the decommissioning works. The assessment is as follows: Option 2A is assessed as being Stronger than both Option 3A and 5B as the number of days of vessel operations is around 2 to 3 times higher for the other options. Option 3A is assessed as being Stronger than Option 5B as the number of days of vessel operations around double for Option 5B. Overall, Option 2A would be preferred from a risk to other users perspective.			
1. Safety	1.4 High Consequence Events	The potential for High Consequence events is considered low for this option.		The potential for High Consequence events is considered low for this option.	Minimised diver support but could (likely) be involved however minor potential for HCE. More significant is the threat from dropped objects associated with material recovery through splash zone and onboarding so whilst low in absolute terms, higher than the other options.
		N	**S**	**S**	
	Summary	The assessment of the potential for High Consequence Events associated with each of the options is as follows: Option 2A is assessed as being Neutral to Option 3A as both are considered to have a low potential for High Consequence Events. Option 2A is assessed as being Stronger than Option 5B due to the potential for dropped objects. Option 3A is assessed as being Stronger than Option 5B for similar reasons. Overall, Option 2A and 3A would be preferred from a potential for high consequence events perspective.			
1. Safety	1.5 Residual Risk	Vessel Type:- PoB / Days / Hours / PLL Survey Vessel (Legacy):- 76 / 30 / 27,360 / 2.05E-03 Rockdump Vessel (Legacy):- 20 / 5 / 1,200 / 9.00E-05 Total offshore hours:- 28,560 hrs Total offshore PLL:- 2.14E-03 The legacy risk to the fishing industry from rock dumped, monitored / remediated mattresses is assessed as having a 'very unlikely' probability of occurrence.		Vessel Type:- PoB / Days / Hours / PLL Survey Vessel (Legacy):- 76 / 30 / 27,360 / 2.05E-03 Rockdump Vessel (Legacy):- 20 / 5 / 1,200 / 9.00E-05 Total offshore hours:- 28,560 hrs Total offshore PLL:- 2.14E-03 The legacy risk to the fishing industry from buried mattresses is assessed as having a 'very unlikely' probability of occurrence.	No residual risk from this full removal option.
		N	**MW**	**MW**	
	Summary	The assessment of the Residual Risk associated with each of the options is as follows: Option 2A is assessed as being Neutral to Option 3A as the residual risk is the same. Option 2A is assessed as being Much Weaker than Option 5B as there is no legacy risk associated with the full removal option. Option 3A is assessed as being Much Weaker than Option 5B for similar reasons. Overall, Option 5B would be preferred from a residual risk perspective.			

		2A. Leave (Minor) - Rock Placement		3A. Leave (Major) - Burial	5B. Full Removal - ROV Removal
		- Rock placement to eliminate hazard - Base case: - 78 mats, 5,450 grout bags - Some mattresses partially buried, bitumen mats, wire mats, hexagonal blocks (wire), grout bags, concrete marbles.		**- Perform in-situ burial of mattresses - Base case: - 78 mats, 5,450 grout bags - Some mattresses partially buried, bitumen mats, wire mats, hexagonal blocks (wire), grout bags, concrete marbles.**	**- Removal and recovery of mattresses using ROV with diver support as required. - Includes grout bags.**
2. Environmental	2.1 Marine Impact (Noise)	Vessel Noise:- 242 dB re 1mP 1.65 TPa²s Under this option, the major sound sources will be the vessels involved with no noise from subsea equipment. The operations are short and expected to only require two vessels, however one of these is a rock dumping vessel, perhaps making the cumulative sound exposure higher than otherwise might be expected. However, the total exposure value is still low, suggesting the overall impact of noise would also be low.		Vessel Noise:- 241 dB re 1mP 0.76 TPa²s Tooling Noise:- 237 dB re 1mP 0.46 TPa²s Under this option, the major sound sources will be the vessels involved with very little noise from equipment. The operations would be short and require few vessels that are not particularly noisy. Therefore, the estimated total sound exposure for the operations is low, suggesting the overall impact of noise would also be low.	Vessel Noise:- 238 dB re 1mP 0.67 TPa²s Under this option, the major sound sources will be the vessels involved. The operations would be short and require few vessels that are not particularly noisy. Therefore, the estimated total sound exposure for the operations is low, suggesting the overall impact of noise would also be low.
		N	**N**	**N**	
	Summary	The assessment of the Marine Impact (Noise) associated with each of the options is as follows: Whilst there are differences between the cumulative noise exposures of the options, these are assessed as being so minimal that all options are Neutral to each other.			
2. Environmental	2.2 Marine Impact (Planned Discharges)	There should be no discharges to sea as a result of these operations (other than standard vessel based discharges).		There should be no discharges to sea as a result of these operations (other than standard vessel based discharges).	There should be no discharges to sea as a result of these operations (other than standard vessel based discharges).
		N	**N**	**N**	
	Summary	The assessment of the Marine Impact (Planned Discharges) associated with each of the options is as follows: There are no expected planned discharges associated with any of the options, as such, they are assessed as Neutral to each other.			
2. Environmental	2.3 Marine Impact (Unplanned Releases)	2 individual vessels 15 combined vessel days The only potential source of a an unplanned release to sea during these operations would be a spill from the vessel itself. Given the short duration of this option, the risk of such a spill is low. As such, the impact of an unplanned release to sea should be low.		2 individual vessels 25 combined vessel days The relatively short duration of operations reduces the risk of spills but the use of a sub-sea equipment provides a potential source of subsea release. However, the types and maximum possible quantities of hydraulic fluid that could be accidentally released under this option would be expected to disperse quickly and not reach the shore. As such, the impact of an unplanned release to sea should be low.	2 individual vessels 44 combined vessel days The relatively short duration of operations reduces the risk of spills but the use of an ROV provides a potential source of subsea releases. However, the types and maximum possible quantities of hydraulic fluid that could be accidentally released under this option would be expected to disperse quickly and not reach the shore. As such, the impact of an unplanned release to sea should be low.
		S	**S**	**N**	
	Summary	The assessment of the Marine Impact (Unplanned Releases) associated with each of the options is as follows: Whilst the overall impact of each of the options is considered low, there is a key difference between Option 2A and both Option 3A and 5B. This relates to the use of subsea equipment where there is the potential for a hydraulic fluid leak. As such Option 2A is assessed as Stronger than both Option 3A and 5B. Options 3A and 5B are assessed as Neutral to each other. Overall, Option 2A would be preferred from a Marine Impact (Unplanned Releases) events perspective.			
2. Environmental	2.4 Fuel & Emissions	Vessel Emissions (in tonnes):- Fuel:- 1,288 CO2e:- 4,220 NOx:- 76.0 SO2:- 15.4 Vessel Energy Use:- 55,361 GJ The total estimated fuel usage required for this option would only represent a very small proportion of the total annual emissions from industry with respect to contribution to climate change. The impact of atmospheric emissions is therefore anticipated to be low.		Vessel Emissions (in tonnes):- Fuel:- 1,537 CO2e:- 5,039 NOx:- 90.7 SO2:- 18.4 Vessel Energy Use:- 66,107 GJ The total estimated fuel usage required for this option would only represent a very small proportion of the total annual emissions from industry with respect to contribution to climate change. The impact of atmospheric emissions is therefore anticipated to be low.	Vessel Emissions (in tonnes):- Fuel:- 792 CO2e:- 2,595 NOx:- 46.7 SO2:- 9.5 Vessel Energy Use:- 34.036 GJ The total estimated fuel usage required for this option would only represent a very small proportion of the total annual emissions from industry with respect to contribution to climate change. The impact of atmospheric emissions is therefore anticipated to be low.
		N	**N**	**N**	
	Summary	The assessment of the Fuel & Emissions associated with each of the options is as follows: The overall impact of each of the options is considered low and, whilst there are differences in the consumption and emissions figures, these are assessed as being so minimal that all options are Neutral to each other.			
2. Environmental	2.5 Other Consumptions	New material introduced:- Rockdump:- 3,511 tonnes No material returned to shore / 513 tonnes CO2 for remaining material. Although a moderate amount of rock dump material will need to be procured under this option, the short duration of operations and few vessels involved suggest that the scale of resource use overall will be low. No materials will be returned to shore so no related impacts will be expected. There is however an associated energy consumption that relates to the requirement to replace the remain in-situ materials.		No new material introduced. No material returned to shore / 513 tonnes CO2 for remaining material. This option is relatively simple in terms of the expected vessels, equipment and resources required and short in duration. The associated impacts in this context are expected to be low. No materials will be returned to shore so no related impacts will be expected. There is however an associated energy consumption that relates to the requirement to replace the remain in-situ materials.	No new material introduced. 583 tonnes of material returned to shore / 610 tonnes of CO2 for processing returned material. This option is relatively simple in terms of the expected vessels, equipment and resources required and short in duration. The associated impacts in this context are expected to be low. Removal of the concrete mattresses will require the materials involved to be transported to shore, most likely for disposal in landfill. No hazardous materials are expected and, given the quantity involved this is anticipated to have a low impact.
		MW	**MW**	**N**	
	Summary	The assessment against the Other Consumptions criterion for each of the options is as follows: Option 2A is assessed as being Much Weaker than Option 3A and Option 5B due to the requirement for significant amounts of new material. Option 3A is assessed as being Neutral to Option 5B as the consumption associated with the replacement of left in-situ material or processing of the returned material is largely similar. Overall, Option 3A and Option 5B are equally preferred from an Other Consumptions perspective.			
2. Environmental	2.6 Seabed Disturbance	Rockdumping:- 5,632 m2 The area of seabed directly disturbed by these operations is extremely small in the context of the surrounding wider region. Although the rock dumping will leave an area of seabed different from the surrounding natural sediments (mud), this area will also be very small. Indirect seabed disturbance is also considered to have limited impact. Therefore, the level of impact on the seabed and related communities is expected to be low.		Trenching:- 1,100 m2 The burial of the mattress will lead to the loss of any epifauna that has grown on the hard substrate provided and the action of burial is likely to cause some disturbance and resuspension of sediments. However the are affected is extremely small and there is good recovery potential once the operations are complete. Indirect seabed disturbance is also considered to have limited impact. Therefore any impacts experienced are anticipated to be low.	Lifting Mattresses:- 1,100 m2 Removal of concrete mattresses will lead to some minor disturbance of sediments and loss of any epifauna that has grown on them, but this will return the seabed to its natural state and any impact will be low. Indirect seabed disturbance is also considered to have limited impact.
		W	**MW**	**W**	
	Summary	The assessment against the Seabed Disturbance criterion for each of the options is as follows: Option 2A is assessed as being Weaker than Option 3A as the seabed disturbance is permanent in nature. Option 2A is assessed as being Much Weaker than Option 5B, as the seabed disturbance is permanent in nature and there is limited impact from the disturbance associated with Option 5B. Option 3A is assessed as being Weaker than Option 5B as, whilst the directly impacted areas are similar, there is a larger area of indirect impact associated with the jet trenching for burial operations under Option 3A. Whilst the overall impact of each of the options is considered low, Option 5B would be preferred from a Seabed Disturbance perspective.			

		2A. Leave (Minor) - Rock Placement		3A. Leave (Major) - Burial	5B. Full Removal - ROV Removal
		- Rock placement to eliminate hazard - Base case: - 78 mats, 5,450 grout bags - Some mattresses partially buried, bitumen mats, wire mats, hexagonal blocks (wire), grout bags, concrete marbles.		**- Perform in-situ burial of mattresses - Base case: - 78 mats, 5,450 grout bags - Some mattresses partially buried, bitumen mats, wire mats, hexagonal blocks (wire), grout bags, concrete marbles.**	**- Removal and recovery of mattresses using ROV with diver support as required. - Includes grout bags.**
3. Technical	3.1 Technical Risk	All technical aspects of this option are considered routine operations.		Likely to require new / novel technology to deliver solution.	Whist will be able to successfully remove materials, this may be time consuming and challenging to achieve. Some technology development may be needed.
		MS	**S**	**W**	
	Summary	The assessment against the Technical criterion for each of the options is as follows: Option 2A is assessed as being Much Stronger than Option 3A as there is likely to be a need for new technology to allow the mattresses to be buried in-situ. Option 2A is assessed as being Stronger than Option 5B as, whilst it is believed that mattress removal is possible, it is expected to be challenging and may require small scale technology development to achieve success. Option 3A is assessed as being Weaker than Option 5B as the required technology development is expected to be more onerous. Overall, Option 2A would be preferred from a Technical perspective.			
4. Societal	4.1 Fishing	Whilst there is 5,632 m2 of seabed impacted, due to rock dump, this is considered minor in scale terms to commercial Nephrop fishing. Short term presence of vessels at Balmoral will exclude fishing activity but not over an area greater than that excluded during production operations and for a very short time period. Nothing will be left exposed on the seabed in the long term that could be a snagging hazard once rock dumping is complete and the rock dump will be designed to be overtrawlable in the long term. The rock dumping will also cover an extremely small area of potential fishing grounds. Therefore, the overall impact on commercial fisheries is seen to be low. Note that the rock dump will be on the seabed and over the mattress and the potential for a snag hazard is assessed as 'Unlikely' rather than 'Very Unlikely' under these circumstances.		1,100 m2 of seabed impacted by operations and, although temporary in nature, will take time to recover for Nephrop fishing. Short term presence of vessels at Balmoral will exclude fishing activity but not over an area greater than that excluded during production operations and for a very short time period. Under this option, the mattresses will be buried beneath the seabed, returning it to its natural state and leaving no impediments to trawling. Therefore, the overall impact on commercial fisheries is seen to be low.	1,100 m2 of seabed impacted by operations and, although temporary in nature, will take time to recover for Nephrop fishing. No material remaining in situ Short term presence of vessels at Balmoral will exclude fishing activity but not over an area greater than that excluded during production operations and for a very short time period. Under this option, the mattresses will be removed, returning the seabed to its natural state and leaving no impediments to trawling. Therefore, the overall impact on commercial fisheries is seen to be low.
		W	**MW**	**W**	
	Summary	The assessment against the Societal - Fishing criterion for each of the options is as follows: Option 2A is assessed as being Weaker than Option 3A as there would be an area of seabed permanently lost to fishing and Much Weaker than Option 5B as all materials are removed under that option. Option 3A is assessed as being Weaker than Option 5B as the areas of impact are expected to be similar in size and temporary in nature, however all materials are removed under Option 5B. Whilst the overall impact of each of the options is considered low, Option 5B would be preferred from a Societal - Fishing perspective.			
4. Societal	4.2 Other Users	No material returned. 3,511 tonnes of new material but not considered significant from societal perspective.		No material returned.	583 tonnes of concrete returned for onshore processing provides a minor societal benefit for re-use.
		N	**W**	**W**	
	Summary	The assessment against the Societal - Other Users criterion for each of the options is as follows: Option 2A is assessed as being Neutral to Option 3A as whilst there is a requirement for over 3,000 tonnes of new material associated with Option 2A, this is not significant in societal terms. Option 2A is assessed as being Weaker than Option 5B due to the benefit from the returned material in Option 5B. Option 3A is assessed as being Weaker than Option 5B for similar reasons. Overall, Option 5B would be preferred from a Societal - Other Users perspective.			
5. Economic	5.1 Short-term Costs	Initial operation cost:- £1.790M Legacy cost:- £1.300M Total cost:- £3.090M		Initial operation cost:- £4.896M Legacy cost:- £1.300M Total cost:- £6.196M	Initial operation cost:- £9.646M Total cost:- £9.646M
		S	**MS**	**S**	
	Summary	The assessment against the Economic criterion for each of the options is as follows: Option 2A is assessed as being Stronger than Option 3A as the costs are around half that of Option 3A. Option 2A is assessed as being Much Stronger than Option 5B as the costs are around a third of Option 5B. Option 3A is assessed as being Stronger than Option 5C as the costs for Option 5B are marginally higher and there is an associated legacy cost component. Overall, Option 2A would be preferred from a Economic perspective.			

Appendix F.2 Group 14 Pairwise Comparison Matrices – Safety

1.1 Personnel Offshore

	2A. Leave (Minor) - Rock Placement	3A. Leave (Major) - Burial	5B. Full Removal - ROV Removal	Weighting
2A. Leave (Minor) - Rock Placement	N	VMS	VMS	82%
3A. Leave (Major) - Burial	VMW	N	N	9%
5B. Full Removal - ROV Removal	VMW	N	N	9%

1.2 Personnel Onshore

	2A. Leave (Minor) - Rock Placement	3A. Leave (Major) - Burial	5B. Full Removal - ROV Removal	Weighting
2A. Leave (Minor) - Rock Placement	N	S	MS	51%
3A. Leave (Major) - Burial	W	N	S	31%
5B. Full Removal - ROV Removal	MW	W	N	19%

1.3 Other Users

	2A. Leave (Minor) - Rock Placement	3A. Leave (Major) - Burial	5B. Full Removal - ROV Removal	Weighting
2A. Leave (Minor) - Rock Placement	N	S	S	43%
3A. Leave (Major) - Burial	W	N	S	33%
5B. Full Removal - ROV Removal	W	W	N	25%

1.4 High Consequence Events

	2A. Leave (Minor) - Rock Placement	3A. Leave (Major) - Burial	5B. Full Removal - ROV Removal	Weighting
2A. Leave (Minor) - Rock Placement	N	N	S	38%
3A. Leave (Major) - Burial	N	N	S	38%
5B. Full Removal - ROV Removal	W	W	N	25%

1.5 Residual Risk

	2A. Leave (Minor) - Rock Placement	3A. Leave (Major) - Burial	5B. Full Removal - ROV Removal	Weighting
2A. Leave (Minor) - Rock Placement	N	N	MW	20%
3A. Leave (Major) - Burial	N	N	MW	20%
5B. Full Removal - ROV Removal	MS	MS	N	60%

Appendix F.3 Group 14 Pairwise Comparison Matrices – Environment

2.1 Marine Impact (Noise)	2A. Leave (Minor) - Rock Placement	3A. Leave (Major) - Burial	5B. Full Removal - ROV Removal	Weighting
2A. Leave (Minor) - Rock Placement	N	N	N	33%
3A. Leave (Major) - Burial	N	N	N	33%
5B. Full Removal - ROV Removal	N	N	N	33%

2.2 Marine Impact (Planned Discharges)	2A. Leave (Minor) - Rock Placement	3A. Leave (Major) - Burial	5B. Full Removal - ROV Removal	Weighting
2A. Leave (Minor) - Rock Placement	N	N	N	33%
3A. Leave (Major) - Burial	N	N	N	33%
5B. Full Removal - ROV Removal	N	N	N	33%

2.3 Marine Impact (Unplanned Releases)	2A. Leave (Minor) - Rock Placement	3A. Leave (Major) - Burial	5B. Full Removal - ROV Removal	Weighting
2A. Leave (Minor) - Rock Placement	N	S	S	43%
3A. Leave (Major) - Burial	W	N	N	29%
5B. Full Removal - ROV Removal	W	N	N	29%

2.4 Fuel & Emissions	2A. Leave (Minor) - Rock Placement	3A. Leave (Major) - Burial	5B. Full Removal - ROV Removal	Weighting
2A. Leave (Minor) - Rock Placement	N	N	N	33%
3A. Leave (Major) - Burial	N	N	N	33%
5B. Full Removal - ROV Removal	N	N	N	33%

2.5 Other Consumptions	2A. Leave (Minor) - Rock Placement	3A. Leave (Major) - Burial	5B. Full Removal - ROV Removal	Weighting
2A. Leave (Minor) - Rock Placement	N	MW	MW	14%
3A. Leave (Major) - Burial	MS	N	N	43%
5B. Full Removal - ROV Removal	MS	N	N	43%

2.6 Seabed Disturbance	2A. Leave (Minor) - Rock Placement	3A. Leave (Major) - Burial	5B. Full Removal - ROV Removal	Weighting
2A. Leave (Minor) - Rock Placement	N	W	MW	19%
3A. Leave (Major) - Burial	S	N	W	31%
5B. Full Removal - ROV Removal	MS	S	N	51%

Appendix F.4 Group 14 Pairwise Comparison Matrices – Technical

3. Technical	2A. Leave (Minor) - Rock Placement	3A. Leave (Major) - Burial	5B. Full Removal - ROV Removal	Weighting
2A. Leave (Minor) - Rock Placement	N	MS	S	51%
3A. Leave (Major) - Burial	MW	N	W	19%
5B. Full Removal - ROV Removal	W	S	N	31%

Appendix F.5 Group 14 Pairwise Comparison Matrices – Societal

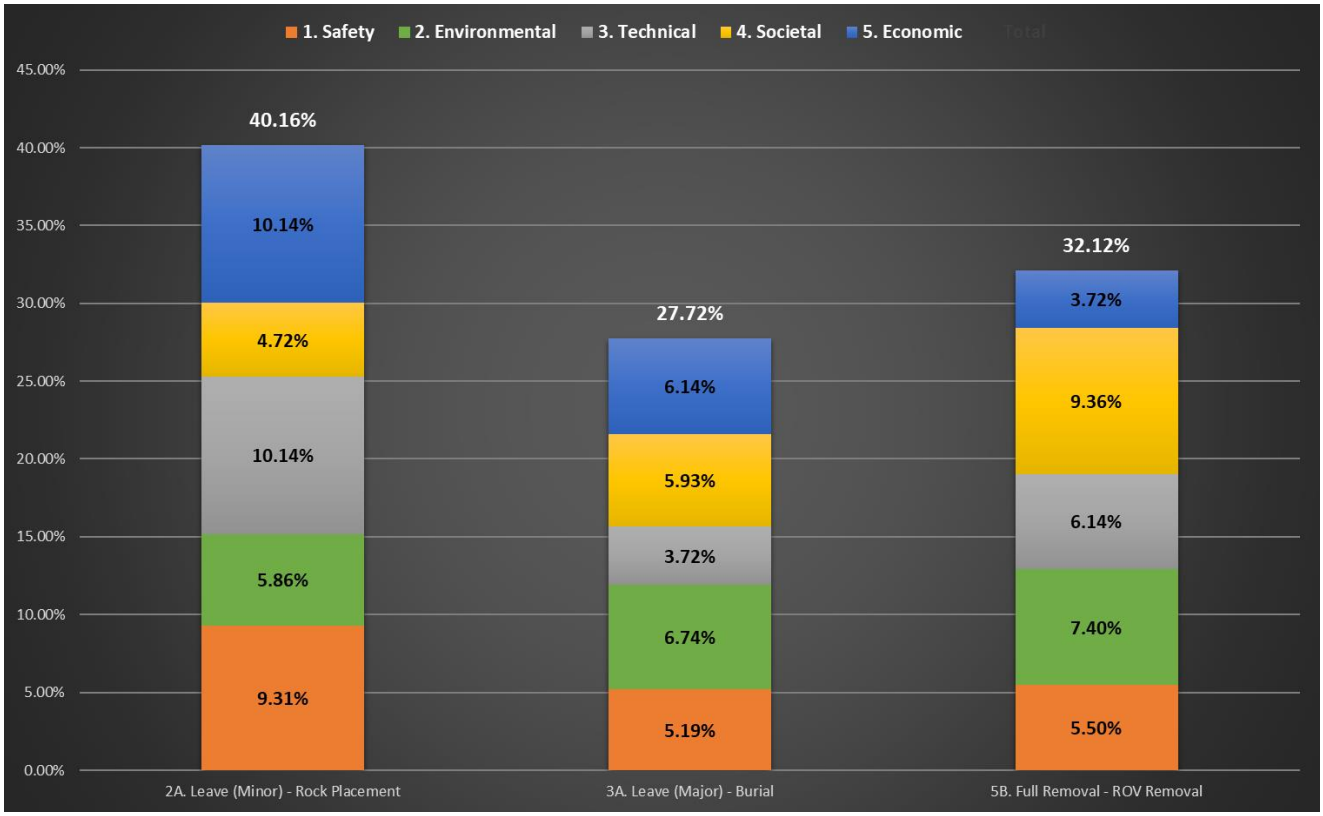
4.1 Fishing	2A. Leave (Minor) - Rock Placement	3A. Leave (Major) - Burial	5B. Full Removal - ROV Removal	Weighting
2A. Leave (Minor) - Rock Placement	N	W	MW	19%
3A. Leave (Major) - Burial	S	N	W	31%
5B. Full Removal - ROV Removal	MS	S	N	51%

4.2 Other Users	2A. Leave (Minor) - Rock Placement	3A. Leave (Major) - Burial	5B. Full Removal - ROV Removal	Weighting
2A. Leave (Minor) - Rock Placement	N	N	W	29%
3A. Leave (Major) - Burial	N	N	W	29%
5B. Full Removal - ROV Removal	S	S	N	43%

Appendix F.6 Group 14 Pairwise Comparison Matrices – Economic

5. Economic	2A. Leave (Minor) - Rock Placement	3A. Leave (Major) - Burial	5B. Full Removal - ROV Removal	Weighting
2A. Leave (Minor) - Rock Placement	N	S	MS	51%
3A. Leave (Major) - Burial	W	N	S	31%
5B. Full Removal - ROV Removal	MW	W	N	19%

Appendix F.7 Group 14 Results Chart



APPENDIX G DECOMMISSIONING OPTION DATA SHEETS

Appendix G.1 Group 1 – Option 3A Data Sheet

Area	Balmoral
Decision / Group	**Group 1: Surface Laid Flexible Flowlines & Umbilicals / Cables**
Option	**Option 3a: Leave In-Situ (Major Intervention) - Trench Entire Line**
Sequence of Works	Perform as-found survey
	Trench and bury flexibles, umbilicals and cables using jet trencher (64,581m)
	Perform as-left survey
	Perform trawl sweep of site

ID No.	Type	Material	OD (inches)	Total Length (m)	Total Weight (Te)
4344	A3 Chem Inj Umbilical	Composite	~4	1414	6.7
4345	B14 Control Umbilical	Composite	~4	3247	13.3
4346	A11 Control Umbilical	Composite	~4	3513	14.5
4347	B29 Chem Inj Umbilical	Composite	~4	5157	24.1
4348	A7z Control Umbilical	Composite	~4	2004	7.3
4349	A2 Chem Inj Umbilical	Composite	~4	1736	8.2
4350	A16 Control Umbilical	Composite	~4	2955	12.1
4351	B4a Control Umbilical	Composite	~4	5517	23.8
4352	A10z Control Umbilical	Composite	~4	1731	6.4
4342	B29 Sensor Umbilical Logging Cable	Composite	0.75	5182	5.2
4343	B14 Sensor Umbilical Logging Cable	Composite	0.75	3343	3.3
983	20z Production	Composite	7.75	2056	82.7
984	20z Gas Lift	Composite	4.06	2056	29.1
985	A20z Chem Inj Umbilical	Composite	~4	2070	31.1
4353	A26 Sensor Umbilical Logging Cable	Composite	0.75	7900	7.9
4354	A27 Sensor Umbilical Logging Cable	Composite	0.75	7000	7.0
4355	A17z Sensor Umbilical Logging Cable	Composite	0.75	7700	7.7
			TOTAL	**64,581**	**290.4**

SAFETY				
Offshore Personnel	Number	116	Man Hours	22,284
Diver Requirement	Number	0	Man Hours	0
Onshore Personnel	Number	20	Man Hours	7,256
Legacy Risk	Number	96	Man Hours	45,888
Impact to Other Users of the Sea (operational)	Number of Vessels Used	3	Duration of Operations	52
Impact to Other Users of the Sea (Legacy)	Number of Vessels Used	2	Duration of Operations	54
Potential for High Consequence Events	Low	**Comments**	Routine operations; Minimal lifting; For further details from the HAZID, see Ref. [4].	
Operational Risk Offshore	PLL	1.67E-03		
Operational Risk Diver	PLL	0.00E+00		
Operational Risk Onshore	PLL	1.76E+04		
Legacy Risk	PLL	3.44E-03		
Fishing Risk	PLL	N/A (No increase in risk over and above what currently exists for fishing)		
Overall Risk	**ΣPLL**	**5.29E-03**		

ENVIRONMENTAL					
Marine Impact (Vessels)	**Vessel Type**	**Number off**	**Duration**	**Activity**	
	Survey Vessel	1	17	Survey	
	Trenching Vessel	1	26	Trench/Backfill	
	Trawler	1	9	Trawl Sweep	
Marine Impact (Vessel Legacy)	**Vessel Type**	**Number off**	**Duration**	**Activity**	
	Survey Vessel (Legacy)	1	49	Survey	
	Rock Placement Vessel (Legacy)	1	5	Rock Placement	
Vessel Noise	**Parameter**	**dB re 1mP**	**TPa²s**		
	Operational SEL	251.98	15.76		
	Legacy SEL	245.54	3.58		
Equipment Noise (Ops)	**Activity**	**Tool Use (days)**	**dB re 1mP**	**TPa²s**	
	Jet Trenching	20.77	227.54	0.057	
Energy Use (Total = Ops + Legacy)	**Fuel**	**CO_2**	**NOx**	**SO_2**	
	2834.5 Te	8985.3 Te	167.2 Te	34 Te	
Life Cycle Emissions (Disposal / Replacement of Material)	**CO_2 (Disposal Ops)**	**CO_2 (Replacement Ops)**			
	0 Te	475 Te			
Marine Impact (Seabed)	**Activity**	**Area (m^2)**	**Resources**		
	Rock Placement	N/A	N/A		
	MFE	N/A	N/A		
	Trenching	64,581	Trenching Spread		
Materials	**Parameter**	**Weight (Te)**	**Length (m)**		
	Recovered	0.0	0.0		
	Remaining	290.4	64,581		
Residuals	**Type**	**Left In-Situ**	**Returned**		
	LSA Scale	Flushed & cleaned, but possible on inner pipe wall	N/A		
	Hydrocarbon	Flushed & cleaned but possible in flexible carcass / annulus	N/A		
	Control Fluids	Flushed & cleaned	N/A		

TECHNICAL				
Technical Considerations	**Feasibility**	Med	**Concept Maturity**	Low
	Availability of Technology	High - Vessels and equipment available		
	Track Record	Medium - Requirement to trench in congested area, acceptable burial depth may not be achievable. Crossings and debris add to complexity.		
	Risk of Failure	High - Uncertainty surrounding congestion and crossings. Considered challenging to accomplish 0.6m Doc over entire length.		
	Consequence of Failure	Additional rock required / schedule and cost impacts		

SOCIETAL		
Societal Factors	**Commercial Fisheries Impact**	Med - Significant area of disturbance, however would recover given time
	Socio Economic	No material returned. No other identified societal benefits.

ECONOMIC								
Economic Considerations	**Comparative Cost Operational**			£6.61	M			
	Comparative Cost Legacy			£2.28	M			
	Project Contingency (30%)			£2.67	M			
	Comparative Cost Total (inc. contingency)			£11.56	M			
Economic Risk	**Cost Risk**	Medium	**Factors**	Considered technically challenging; Geotechnical study required; Trenching works uncertain; May require unplanned additional rock placement; Legacy management required.				

Appendix G.2 Group 1 – Option 5A Data Sheet

Area	Balmoral
Decision / Group	**Group 1: Surface Laid Flexible Flowlines & Umbilicals / Cables**
Option	**Option 5a: Full Removal - Reverse Reel**
Sequence of Works	Perform as-found survey
	Reverse reel flexibles, umbilicals and cables (64,581m)
	Perform as-left survey

ID No.	Type	Material	OD (inches)	Total Length (m)	Total Weight (Te)
4344	A3 Chem Inj Umbilical	Composite	~4	1414	6.7
4345	B14 Control Umbilical	Composite	~4	3247	13.3
4346	A11 Control Umbilical	Composite	~4	3513	14.5
4347	B29 Chem Inj Umbilical	Composite	~4	5157	24.1
4348	A7z Control Umbilical	Composite	~4	2004	7.3
4349	A2 Chem Inj Umbilical	Composite	~4	1736	8.2
4350	A16 Control Umbilical	Composite	~4	2955	12.1
4351	B4a Control Umbilical	Composite	~4	5517	23.8
4352	A10z Control Umbilical	Composite	~4	1731	6.4
4342	B29 Sensor Umbilical Logging Cable	Composite	0.75	5182	5.2
4343	B14 Sensor Umbilical Logging Cable	Composite	0.75	3343	3.3
983	20z Production	Composite	7.75	2056	82.7
984	20z Gas Lift	Composite	4.06	2056	29.1
985	A20z Chem Inj Umbilical	Composite	~4	2070	31.1
4353	A26 Sensor Umbilical Logging Cable	Composite	0.75	7900	7.9
4354	A27 Sensor Umbilical Logging Cable	Composite	0.75	7000	7.0
4355	A17z Sensor Umbilical Logging Cable	Composite	0.75	7700	7.7
			TOTAL	**64,581**	**290.4**

SAFETY				
Offshore Personnel	Number	157	Man Hours	36,196
Diver Requirement	Number	0	Man Hours	0
Onshore Personnel	Number	20	Man Hours	9,592
Legacy Risk	Number	0	Man Hours	0
Impact to Other Users of the Sea (operational)	Number of Vessels Used	3	Duration of Operations	47
Impact to Other Users of the Sea (Legacy)	Number of Vessels Used	0	Duration of Operations	0
Potential for High Consequence Events	Low	**Comments**	Integrity assumed by engineering only; Minimal lifting; For further details from the HAZID, see Ref. [4]	
Operational Risk Offshore	PLL	2.64E-03		
Operational Risk Diver	PLL	0.00E+00		
Operational Risk Onshore	PLL	1.63E-04		
Legacy Risk	PLL	0.00E+00		
Fishing Risk	PLL	N/A (No increase in risk over and above what currently exists for fishing)		
Overall Risk	**ΣPLL**	**2.80E-03**		

ENVIRONMENTAL				
Marine Impact (Vessels)	**Vessel Type**	**Number off**	**Duration**	**Activity**
	Survey Vessel	1	17	Survey
	Reel Vessel	1	21	Reverse Reeling
	Trawler	1	9	Trawl Sweep
Marine Impact (Vessel Legacy)	**Vessel Type**	**Number off**	**Duration**	**Activity**
	Survey Vessel (Legacy)	0	0	N/A
	Rock Placement Vessel (Legacy)	0	0	N/A
Vessel Noise	**Parameter**	**dB re 1mP**	**TPa²s**	
	Operational SEL	251.16	13.07	
	Legacy SEL	N/A	N/A	
Equipment Noise (Ops)	**Activity**	**Tool Use (days)**	**dB re 1mP**	**TPa²s**
	N/A	N/A	N/A	N/A
Energy Use (Total = Ops + Legacy)	**Fuel**	**CO_2**	**NOx**	**SO_2**
	1578.7 Te	5004.6 Te	93.1 Te	18.9 Te
Life Cycle Emissions (Disposal / Replacement of Material)	**CO_2 (Disposal Ops)**	**CO_2 (Replacement Ops)**		
	131.6 Te	0.0 Te		
Marine Impact (Seabed)	**Activity**	**Area (m^2)**	**Resources**	
	Rock Placement	N/A	N/A	
	MFE	N/A	N/A	
	Trenching	N/A	N/A	
Materials	**Parameter**	**Weight (Te)**	**Length (m)**	
	Recovered	290.4	64581.0	
	Remaining	0.0	0	
Residuals	**Type**	**Left In-Situ**	**Returned**	
	LSA Scale	N/A	Flushed & cleaned, but possible on inner pipe wall	
	Hydrocarbon	N/A	Flushed & cleaned but possible in flexible carcass / annulus	
	Control Fluids	N/A	Flushed & cleaned	

TECHNICAL				
Technical Considerations	**Feasibility**	High	**Concept Maturity**	Med
	Availability of Technology	High - Vessels and equipment available		
	Track Record	Med - Routine installation operation. Recent decommissioning of the Staffa Field utilised reverse reeling.		
	Risk of Failure	Low		
	Consequence of Failure	Additional rock / trenching required / schedule & cost impact		

SOCIETAL		
Societal Factors	**Commercial Fisheries Impact**	Low - Limited impact on fishing
	Socio Economic	High - 290Te of material returned to shore

ECONOMIC								
Economic Considerations	**Comparative Cost Operational**			£5.26	M			
	Comparative Cost Legacy			£0.00	M			
	Project Contingency (30%)			£1.58	M			
	Comparative Cost Total (inc. contingency)			£6.84	M			
Economic Risk	**Cost Risk**	Low	**Factors**	High degree of achievability; No legacy management requirement.				

Appendix G.3 Group 3 – Option 1B Data Sheet

Area	Balmoral
Decision / Group	**Group 3: Buried Rigid Flowlines**
Option	**Option 1b: Leave In-Situ (Minimal Intervention) - Remove Exposed Ends & Local rock placement**
Sequence of Works	Perform as-found survey
	Cut and bundle exposed end sections (400m exposed at central location & 100m exposed at tree)
	Recover bundles to pipehaul vessel and transit to shore
	Rock placement at cut ends and midline exposures (65 exposures identified, 1077m exposed midline)
	Perform as-left survey

ID No.	Type	Material	OD (inches)	Total Length (m)	Total Weight (Te)
218	Oil export	Rigid Steel	14	14,460	1920.8
219	A3 Gas Lift	Rigid Steel	2.375	1,247	11.6
220	A3 Production	Rigid Steel	4.5	1,242	35.1
221	B29 Gas Lift	Rigid Steel	2.375	4,985	46.5
222	B29 Production	Rigid Steel	4.5	4,999	141.3
223	A2 Gas Lift	Rigid Steel	2.375	1,633	15.2
224	A2 Production	Rigid Steel	4.5	1,628	46.0
225	A7z Water Injection	Rigid Steel	6.625	1,763	65.7
226	A10z Water Injection	Rigid Steel	6.625	1,575	58.7
227	B4a Water Injection	Rigid Steel	6.625	5,286	196.9
228	A11 Water Injection	Rigid Steel	6.625	3,261	121.4
229	B14 Water Injection	Rigid Steel	6.625	2,850	106.1
230	A16 Water Injection	Rigid Steel	6.625	2,641	98.4
2565	B29 Production	Rigid Steel	6.625	3,905	211.8
2329	Brenda Production	Rigid Steel	10.75	8,844	720.0
2330	Brenda Gas Lift	Rigid Steel	6.625	8,844	329.0
2350	Nicol Production	Rigid Steel	6.625	9,576	356.0
2351	Nicol Gas Lift	Rigid Steel	3.5	9,583	108.0
638	A26 Production	Rigid Steel	6.625	7,861	621.8
639	A27 Production	Rigid Steel	8.625	6,872	763.7
640	A17z Water Injection	Rigid Steel	8.625	7,536	486.5
980	A27 Service (ex-Blair)	Rigid Steel	4.5	5,798	162.5
			TOTAL	**116,349**	**6,622.9**

SAFETY				
Offshore Personnel	Number	197	Man Hours	62,412
Diver Requirement	Number	3	Man Hours	2,448
Onshore Personnel	Number	20	Man Hours	16,668
Legacy Risk	Number	96	Man Hours	61,392
Impact to Other Users of the Sea (operational)	Number of Vessels Used	5	Duration of Operations	110
Impact to Other Users of the Sea (Legacy)	Number of Vessels Used	2	Duration of Operations	71
Potential for High Consequence Events	Low	**Comments**	Routine operations; Minimal lifting; For further details from the HAZID, see Ref. [4].	
Operational Risk Offshore	PLL	4.51E-03		
Operational Risk Diver	PLL	2.37E-03		
Operational Risk Onshore	PLL	2.75E-04		
Legacy Risk	PLL	4.60E-03		
Fishing Risk	PLL	N/A (No increase in risk over and above what currently exists for fishing)		
Overall Risk	ΣPLL	1.18E-02		

ENVIRONMENTAL				
Marine Impact (Vessels)	**Vessel Type**	**Number off**	**Duration**	**Activity**
	Survey Vessel	1	22	Survey
	Rock Placement Vessel	1	10	Rock Placement
	DSV	1	34	Destruct
	Barge / Pipehaul	1	35	Material Transport
	Trawler	1	9	Trawl Sweep
Marine Impact (Vessel Legacy)	**Vessel Type**	**Number off**	**Duration**	**Activity**
	Survey Vessel (Legacy)	1	66	Survey
	Rock Placement Vessel (Legacy)	1	5	Rock Placement
Vessel Noise	**Parameter**	**dB re 1mP**	**TPa²s**	
	Operational SEL	244.17	2.61	
	Legacy SEL	245.83	3.82	
Equipment Noise (Ops)	**Activity**	**Tool Use (days)**	**dB re 1mP**	**TPa²s**
	Cutting	23.8	218.13	0.007
Energy Use (Total = Ops + Legacy)	**Fuel**	**CO_2**	**NOx**	**SO_2**
	5185.9 Te	16439.4 Te	306 Te	62.2 Te
Life Cycle Emissions (Disposal / Replacement of Material)	**CO_2 (Disposal Ops)**	**CO_2 (Replacement Ops)**		
	495.0 Te	11,634.5 Te		
Marine Impact (Seabed)	**Activity**	**Area (m^2)**	**Resources**	
	Rock Placement	6,925	4902Te of rock placement	
	MFE	N/A	N/A	
	Trenching	N/A	N/A	
Materials	**Parameter**	**Weight (Te)**	**Length (m)**	
	Recovered	491.4	11,000	
	Remaining	6159.1	105,339	
Residuals	**Type**	**Left In-Situ**	**Returned**	
	LSA Scale	Flushed & cleaned, but possible on inner pipe wall	Flushed & cleaned, but possible on inner pipe wall	
	Hydrocarbon	Flushed & cleaned	Flushed & cleaned	
	Control Fluids	N/A	N/A	

TECHNICAL				
Technical Considerations	**Feasibility**	High	**Concept Maturity**	High
	Availability of Technology	High - Off the shelf		
	Track Record	High - All technical aspects of this option are considered routine operations.		
	Risk of Failure	Low		
	Consequence of Failure	Low - Limited impact of failure		

SOCIETAL		
Societal Factors	**Commercial Fisheries Impact**	Med - Limited area permanently lost due to rock placement
	Socio Economic	Med - Minor benefits due to returned material

ECONOMIC								
Economic Considerations	**Comparative Cost Operational**			£9.16	M			
	Comparative Cost Legacy			£3.23	M			
	Project Contingency (30%)			£3.72	M			
	Comparative Cost Total (inc. contingency)			£16.12	M			
Economic Risk	**Cost Risk**	Medium	**Factors**	High degree of achievability; Potential requirement for additional rock dependent on trawl activity.				

Appendix G.4 Group 3 – Option 2A Data Sheet

Area	Balmoral
Decision / Group	**Group 3: Trenched & Buried Rigid Flowlines**
Option	**Option 2a: Leave In-Situ (Minor Intervention) - Remove Ends Exposed / Midline Exposures & Rock Placement**
Sequence of Works	Perform as-found survey
	Cut and bundle exposed end sections and midline exposures (400m exposed at central location & 100m exposed at tree)
	Recover bundles to pipehaul vessel and transit to shore
	Rock placement at all cut ends (44 pipeline ends + 65 midline exposures, therefore 174 cut ends)
	Perform as-left survey

ID No.	Type	Material	OD (inches)	Total Length (m)	Total Weight (Te)
218	Oil export	Rigid Steel	14	14,460	1920.8
219	A3 Gas Lift	Rigid Steel	2.375	1,247	11.6
220	A3 Production	Rigid Steel	4.5	1,242	35.1
221	B29 Gas Lift	Rigid Steel	2.375	4,985	46.5
222	B29 Production	Rigid Steel	4.5	4,999	141.3
223	A2 Gas Lift	Rigid Steel	2.375	1,633	15.2
224	A2 Production	Rigid Steel	4.5	1,628	46.0
225	A7z Water Injection	Rigid Steel	6.625	1,763	68.3
226	A10z Water Injection	Rigid Steel	6.625	1,575	61.0
227	B4a Water Injection	Rigid Steel	6.625	5,286	204.7
228	A11 Water Injection	Rigid Steel	6.625	3,261	126.3
229	B14 Water Injection	Rigid Steel	6.625	2,850	110.4
230	A16 Water Injection	Rigid Steel	6.625	2,641	102.3
2565	B29 Production	Rigid Steel	6.625	3,905	213.5
2329	Brenda Production	Rigid Steel	10.75	8,844	720.0
2330	Brenda Gas Lift	Rigid Steel	6.625	8,844	329.0
2350	Nicol Production	Rigid Steel	6.625	9,576	356.0
2351	Nicol Gas Lift	Rigid Steel	3.5	9,583	108.0
638	A26 Production	Rigid Steel	6.625	7,861	621.8
639	A27 Production	Rigid Steel	8.625	6,872	763.7
640	A17z Water Injection	Rigid Steel	8.625	7,536	486.5
980	A27 Service (ex-Blair)	Rigid Steel	4.5	5,798	162.5
			TOTAL	**116,349**	**6,622.9**

SAFETY				
Offshore Personnel	Number	197	Man Hours	69,804
Diver Requirement	Number	3	Man Hours	2,880
Onshore Personnel	Number	20	Man Hours	19,203
Legacy Risk	Number	96	Man Hours	61,392
Impact to Other Users of the Sea (operational)	Number of Vessels Used	5	Duration of Operations	124
Impact to Other Users of the Sea (Legacy)	Number of Vessels Used	2	Duration of Operations	71
Potential for High Consequence Events	Low	**Comments**	Routine operations; Minimal lifting; For further details from the HAZID, see Ref. [4].	
Operational Risk Offshore	PLL	5.04E-03		
Operational Risk Diver	PLL	2.79E-03		
Operational Risk Onshore	PLL	3.26E-04		
Legacy Risk	PLL	4.60E-03		
Fishing Risk	PLL	N/A (No increase in risk over and above what currently exists for fishing)		
Overall Risk	**ΣPLL**	**1.28E-02**		

ENVIRONMENTAL				
Marine Impact (Vessels)	**Vessel Type**	**Number off**	**Duration**	**Activity**
	Survey Vessel	1	22	Survey
	Rock Placement Vessel	1	12	Rock Placement
	DSV	1	40	Destruct
	Barge / Pipehaul	1	41	Material Transport
	Trawler	1	9	Trawl Sweep
Marine Impact (Vessel Legacy)	**Vessel Type**	**Number off**	**Duration**	**Activity**
	Survey Vessel (Legacy)	1	66	Survey
	Rock Placement Vessel (Legacy)	1	5	Rock Placement
Vessel Noise	**Parameter**	**dB re 1mP**	**TPa²s**	
	Operational SEL	250.12	10.28	
	Legacy SEL	245.83	3.82	
Equipment Noise (Ops)	**Activity**	**Tool Use (days)**	**dB re 1mP**	**TPa²s**
	Cutting	26.77	218.64	0.007
Energy Use (Total = Ops + Legacy)	**Fuel**	**CO_2**	**NOx**	**SO_2**
	5534.5 Te	17544.4 Te	326.5 Te	66.4 Te
Life Cycle Emissions (Disposal / Replacement of Material)	**CO_2 (Disposal Ops)**	**CO_2 (Replacement Ops)**		
	550.8 Te	11,529.5 Te		
Marine Impact (Seabed)	**Activity**	**Area (m^2)**	**Resources**	
	Rock Placement	6,475	4625Te of rock placement	
	MFE	N/A	N/A	
	Trenching	N/A	N/A	
Materials	**Parameter**	**Weight (Te)**	**Length (m)**	
	Recovered	547.0	12,077	
	Remaining	6075.9	104,262	
Residuals	**Type**	**Left In-Situ**	**Returned**	
	LSA Scale	Flushed & cleaned, but possible on inner pipe wall	Flushed & cleaned, but possible on inner pipe wall	
	Hydrocarbon	Flushed & cleaned	Flushed & cleaned	
	Control Fluids	N/A	N/A	

TECHNICAL				
Technical Considerations	**Feasibility**	High	**Concept Maturity**	High
	Availability of Technology	High - Off the shelf		
	Track Record	High - All technical aspects of this option are considered routine operations.		
	Risk of Failure	Low		
	Consequence of Failure	Low - Limited impact of failure		

SOCIETAL		
Societal Factors	**Commercial Fisheries Impact**	Med - Limited area permanently lost due to rock placement
	Socio Economic	Med - Minor benefits due to returned material

ECONOMIC								
Economic Considerations	**Comparative Cost Operational**			£10.43	M			
	Comparative Cost Legacy			£3.23	M			
	Project Contingency (30%)			£4.10	M			
	Comparative Cost Total (inc. contingency)			£17.77	M			
Economic Risk	**Cost Risk**	Low	**Factors**	High degree of achievability; Potential requirement for additional rock dependent on trawl activity.				

Appendix G.5 Group 3 – Option 3A Data Sheet

Area	Balmoral
Decision / Group	**Group 3: Trenched & Buried Rigid Flowlines**
Option	**Option 3a: Leave In-Situ (Major Intervention) - Re-trench Entire Line**
Sequence of Works	Perform as-found survey
	Trench and bury entire pipeline lengths (116,339m)
	Perform as-left survey
	Perform trawl sweep of site

ID No.	Type	Material	OD (inches)	Total Length (m)	Total Weight (Te)
218	Oil export	Rigid Steel	14	14,460	1920.8
219	A3 Gas Lift	Rigid Steel	2.375	1,247	11.6
220	A3 Production	Rigid Steel	4.5	1,242	35.1
221	B29 Gas Lift	Rigid Steel	2.375	4,985	46.5
222	B29 Production	Rigid Steel	4.5	4,999	141.3
223	A2 Gas Lift	Rigid Steel	2.375	1,633	15.2
224	A2 Production	Rigid Steel	4.5	1,628	46.0
225	A7z Water Injection	Rigid Steel	6.625	1,763	68.3
226	A10z Water Injection	Rigid Steel	6.625	1,575	61.0
227	B4a Water Injection	Rigid Steel	6.625	5,286	204.7
228	A11 Water Injection	Rigid Steel	6.625	3,261	126.3
229	B14 Water Injection	Rigid Steel	6.625	2,850	110.4
230	A16 Water Injection	Rigid Steel	6.625	2,641	102.3
2565	B29 Production	Rigid Steel	6.625	3,905	213.5
2329	Brenda Production	Rigid Steel	10.75	8,844	720.0
2330	Brenda Gas Lift	Rigid Steel	6.625	8,844	329.0
2350	Nicol Production	Rigid Steel	6.625	9,576	356.0
2351	Nicol Gas Lift	Rigid Steel	3.5	9,583	108.0
638	A26 Production	Rigid Steel	6.625	7,861	621.8
639	A27 Production	Rigid Steel	8.625	6,872	763.7
640	A17z Water Injection	Rigid Steel	8.625	7,536	486.5
980	A27 Service (ex-Blair)	Rigid Steel	4.5	5,798	162.5
			TOTAL	**116,349**	**6,622.9**

SAFETY				
Offshore Personnel	Number	101	Man Hours	30,684
Diver Requirement	Number	0	Man Hours	0
Onshore Personnel	Number	20	Man Hours	19,058
Legacy Risk	Number	96	Man Hours	61,392
Impact to Other Users of the Sea (operational)	Number of Vessels Used	3	Duration of Operations	73
Impact to Other Users of the Sea (Legacy)	Number of Vessels Used	2	Duration of Operations	71
Potential for High Consequence Events	Low	**Comments**	Routine operations; Minimal lifting; For further details from the HAZID, see Ref. [4].	
Operational Risk Offshore	PLL	2.30E-03		
Operational Risk Diver	PLL	0.00E+00		
Operational Risk Onshore	PLL	3.11E-04		
Legacy Risk	PLL	4.60E-03		
Fishing Risk	PLL	N/A (No increase in risk over and above what currently exists for fishing)		
Overall Risk	**ΣPLL**	**7.22E-03**		

ENVIRONMENTAL				
Marine Impact (Vessels)	**Vessel Type**	**Number off**	**Duration**	**Activity**
	Survey Vessel	1	22	Survey
	Trenching Vessel	1	42	Trench/Backfill
	Trawler	1	9	Trawl Sweep
Marine Impact (Vessel Legacy)	**Vessel Type**	**Number off**	**Duration**	**Activity**
	Survey Vessel (Legacy)	1	66	Survey
	Rock Placement Vessel (Legacy)	1	5	Rock Placement
Vessel Noise	**Parameter**	**dB re 1mP**	**TPa²s**	
	Operational SEL	253.89	24.49	
	Legacy SEL	245.83	3.82	
Equipment Noise (Ops)	**Activity**	**Tool Use (days)**	**dB re 1mP**	**TPa²s**
	Jet Trenching	35.98	229.93	0.098
Energy Use (Total = Ops + Legacy)	**Fuel**	**CO_2**	**NOx**	**SO_2**
	3820 Te	12109.3 Te	225.4 Te	45.8 Te
Life Cycle Emissions (Disposal / Replacement of Material)	**CO_2 (Disposal Ops)**	**CO_2 (Replacement Ops)**		
	0 Te	12,562.8 Te		
Marine Impact (Seabed)	**Activity**	**Area (m^2)**	**Resources**	
	Rock Placement	N/A	N/A	
	MFE	N/A	N/A	
	Trenching	116,339	Trenching Spread	
Materials	**Parameter**	**Weight (Te)**	**Length (m)**	
	Recovered	0.0	0	
	Remaining	6650.5	116,339	
Residuals	**Type**	**Left In-Situ**	**Returned**	
	LSA Scale	Flushed & cleaned, but possible on inner pipe wall	Flushed & cleaned, but possible on inner pipe wall	
	Hydrocarbon	Flushed & cleaned	Flushed & cleaned	
	Control Fluids	N/A	N/A	

TECHNICAL				
Technical Considerations	**Feasibility**	Med	**Concept Maturity**	Low
	Availability of Technology	High - Vessels and equipment available		
	Track Record	Medium - Requirement to trench in congested area, acceptable burial depth may not be achievable. Crossings and debris add to complexity.		
	Risk of Failure	High - Uncertainty surrounding congestion and crossings. Considered challenging to accomplish 0.6m Doc over entire length.		
	Consequence of Failure	Additional rock required / schedule and cost impacts		

SOCIETAL		
Societal Factors	**Commercial Fisheries Impact**	Med - Significant area of short term disturbance
	Socio Economic	Low - No perceived benefit

ECONOMIC								
Economic Considerations	**Comparative Cost Operational**			£10.21	M			
	Comparative Cost Legacy			£3.23	M			
	Project Contingency (30%)			£4.03	M			
	Comparative Cost Total (inc. contingency)			£17.47	M			
Economic Risk	**Cost Risk**	Medium	**Factors**	Considered technically challenging; Geotechnical study required; Trenching works uncertain; May require unplanned additional rock placement; Legacy management required.				

Appendix G.6 Group 3 – Option 3B Data Sheet

Area	Balmoral
Decision / Group	**Group 3: Trenched & Buried Rigid Flowlines**
Option	**Option 3b: Leave In-Situ (Major Intervention) - Full Rock Placement**
Sequence of Works	Perform as-found survey
	Rock placement of entire pipeline lengths (116,339m)
	Perform as-left survey
	Perform trawl sweep of site

ID No.	Type	Material	OD (inches)	Total Length (m)	Total Weight (Te)
218	Oil export	Rigid Steel	14	14,460	1920.8
219	A3 Gas Lift	Rigid Steel	2.375	1,247	11.6
220	A3 Production	Rigid Steel	4.5	1,242	35.1
221	B29 Gas Lift	Rigid Steel	2.375	4,985	46.5
222	B29 Production	Rigid Steel	4.5	4,999	141.3
223	A2 Gas Lift	Rigid Steel	2.375	1,633	15.2
224	A2 Production	Rigid Steel	4.5	1,628	46.0
225	A7z Water Injection	Rigid Steel	6.625	1,763	68.3
226	A10z Water Injection	Rigid Steel	6.625	1,575	61.0
227	B4a Water Injection	Rigid Steel	6.625	5,286	204.7
228	A11 Water Injection	Rigid Steel	6.625	3,261	126.3
229	B14 Water Injection	Rigid Steel	6.625	2,850	110.4
230	A16 Water Injection	Rigid Steel	6.625	2,641	102.3
2565	B29 Production	Rigid Steel	6.625	3,905	213.5
2329	Brenda Production	Rigid Steel	10.75	8,844	720.0
2330	Brenda Gas Lift	Rigid Steel	6.625	8,844	329.0
2350	Nicol Production	Rigid Steel	6.625	9,576	356.0
2351	Nicol Gas Lift	Rigid Steel	3.5	9,583	108.0
638	A26 Production	Rigid Steel	6.625	7,861	621.8
639	A27 Production	Rigid Steel	8.625	6,872	763.7
640	A17z Water Injection	Rigid Steel	8.625	7,536	486.5
980	A27 Service (ex-Blair)	Rigid Steel	4.5	5,798	162.5
			TOTAL	**116,349**	**6,622.9**

SAFETY				
Offshore Personnel	Number	101	Man Hours	38,844
Diver Requirement	Number	0	Man Hours	0
Onshore Personnel	Number	20	Man Hours	4,840
Legacy Risk	Number	96	Man Hours	61,392
Impact to Other Users of the Sea (operational)	Number of Vessels Used	3	Duration of Operations	107
Impact to Other Users of the Sea (Legacy)	Number of Vessels Used	2	Duration of Operations	71
Potential for High Consequence Events	Low	**Comments**	Routine operations; Minimal lifting; For further details from the HAZID, see Ref. [4].	
Operational Risk Offshore	PLL	2.91E-03		
Operational Risk Diver	PLL	0.00E+00		
Operational Risk Onshore	PLL	8.22E-05		
Legacy Risk	PLL	4.60E-03		
Fishing Risk	PLL	N/A (No increase in risk over and above what currently exists for fishing)		
Overall Risk	**ΣPLL**	**7.60E-03**		

ENVIRONMENTAL				
Marine Impact (Vessels)	**Vessel Type**	**Number off**	**Duration**	**Activity**
	Survey Vessel	1	22	Survey
	Rock Placement Vessel	1	76	Rock Placement
	Trawler	1	9	Trawl Sweep
Marine Impact (Vessel Legacy)	**Vessel Type**	**Number off**	**Duration**	**Activity**
	Survey Vessel (Legacy)	1	66	Survey
	Rock Placement Vessel (Legacy)	1	5	Rock Placement
Vessel Noise	**Parameter**	**dB re 1mP**	**TPa²s**	
	Operational SEL	256.52	44.89	
	Legacy SEL	245.83	3.82	
Equipment Noise (Ops)	**Activity**	**Tool Use (days)**	**dB re 1mP**	**TPa²s**
	N/A	N/A	N/A	N/A
Energy Use (Total = Ops + Legacy)	**Fuel**	**CO_2**	**NOx**	**SO_2**
	4406.5 Te	13968.5 Te	260 Te	52.9 Te
Life Cycle Emissions (Disposal / Replacement of Material)	**CO_2 (Disposal Ops)**	**CO_2 (Replacement Ops)**		
	0 Te	12,562.8 Te		
Marine Impact (Seabed)	**Activity**	**Area (m^2)**	**Resources**	
	Rock Placement	581,695	399,901Te of rock placement	
	MFE	N/A	N/A	
	Trenching	N/A	N/A	
Materials	**Parameter**	**Weight (Te)**	**Length (m)**	
	Recovered	0.0	0	
	Remaining	6650.5	116,339	
Residuals	**Type**	**Left In-Situ**	**Returned**	
	LSA Scale	Flushed & cleaned, but possible on inner pipe wall	N/A	
	Hydrocarbon	Flushed & cleaned	N/A	
	Control Fluids	N/A	N/A	

TECHNICAL				
Technical Considerations	**Feasibility**	High	**Concept Maturity**	High
	Availability of Technology	High - Off the shelf		
	Track Record	High - All technical aspects of this option are considered routine operations.		
	Risk of Failure	Low		
	Consequence of Failure	Low - Limited impact		

SOCIETAL		
Societal Factors	**Commercial Fisheries Impact**	High - Significant area permanently lost due to rock placement
	Socio Economic	Low - rock placement procurement, negative transportation impact

ECONOMIC							
Economic Considerations	**Comparative Cost Operational**		£18.21	M			
	Comparative Cost Legacy		£3.23	M			
	Project Contingency (30%)		£6.43	M			
	Comparative Cost Total (inc. contingency)		£27.88	M			
Economic Risk	**Cost Risk**	Medium	**Factors**	High degree of achievability; Potential requirement for additional rock dependent on trawl activity. Responsible for maintenance of significant length of rock berm.			

Appendix G.7 Group 3 – Option 5C Data Sheet

Area	**Balmoral**
Decision / Group	**Group 3: Trenched & Buried Rigid Flowlines**
Option	**Option 5c: Full removal - Deburial & Cut and Lift**
Sequence of Works	Perform as-found survey
	Unbury buried pipeline sections using MFE
	Cut and bundle entire pipeline lengths (116,339m, cut in to 20m sections & bundled in to 6 sections for recover)
	Recover bundles to pipehaul vessel and transit to shore
	Perform as-left survey

ID No.	Type	Material	OD (inches)	Total Length (m)	Total Weight (Te)
218	Oil export	Rigid Steel	14	14,460	1920.8
219	A3 Gas Lift	Rigid Steel	2.375	1,247	11.6
220	A3 Production	Rigid Steel	4.5	1,242	35.1
221	B29 Gas Lift	Rigid Steel	2.375	4,985	46.5
222	B29 Production	Rigid Steel	4.5	4,999	141.3
223	A2 Gas Lift	Rigid Steel	2.375	1,633	15.2
224	A2 Production	Rigid Steel	4.5	1,628	46.0
225	A7z Water Injection	Rigid Steel	6.625	1,763	68.3
226	A10z Water Injection	Rigid Steel	6.625	1,575	61.0
227	B4a Water Injection	Rigid Steel	6.625	5,286	204.7
228	A11 Water Injection	Rigid Steel	6.625	3,261	126.3
229	B14 Water Injection	Rigid Steel	6.625	2,850	110.4
230	A16 Water Injection	Rigid Steel	6.625	2,641	102.3
2565	B29 Production	Rigid Steel	6.625	3,905	213.5
2329	Brenda Production	Rigid Steel	10.75	8,844	720.0
2330	Brenda Gas Lift	Rigid Steel	6.625	8,844	329.0
2350	Nicol Production	Rigid Steel	6.625	9,576	356.0
2351	Nicol Gas Lift	Rigid Steel	3.5	9,583	108.0
638	A26 Production	Rigid Steel	6.625	7,861	621.8
639	A27 Production	Rigid Steel	8.625	6,872	763.7
640	A17z Water Injection	Rigid Steel	8.625	7,536	486.5
980	A27 Service (ex-Blair)	Rigid Steel	4.5	5,798	162.5
			TOTAL	**116,349**	**6,622.9**

SAFETY				
Offshore Personnel	Number	253	Man Hours	245,484
Diver Requirement	Number	3	Man Hours	9,216
Onshore Personnel	Number	20	Man Hours	72,643
Legacy Risk	Number	0	Man Hours	0
Impact to Other Users of the Sea (operational)	Number of Vessels Used	5	Duration of Operations	324
Impact to Other Users of the Sea (Legacy)	Number of Vessels Used	0	Duration of Operations	0
Potential for High Consequence Events	Med	**Comments**	Potential diver works; Extensive subsea operations; Significant lifting required; For further details from the HAZID, see Ref. [4].	
Operational Risk Offshore	PLL	1.62E-02		
Operational Risk Diver	PLL	8.94E-03		
Operational Risk Onshore	PLL	1.23E-03		
Legacy Risk	PLL	0.00E+00		
Fishing Risk	PLL	N/A (No increase in risk over and above what currently exists for fishing)		
Overall Risk	**ΣPLL**	**2.64E-02**		

ENVIRONMENTAL				
Marine Impact (Vessels)	**Vessel Type**	**Number off**	**Duration**	**Activity**
	Survey Vessel	1	22	Survey
	DSV	1	128	Destruct
	CSV	1	102	Unburial / Destruct
	Barge / Pipehaul	1	63	Material Transport
	Trawler	1	9	Trawl Sweep
Marine Impact (Vessel Legacy)	**Vessel Type**	**Number off**	**Duration**	**Activity**
	Survey Vessel (Legacy)	0	0	N/A
	Rock Placement Vessel (Legacy)	0	0	N/A
Vessel Noise	**Parameter**	**dB re 1mP**	**TPa²s**	
	Operational SEL	255.69	37.05	
	Legacy SEL	N/A	N/A	
Equipment Noise (Ops)	**Activity**	**Tool Use (days)**	**dB re 1mP**	**TPa²s**
	MFE	52.14	229.55	0.034
	Cutting	121.2		
Energy Use (Total = Ops + Legacy)	**Fuel**	**CO_2**	**NOx**	**SO_2**
	8410.1 Te	26659.9 Te	496.2 Te	100.9 Te
Life Cycle Emissions (Disposal / Replacement of Material)	**CO_2 (Disposal Ops)**	**CO_2 (Replacement Ops)**		
	6,695.2 Te	0 Te		
Marine Impact (Seabed)	**Activity**	**Area (m^2)**	**Resources**	
	Rock Placement	N/A	N/A	
	MFE	465,356	MFE Spread	
	Trenching	N/A	N/A	
Materials	**Parameter**	**Weight (Te)**	**Length (m)**	
	Recovered	6650.5	116,339	
	Remaining	0.0	0	
Residuals	**Type**	**Left In-Situ**	**Returned**	
	LSA Scale	N/A	Flushed & cleaned, but possible on inner pipe wall	
	Hydrocarbon	N/A	Flushed & cleaned	
	Control Fluids	N/A	N/A	

TECHNICAL				
Technical Considerations	**Feasibility**	Med	**Concept Maturity**	Low
	Availability of Technology	Med - Generally available but may require bespoke tooling for extended operations. Suitable diverless technology limited.		
	Track Record	Low - Routine operation but track record low for cut & lift over extended distance. Low track record of unburial over extended distance		
	Risk of Failure	High - Considered challenging over large distance. May require diver support. Extended subsea works & simultaneous operations.		
	Consequence of Failure	High - Significant risk of schedule / cost overrun. Alternative decommissioning method may be required if failure occurs.		

SOCIETAL		
Societal Factors	**Commercial Fisheries Impact**	Med - Significant area temporarily disturbed
	Socio Economic	Med - Significant volume of material returned to shore

ECONOMIC								
Economic Considerations	**Comparative Cost Operational**			£38.04	M			
	Comparative Cost Legacy			£0.00	M			
	Project Contingency (30%)			£11.41	M			
	Comparative Cost Total (inc. contingency)			£49.46	M			
Economic Risk	**Cost Risk**	High	**Factors**	Considered achievable but concept maturity low at this stage; Increased technical and safety risk associated with extended subsea operations; No legacy management requirement.				

Appendix G.8 Group 4 – Option 1B Data Sheet

Area	Balmoral
Decision / Group	**Group 4: Trenched & Buried Flexibles and Umbilicals**
Option	**Option 1b: Leave In-Situ (Minimal Intervention) - Remove Exposed Ends & Local Rock Placement**
Sequence of Works	Perform as-found survey
	Cut and bundle exposed end sections (400m exposed at central location & 100m exposed at tree)
	Recover bundles to pipehaul vessel and transit to shore
	Rock placement cut ends and midline exposures (23 exposures identified, 421m total exposed midline)
	Perform as-left survey

ID No.	Type	Material	OD (inches)	Total Length (m)	Total Weight (Te)
222A	B29 Production	Composite	4	5,048	109.0
980	A27 Service	Composite	2	2,351	33.9
644	A26 Chemical Injection Umbilical	Composite	~4	7,995	104.0
645	A27 Chemical Injection Umbilical	Composite	~4	7,098	92.5
4356	A17z Control Umbilical	Composite	~4	7,714	82.3
646	A13 Chemical Injection Umbilical	Composite	~4	5,841	76.1
2000	Stirling Production	Composite	7.75	3,798	152.7
2001	Stirling Gas Lift	Composite	4.47	3,824	68.7
2002	SES Control Umbilical	Composite	~4	3,900	15.9
2328	Brenda Control Umbilical	Composite	~6	8,729	278.0
2352	Nicol Control Umbilical	Composite	~4	9,494	128.0
			TOTAL	**65,790**	**1,141.1**

SAFETY				
Offshore Personnel	Number	197	Man Hours	40,944
Diver Requirement	Number	3	Man Hours	1,584
Onshore Personnel	Number	20	Man Hours	10,959
Legacy Risk	Number	96	Man Hours	42,240
Impact to Other Users of the Sea (operational)	Number of Vessels Used	5	Duration of Operations	73
Impact to Other Users of the Sea (Legacy)	Number of Vessels Used	2	Duration of Operations	50
Potential for High Consequence Events	Low	**Comments**	Routine operations; Minimal lifting; For further details from the HAZID, see Ref. [4].	
Operational Risk Offshore	PLL	2.97E-03		
Operational Risk Diver	PLL	1.54E-03		
Operational Risk Onshore	PLL	1.69E-04		
Legacy Risk	PLL	3.17E-03		
Fishing Risk	PLL	N/A (No increase in risk over and above what currently exists for fishing)		
Overall Risk	**ΣPLL**	**7.84E-03**		

ENVIRONMENTAL				
Marine Impact (Vessels)	**Vessel Type**	**Number off**	**Duration**	**Activity**
	Survey Vessel	1	15	Survey
	Rock Placement Vessel	1	7	Rock Placement
	DSV	1	22	Destruct
	Barge / Pipehaul	1	21	Material Transport
	Trawler	1	8	Trawl Sweep
Marine Impact (Vessel Legacy)	**Vessel Type**	**Number off**	**Duration**	**Activity**
	Survey Vessel (Legacy)	1	45	Survey
	Rock Placement Vessel (Legacy)	1	5	Rock Placement
Vessel Noise	**Parameter**	**dB re 1mP**	**TPa²s**	
	Operational SEL	247.04	5.06	
	Legacy SEL	245.42	3.48	
Equipment Noise (Ops)	**Activity**	**Tool Use (days)**	**dB re 1mP**	**TPa²s**
	Cutting	11.92	215.13	0.003
Energy Use (Total = Ops + Legacy)	**Fuel**	**CO_2**	**NOx**	**SO_2**
	3537 Te	11212.1 Te	208.7 Te	42.4 Te
Life Cycle Emissions (Disposal / Replacement of Material)	**CO_2 (Disposal Ops)**	**CO_2 (Replacement Ops)**		
	90.0 Te	1,570.6 Te		
Marine Impact (Seabed)	**Activity**	**Area (m^2)**	**Resources**	
	Rock Placement	2,875	2036Te of rock placement	
	MFE	N/A	N/A	
	Trenching	N/A	N/A	
Materials	**Parameter**	**Weight (Te)**	**Length (m)**	
	Recovered	112.0	9,875	
	Remaining	1029.1	55,956	
Residuals	**Type**	**Left In-Situ**	**Returned**	
	LSA Scale	Flushed & cleaned, but possible in flexible carcass / annulus	Flushed & cleaned, but possible in flexible carcass / annulus	
	Hydrocarbon	Flushed & cleaned, but possible in flexible carcass / annulus	Flushed & cleaned, but possible in flexible carcass / annulus	
	Control Fluids	Flushed & cleaned	Flushed & cleaned	

TECHNICAL				
Technical Considerations	**Feasibility**	High	**Concept Maturity**	High
	Availability of Technology	High - Off the shelf		
	Track Record	High - All technical aspects of this option are considered routine operations.		
	Risk of Failure	Low		
	Consequence of Failure	Low - Limited impact of failure		

SOCIETAL		
Societal Factors	**Commercial Fisheries Impact**	Med - Limited area permanently lost due to rock placement
	Socio Economic	Med - Minor benefits due to returned material

ECONOMIC								
Economic Considerations	**Comparative Cost Operational**			£7.89	M			
	Comparative Cost Legacy			£2.03	M			
	Project Contingency (30%)			£2.98	M			
	Comparative Cost Total (inc. contingency)			£12.91	M			
Economic Risk	**Cost Risk**	Low	**Factors**	High degree of achievability; Potential requirement for additional rock dependent on trawl activity.				

Appendix G.9 Group 4 – Option 2A Data Sheet

Area	Balmoral
Decision / Group	**Group 4: Trenched & Buried Flexibles and Umbilicals**
Option	**Option 2a: Leave In-Situ (Minor Intervention) - Remove Exposed Ends / Midline Exposures & Rock Placement**
Sequence of Works	Perform as-found survey
	Cut and bundle exposed end sections and midline exposures (400m exposed at central location & 100m exposed at tree)
	Recover bundles to pipehaul vessel and transit to shore
	Rock placement all cut ends (22 pipeline ends + 23 midline exposures, therefore 68 cut ends)
	Perform as-left survey

ID No.	Type	Material	OD (inches)	Total Length (m)	Total Weight (Te)
222A	B29 Production	Composite	4	5,048	109.0
980	A27 Service	Composite	2	2,351	33.9
644	A26 Chemical Injection Umbilical	Composite	~4	7,995	104.0
645	A27 Chemical Injection Umbilical	Composite	~4	7,098	92.5
4356	A17z Control Umbilical	Composite	~4	7,714	82.3
646	A13 Chemical Injection Umbilical	Composite	~4	5,841	76.1
2000	Stirling Production	Composite	7.75	3,798	152.7
2001	Stirling Gas Lift	Composite	4.47	3,824	68.7
2002	SES Control Umbilical	Composite	~4	3,900	15.9
2328	Brenda Control Umbilical	Composite	~6	8,729	278.0
2352	Nicol Control Umbilical	Composite	~4	9,494	128.0
			TOTAL	**65,790**	**1,141.1**

SAFETY				
Offshore Personnel	Number	197	Man Hours	44,640
Diver Requirement	Number	3	Man Hours	1,800
Onshore Personnel	Number	20	Man Hours	12,239
Legacy Risk	Number	96	Man Hours	42,240
Impact to Other Users of the Sea (operational)	Number of Vessels Used	5	Duration of Operations	80
Impact to Other Users of the Sea (Legacy)	Number of Vessels Used	2	Duration of Operations	50
Potential for High Consequence Events	Low	**Comments**	Routine operations; Minimal lifting; For further details from the HAZID, see Ref. [4].	
Operational Risk Offshore	PLL	3.23E-03		
Operational Risk Diver	PLL	1.75E-03		
Operational Risk Onshore	PLL	1.90E-04		
Legacy Risk	PLL	3.17E-03		
Fishing Risk	PLL	N/A (No increase in risk over and above what currently exists for fishing)		
Overall Risk	**ΣPLL**	**8.34E-03**		

ENVIRONMENTAL				
Marine Impact (Vessels)	**Vessel Type**	**Number off**	**Duration**	**Activity**
	Survey Vessel	1	15	Survey
	Rock Placement Vessel	1	8	Rock Placement
	DSV	1	25	Destruct
	Barge / Pipehaul	1	24	Material Transport
	Trawler	1	8	Trawl Sweep
Marine Impact (Vessel Legacy)	**Vessel Type**	**Number off**	**Duration**	**Activity**
	Survey Vessel (Legacy)	1	45	Survey
	Rock Placement Vessel (Legacy)	1	5	Rock Placement
Vessel Noise	**Parameter**	**dB re 1mP**	**TPa²s**	
	Operational SEL	247.82	6.05	
	Legacy SEL	245.42	3.48	
Equipment Noise (Ops)	**Activity**	**Tool Use (days)**	**dB re 1mP**	**TPa²s**
	Cutting	13.30	215.60	0.004
Energy Use (Total = Ops + Legacy)	**Fuel**	**CO_2**	**NOx**	**SO_2**
	3711.3 Te	11764.7 Te	219 Te	44.5 Te
Life Cycle Emissions (Disposal / Replacement of Material)	**CO_2 (Disposal Ops)**	**CO_2 (Replacement Ops)**		
	90.1 Te	1,561.1 Te		
Marine Impact (Seabed)	**Activity**	**Area (m^2)**	**Resources**	
	Rock Placement	2,380	1700Te of rock placement	
	MFE	N/A	N/A	
	Trenching	N/A	N/A	
Materials	**Parameter**	**Weight (Te)**	**Length (m)**	
	Recovered	118.0	10,296	
	Remaining	1023.1	55,535	
Residuals	**Type**	**Left In-Situ**	**Returned**	
	LSA Scale	Flushed & cleaned, but possible in flexible carcass / annulus	Flushed & cleaned, but possible in flexible carcass / annulus	
	Hydrocarbon	Flushed & cleaned, but possible in flexible carcass / annulus	Flushed & cleaned, but possible in flexible carcass / annulus	
	Control Fluids	Flushed & cleaned	Flushed & cleaned	

TECHNICAL					
Technical Considerations	**Feasibility**	High	**Concept Maturity**	High	
	Availability of Technology	High - Off the shelf			
	Track Record	High - All technical aspects of this option are considered routine operations.			
	Risk of Failure	Low			
	Consequence of Failure	Low - Limited impact of failure			

SOCIETAL		
Societal Factors	**Commercial Fisheries Impact**	Med - Limited area permanently lost due to rock placement
	Socio Economic	Med - Minor benefits due to returned material

ECONOMIC								
Economic Considerations	**Comparative Cost Operational**			£8.55	M			
	Comparative Cost Legacy			£2.03	M			
	Project Contingency (30%)			£3.18	M			
	Comparative Cost Total (inc. contingency)			£13.76	M			
Economic Risk	**Cost Risk**	Low	**Factors**	High degree of achievability; Potential requirement for additional rock dependent on trawl activity.				

Appendix G.10 Group 4 – Option 3A Data Sheet

Area	Balmoral
Decision / Group	**Group 4: Trenched & Buried Flexibles and Umblicals**
Option	**Option 3a: Leave In-Situ - Retrench the entire line (Major Intervention)**
Sequence of Works	Perform as-found survey
	Cut flexibles and umbilicals at either end
	Re-trench and bury entire length (65,830m)
	Perform as-left survey
	Perform trawl sweep of site

ID No.	Type	Material	OD (inches)	Total Length (m)	Total Weight (Te)
222A	B29 Production	Composite	4	5,048	109.0
980	A27 Service	Composite	2	2,351	33.9
644	A26 Chemical Injection Umbilical	Composite	~4	7,995	104.0
645	A27 Chemical Injection Umbilical	Composite	~4	7,098	92.5
4356	A17z Control Umbilical	Composite	~4	7,714	82.3
646	A13 Chemical Injection Umbilical	Composite	~4	5,841	76.1
2000	Stirling Production	Composite	7.75	3,798	152.7
2001	Stirling Gas Lift	Composite	4.47	3,824	68.7
2002	SES Control Umbilical	Composite	~4	3,900	15.9
2328	Brenda Control Umbilical	Composite	~6	8,729	278.0
2352	Nicol Control Umbilical	Composite	~4	9,494	128.0
			TOTAL	**65,790**	**1,141.1**

SAFETY				
Offshore Personnel	Number	101	Man Hours	20,160
Diver Requirement	Number	0	Man Hours	0
Onshore Personnel	Number	20	Man Hours	11,954
Legacy Risk	Number	96	Man Hours	42,240
Impact to Other Users of the Sea (operational)	Number of Vessels Used	3	Duration of Operations	48
Impact to Other Users of the Sea (Legacy)	Number of Vessels Used	2	Duration of Operations	50
Potential for High Consequence Events	Low	**Comments**	Routine operations; Minimal lifting; For further details from the HAZID, see Ref. [4].	
Operational Risk Offshore	PLL	1.51E-03		
Operational Risk Diver	PLL	0.00E+00		
Operational Risk Onshore	PLL	1.86E-04		
Legacy Risk	PLL	3.17E-03		
Fishing Risk	PLL	N/A (No increase in risk over and above what currently exists for fishing)		
Overall Risk	**ΣPLL**	**4.87E-03**		

ENVIRONMENTAL				
Marine Impact (Vessels)	**Vessel Type**	**Number off**	**Duration**	**Activity**
	Survey Vessel	1	15	Survey
	Trenching Vessel	1	25	Trench/Backfill
	Trawler	1	8	Trawl Sweep
Marine Impact (Vessel Legacy)	**Vessel Type**	**Number off**	**Duration**	**Activity**
	Survey Vessel (Legacy)	1	45	Survey
	Rock Placement Vessel (Legacy)	1	5	Rock Placement
Vessel Noise	**Parameter**	**dB re 1mP**	**TPa²s**	
	Operational SEL	250.67	11.66	
	Legacy SEL	245.42	3.48	
Equipment Noise (Ops)	**Activity**	**Tool Use (days)**	**dB re 1mP**	**TPa²s**
	Jet Trenching	20.12	227.40	0.055
Energy Use (Total = Ops + Legacy)	**Fuel**	**CO_2**	**NOx**	**SO_2**
	2622.2 Te	8312.4 Te	154.7 Te	31.5 Te
Life Cycle Emissions (Disposal / Replacement of Material)	**CO_2 (Disposal Ops)**	**CO_2 (Replacement Ops)**		
	0 Te	1,741.2 Te		
Marine Impact (Seabed)	**Activity**	**Area (m^2)**	**Resources**	
	Rock Placement	N/A	N/A	
	MFE	N/A	N/A	
	Trenching	65,830	Trenching Spread	
Materials	**Parameter**	**Weight (Te)**	**Length (m)**	
	Recovered	0.0	0	
	Remaining	1,141.1	65,830	
Residuals	**Type**	**Left In-Situ**	**Returned**	
	LSA Scale	Flushed & cleaned, but possible in flexible carcass / annulus	N/A	
	Hydrocarbon	Flushed & cleaned, but possible in flexible carcass / annulus	N/A	
	Control Fluids	Flushed & cleaned	N/A	

TECHNICAL				
Technical Considerations	**Feasibility**	Med	**Concept Maturity**	Low
	Availability of Technology	High - Vessels and equipment available		
	Track Record	Medium - Requirement to trench in congested area, acceptable burial depth may not be achievable. Crossings and debris add to complexity.		
	Risk of Failure	High - Uncertainty surrounding congestion and crossings. Considered challenging to accomplish 0.6m Doc over entire length.		
	Consequence of Failure	Additional rock required / schedule and cost impacts		

SOCIETAL		
Societal Factors	**Commercial Fisheries Impact**	Med - Significant area of short term disturbance
	Socio Economic	Low - No perceived benefit

ECONOMIC								
Economic Considerations	**Comparative Cost Operational**			£8.35	M			
	Comparative Cost Legacy			£2.03	M			
	Project Contingency (30%)			£3.11	M			
	Comparative Cost Total (inc. contingency)			£13.49	M			
Economic Risk	**Cost Risk**	Medium	**Factors**	Considered technically challenging; Geotechnical study required; Trenching works uncertain; May require unplanned additional rock placement; Legacy management required.				

Appendix G.11 Group 4 – Option 3B Data Sheet

Area	Balmoral
Decision / Group	**Group 4: Trenched & Buried Flexibles and Umbilicals**
Option	**Option 3b: Leave In-Situ (Major Intervention) - Rock Placement the entire line**
Sequence of Works	Perform as-found survey
	Rock placement entire length (65,830m)
	Perform as-left survey
	Perform trawl sweep of site

ID No.	Type	Material	OD (inches)	Total Length (m)	Total Weight (Te)
222A	B29 Production	Composite	4	5,048	109.0
980	A27 Service	Composite	2	2,351	33.9
644	A26 Chemical Injection Umbilical	Composite	~4	7,995	104.0
645	A27 Chemical Injection Umbilical	Composite	~4	7,098	92.5
4356	A17z Control Umbilical	Composite	~4	7,714	82.3
646	A13 Chemical Injection Umbilical	Composite	~4	5,841	76.1
2000	Stirling Production	Composite	7.75	3,798	152.7
2001	Stirling Gas Lift	Composite	4.47	3,824	68.7
2002	SES Control Umbilical	Composite	~4	3,900	15.9
2328	Brenda Control Umbilical	Composite	~6	8,729	278.0
2352	Nicol Control Umbilical	Composite	~4	9,494	128.0
			TOTAL	**65,790**	**1,141.1**

SAFETY				
Offshore Personnel	Number	101	Man Hours	25,200
Diver Requirement	Number	0	Man Hours	0
Onshore Personnel	Number	20	Man Hours	6,332
Legacy Risk	Number	96	Man Hours	42,240
Impact to Other Users of the Sea (operational)	Number of Vessels Used	3	Duration of Operations	69
Impact to Other Users of the Sea (Legacy)	Number of Vessels Used	2	Duration of Operations	50
Potential for High Consequence Events	Low	**Comments**	Routine operations; Minimal lifting; For further details from the HAZID, see Ref. [4].	
Operational Risk Offshore	PLL	1.89E-03		
Operational Risk Diver	PLL	0.00E+00		
Operational Risk Onshore	PLL	2.86E-04		
Legacy Risk	PLL	3.17E-03		
Fishing Risk	PLL	N/A (No increase in risk over and above what currently exists for fishing)		
Overall Risk	**ΣPLL**	**5.34E-03**		

ENVIRONMENTAL				
Marine Impact (Vessels)	**Vessel Type**	**Number off**	**Duration**	**Activity**
	Survey Vessel	1	15	Survey
	Rock Placement Vessel	1	46	Rock Placement
	Trawler	1	8	Trawl Sweep
Marine Impact (Vessel Legacy)	**Vessel Type**	**Number off**	**Duration**	**Activity**
	Survey Vessel (Legacy)	1	45	Survey
	Rock Placement Vessel (Legacy)	1	5	Rock Placement
Vessel Noise	**Parameter**	**dB re 1mP**	**TPa²s**	
	Operational SEL	253.14	20.59	
	Legacy SEL	245.42	3.48	
Equipment Noise (Ops)	**Activity**	**Tool Use (days)**	**dB re 1mP**	**TPa²s**
	N/A	N/A	N/A	N/A
Energy Use (Total = Ops + Legacy)	**Fuel**	**CO_2**	**NOx**	**SO_2**
	2984.5 Te	9460.7 Te	176.1 Te	35.8 Te
Life Cycle Emissions (Disposal / Replacement of Material)	**CO_2 (Disposal Ops)**	**CO_2 (Replacement Ops)**		
	0 Te	1,741.2 Te		
Marine Impact (Seabed)	**Activity**	**Area (m^2)**	**Resources**	
	Rock Placement	329,150	232380Te of rock placement	
	MFE	N/A	N/A	
	Trenching	N/A	N/A	
Materials	**Parameter**	**Weight (Te)**	**Length (m)**	
	Recovered	0.0	0	
	Remaining	1141.1	65,830	
Residuals	**Type**	**Left In-Situ**	**Returned**	
	LSA Scale	Flushed & cleaned, but possible in flexible carcass / annulus	N/A	
	Hydrocarbon	Flushed & cleaned, but possible in flexible carcass / annulus	N/A	
	Control Fluids	Flushed & cleaned	N/A	

TECHNICAL				
Technical Considerations	**Feasibility**	High	**Concept Maturity**	High
	Availability of Technology	High - Off the shelf		
	Track Record	High - All technical aspects of this option are considered routine operations.		
	Risk of Failure	Low		
	Consequence of Failure	Low - Limited impact of failure		

SOCIETAL		
Societal Factors	**Commercial Fisheries Impact**	High - Significant area permanently lost due to rock placement
	Socio Economic	Low - rock placement procurement, negative transportation impact

ECONOMIC								
Economic Considerations	**Comparative Cost Operational**			£13.53	M			
	Comparative Cost Legacy			£2.03	M			
	Project Contingency (30%)			£4.67	M			
	Comparative Cost Total (inc. contingency)			£20.23	M			
Economic Risk	**Cost Risk**	Medium	**Factors**	High degree of achievability; Potential requirement for additional rock dependent on trawl activity; Responsible for maintenance of significant length of rock berm.				

Appendix G.12 Group 4 – Option 5A Data Sheet

Area	Balmoral
Decision / Group	**Group 4: Trenched & Buried Flexibles and Umbilicals**
Option	**Option 5a: Full Removal - Deburial and Reverse Reel**
Sequence of Works	Perform as-found survey
	Unbury buried flexible and umbilical sections using MFE
	Disconnect / cut flexibles, umbilicals and cables at either end and lay aside
	Reverse reel flexibles, umbilicals and cables (65,830m)
	Perform as-left survey

ID No.	Type	Material	OD (inches)	Total Length (m)	Total Weight (Te)
222A	B29 Production	Composite	4	5,048	109.0
980	A27 Service	Composite	2	2,351	33.9
644	A26 Chemical Injection Umbilical	Composite	~4	7,995	104.0
645	A27 Chemical Injection Umbilical	Composite	~4	7,098	92.5
4356	A17z Control Umbilical	Composite	~4	7,714	82.3
646	A13 Chemical Injection Umbilical	Composite	~4	5,841	76.1
2000	Stirling Production	Composite	7.75	3,798	152.7
2001	Stirling Gas Lift	Composite	4.47	3,824	68.7
2002	SES Control Umbilical	Composite	~4	3,900	15.9
2328	Brenda Control Umbilical	Composite	~6	8,729	278.0
2352	Nicol Control Umbilical	Composite	~4	9,494	128.0
			TOTAL	**65,790**	**1,141.1**

SAFETY				
Offshore Personnel	Number	233	Man Hours	66,144
Diver Requirement	Number	0	Man Hours	0
Onshore Personnel	Number	20	Man Hours	17,146
Legacy Risk	Number	0	Man Hours	0
Impact to Other Users of the Sea (operational)	Number of Vessels Used	4	Duration of Operations	80
Impact to Other Users of the Sea (Legacy)	Number of Vessels Used	0	Duration of Operations	0
Potential for High Consequence Events	Low	**Comments**	Integrity assumed by engineering only; Minimal lifting; For further details from the HAZID, see Ref. [4].	
Operational Risk Offshore	PLL	4.34E-03		
Operational Risk Diver	PLL	0.00E+00		
Operational Risk Onshore	PLL	2.97E-04		
Legacy Risk	PLL	0.00E+00		
Fishing Risk	PLL	N/A (No increase in risk over and above what currently exists for fishing)		
Overall Risk	**ΣPLL**	**4.64E-03**		

ENVIRONMENTAL				
Marine Impact (Vessels)	**Vessel Type**	**Number off**	**Duration**	**Activity**
	Survey Vessel	1	15	Survey
	CSV	1	34	Unburial / Destruct
	Reel Vessel	1	23	Reverse Reeling
	Trawler	1	8	Trawl Sweep
Marine Impact (Vessel Legacy)	**Vessel Type**	**Number off**	**Duration**	**Activity**
	Survey Vessel (Legacy)	0	0	N/A
	Rock Placement Vessel (Legacy)	0	0	N/A
Vessel Noise	**Parameter**	**dB re 1mP**	**TPa²s**	
	Operational SEL	251.91	15.52	
	Legacy SEL	N/A	N/A	
Equipment Noise (Ops)	**Activity**	**Tool Use (days)**	**dB re 1mP**	**TPa²s**
	MFE	27.43	225.75	0.038
Energy Use (Total = Ops + Legacy)	**Fuel**	**CO_2**	**NOx**	**SO_2**
	2615.2 Te	8290.2 Te	154.3 Te	31.4 Te
Life Cycle Emissions (Disposal / Replacement of Material)	**CO_2 (Disposal Ops)**	**CO_2 (Replacement Ops)**		
	477.2 Te	0.0 Te		
Marine Impact (Seabed)	**Activity**	**Area (m^2)**	**Resources**	
	Rock Placement	N/A	N/A	
	MFE	263,320	MFE Spread	
	Trenching	N/A	N/A	
Materials	**Parameter**	**Weight (Te)**	**Length (m)**	
	Recovered	1141.1	65,830	
	Remaining	0.0	0	
Residuals	**Type**	**Left In-Situ**	**Returned**	
	LSA Scale	N/A	Flushed & cleaned, but possible in flexible carcass / annulus	
	Hydrocarbon	N/A	Flushed & cleaned, but possible in flexible carcass / annulus	
	Control Fluids	N/A	Flushed & cleaned	

TECHNICAL				
Technical Considerations	**Feasibility**	Med	**Concept Maturity**	Med
	Availability of Technology	Med - Limited existing techniques for de-burial over extended distances		
	Track Record	Low – Limited experience of exposing pipelines over extended distances to enable re-reeling. Reeling is a routine installation operation. Recent decommissioning of the Staffa Field utilised reverse reeling.		
	Risk of Failure	High		
	Consequence of Failure	Alternate de-burial techniques / Alternate recovery techniques / additional rock placement / schedule & cost impact		

SOCIETAL		
Societal Factors	**Commercial Fisheries Impact**	High - Significant area temporarily disturbed
	Socio Economic	Med - Significant volume of material returned to shore

ECONOMIC								
Economic Considerations	**Comparative Cost Operational**			£11.09	M			
	Comparative Cost Legacy			£0.00	M			
	Project Contingency (30%)			£3.33	M			
	Comparative Cost Total (inc. contingency)			£14.41	M			
Economic Risk	**Cost Risk**	High	**Factors**	Medium degree of achievability; High likelihood of failure to expose the line fully without multiple de-burial techniques and passes; Opportunity to remove unburial works if engineering study confirms integrity of buried flexibles / umbilicals; No legacy management required.				

Appendix G.13 Group 4 – Option 5C Data Sheet

Area	Balmoral
Decision / Group	**Group 4: Trenched & Buried Flexibles and Umbilicals**
Option	**Option 5c: Full Removal - Deburial, Cut and Lift**
Sequence of Works	Perform as-found survey
	Unbury buried flexible and umbilical sections using MFE
	Cut and bundle entire flexible and umbilical lengths (65,830m, cut in to 20m sections & bundled in to 6 for recover)
	Recover bundles to pipehaul vessel and transit to shore
	Perform as-left survey

ID No.	Type	Material	OD (inches)	Total Length (m)	Total Weight (Te)
222A	B29 Production	Composite	4	5,048	109.0
980	A27 Service	Composite	2	2,351	33.9
644	A26 Chemical Injection Umbilical	Composite	~4	7,995	104.0
645	A27 Chemical Injection Umbilical	Composite	~4	7,098	92.5
4356	A17z Control Umbilical	Composite	~4	7,714	82.3
646	A13 Chemical Injection Umbilical	Composite	~4	5,841	76.1
2000	Stirling Production	Composite	7.75	3,798	152.7
2001	Stirling Gas Lift	Composite	4.47	3,824	68.7
2002	SES Control Umbilical	Composite	~4	3,900	15.9
2328	Brenda Control Umbilical	Composite	~6	8,729	278.0
2352	Nicol Control Umbilical	Composite	~4	9,494	128.0
			TOTAL	**65,790**	**1,141.1**

SAFETY				
Offshore Personnel	Number	253	Man Hours	150,048
Diver Requirement	Number	3	Man Hours	5,472
Onshore Personnel	Number	20	Man Hours	44,980
Legacy Risk	Number	0	Man Hours	0
Impact to Other Users of the Sea (operational)	Number of Vessels Used	5	Duration of Operations	200
Impact to Other Users of the Sea (Legacy)	Number of Vessels Used	0	Duration of Operations	0
Potential for High Consequence Events	Med	**Comments**	Potential diver works; Extensive subsea operations; Significant lifting required; For further details from the HAZID, see Ref. [4].	
Operational Risk Offshore	PLL	9.92E-03		
Operational Risk Diver	PLL	5.31E-03		
Operational Risk Onshore	PLL	6.46E-04		
Legacy Risk	PLL	0.00E+00		
Fishing Risk	PLL	N/A (No increase in risk over and above what currently exists for fishing)		
Overall Risk	**ΣPLL**	**1.59E-02**		

ENVIRONMENTAL				
Marine Impact (Vessels)	**Vessel Type**	**Number off**	**Duration**	**Activity**
	Survey Vessel	1	15	Survey
	DSV	1	76	Destruct
	CSV	1	63	Unburial / Destruct
	Barge / Pipehaul	1	38	Material Transport
	Trawler	1	8	Trawl Sweep
Marine Impact (Vessel Legacy)	**Vessel Type**	**Number off**	**Duration**	**Activity**
	Survey Vessel (Legacy)	0	0	N/A
	Rock Placement Vessel (Legacy)	0	0	N/A
Vessel Noise	**Parameter**	**dB re 1mP**	**TPa²s**	
	Operational SEL	252.29	16.93	
	Legacy SEL	N/A	N/A	
Equipment Noise (Ops)	**Activity**	**Tool Use (days)**	**dB re 1mP**	**TPa²s**
	Cutting	68.57	227.5	0.056
	MFE	27.43		
Energy Use (Total = Ops + Legacy)	**Fuel**	**CO_2**	**NOx**	**SO_2**
	5239.4 Te	16608.7 Te	309.1 Te	62.9 Te
Life Cycle Emissions (Disposal / Replacement of Material)	**CO_2 (Disposal Ops)**	**CO_2 (Replacement Ops)**		
	912.7 Te	0.0 Te		
Marine Impact (Seabed)	**Activity**	**Area (m^2)**	**Resources**	
	Rock Placement	N/A	N/A	
	MFE	263,320	MFE Spread	
	Trenching	N/A	N/A	
Materials	**Parameter**	**Weight (Te)**	**Length (m)**	
	Recovered	1141.1	65,830	
	Remaining	0.0	0	
Residuals	**Type**	**Left In-Situ**	**Returned**	
	LSA Scale	N/A	Flushed & cleaned, but possible in flexible carcass / annulus	
	Hydrocarbon	N/A	Flushed & cleaned, but possible in flexible carcass / annulus	
	Control Fluids	N/A	Flushed & cleaned	

TECHNICAL				
Technical Considerations	**Feasibility**	Med	**Concept Maturity**	Low
	Availability of Technology	Med - Generally available but may require bespoke tooling for extended operations. Suitable diverless technology limited.		
	Track Record	Low - Routine operation but track record low for cut & lift over extended distance. Low track record of unburial over extended distance		
	Risk of Failure	High - Considered challenging over large distance. May require diver support. Extended subsea works & simultaneous operations.		
	Consequence of Failure	High - Significant risk of schedule / cost overrun. Alternative decommissioning method may be required if failure occurs.		

SOCIETAL		
Societal Factors	**Commercial Fisheries Impact**	Med - Significant area temporarily disturbed
	Socio Economic	Med - Significant volume of material returned to shore

ECONOMIC							
Economic Considerations	**Comparative Cost Operational**			£26.03	M		
	Comparative Cost Legacy			£0.00	M		
	Project Contingency (30%)			£7.81	M		
	Comparative Cost Total (inc. contingency)			£33.84	M		
Economic Risk	**Cost Risk**	High	**Factors**	Considered achievable but concept maturity low at this stage; High likelihood of failure to expose the line fully without multiple de-burial techniques and passes; Increased technical and safety risk associated with extended subsea operations; No legacy management requirement.			

Appendix G.14 Group 14 – Option 2A Data Sheet

Area	Balmoral
Decision / Group	**Group 14: Mattresses (Other)**
Option	**Option 2a: Leave In-Situ (Minor Intervention) - Rock Placement**
Sequence of Works	Rock placement over mattresses
	Perform trawl sweep of site

ID No.	Type	Material	Size (m)	Number	Total Weight (Te)	Status
218	Concrete Mattress	Concrete	4x5	5	25	Difficult to recover
219 / 220	Concrete Mattress	Concrete	5x2x0.15	4	20	Difficult to recover
221 / 222	Concrete Mattress	Concrete	4x5	16	80	Difficult to recover
638	Concrete Mattress	Concrete	10x2x0.15	2	20	Difficult to recover
640	Concrete Mattress	Concrete	10x2x0.15	2	20	Difficult to recover
646	Concrete Mattress	Concrete	5x2x0.15	2	10	
980	Concrete Mattress	Concrete	5x2x0.15 & 10x2x0.15	48	260	Difficult to recover
644	Concrete Mattress	Concrete	10x2x0.15	1	10	Difficult to recover
			TOTAL	**79**	**445**	

SAFETY				
Offshore Personnel	Number	25	Man Hours	1,980
Diver Requirement	Number	0	Man Hours	0
Onshore Personnel	Number	20	Man Hours	695
Legacy Risk	Number	96	Man Hours	28,560
Impact to Other Users of the Sea (operational)	Number of Vessels Used	2	Duration of Operations	15
Impact to Other Users of the Sea (Legacy)	Number of Vessels Used	2	Duration of Operations	35
Potential for High Consequence Events	Low	**Comments**	Routine operations; Minimal lifting; For further details from the HAZID, see Ref. [4].	
Operational Risk Offshore	PLL	1.49E-04		
Operational Risk Diver	PLL	0.00E+00		
Operational Risk Onshore	PLL	5.42E-05		
Legacy Risk	PLL	2.14E-03		
Fishing Risk	PLL	N/A (No increase in risk over and above what currently exists for fishing)		
Overall Risk	**ΣPLL**	**2.34E-03**		

ENVIRONMENTAL				
Marine Impact (Vessels)	**Vessel Type**	**Number off**	**Duration**	**Activity**
	Rock Placement Vessel	1	6	Rock Placement
	Trawler	1	9	Trawl Sweep
Marine Impact (Vessel Legacy)	**Vessel Type**	**Number off**	**Duration**	**Activity**
	Survey Vessel (Legacy)	1	30	Survey
	Rock Placement Vessel (Legacy)	1	5	Rock Placement
Vessel Noise	**Parameter**	**dB re 1mP**	**TPa²s**	
	Operational SEL	242	1.56	
	Legacy SEL	229	0.09	
Equipment Noise (Ops)	**Activity**	**Tool Use (days)**	**dB re 1mP**	**TPa²s**
	N/A	N/A	N/A	N/A
Energy Use (Total = Ops + Legacy)	**Fuel**	**CO_2**	**NOx**	**SO_2**
	1288 Te	4081.3 Te	76 Te	15.4 Te
Life Cycle Emissions (Disposal / Replacement of Material)	**CO_2 (Disposal Ops)**	**CO_2 (Replacement Ops)**		
	0.0 Te	391.6 Te		
Marine Impact (Seabed)	**Activity**	**Area (m^2)**	**Resources**	
	Rock Placement	5,632	3,511 Te of rock placement	
	MFE	N/A	N/A	
	Trenching	N/A	N/A	
Materials	**Parameter**	**Weight (Te)**	**Length (m)**	
	Recovered	0.0	N/A	
	Remaining	405.0	N/A	
Residuals	**Type**	**Left In-Situ**	**Returned**	
	LSA Scale	N/A	N/A	
	Hydrocarbon	N/A	N/A	
	Control Fluids	N/A	N/A	

TECHNICAL				
Technical Considerations	**Feasibility**	High	**Concept Maturity**	High
	Availability of Technology	High - Off the shelf		
	Track Record	High - All technical aspects of this option are considered routine operations.		
	Risk of Failure	Low		
	Consequence of Failure	Low - Additional rock required		

SOCIETAL		
Societal Factors	**Commercial Fisheries Impact**	Med - Reasonable area of fishing ground permanently lost
	Socio Economic	Low - No material returned to shore

ECONOMIC								
Economic Considerations	**Comparative Cost Operational**			£1.08	M			
	Comparative Cost Legacy			£1.30	M			
	Project Contingency (30%)			£0.71	M			
	Comparative Cost Total (inc. contingency)			£3.09	M			
Economic Risk	**Cost Risk**	Low	**Factors**	High degree of achievability; Long term liability				

Appendix G.15 Group 14 – Option 3A Data Sheet

Area	Balmoral
Decision / Group	**Group 14: Mattresses (Other)**
Option	**Option 3a: Leave In-Situ (Major Intervention) - Burial**
Sequence of Works	Sink / bury mattresses using emerging technology
	Perform trawl sweep of site

ID No.	Type	Material	Size (m)	Number	Total Weight (Te)	Status
218	Concrete Mattress	Concrete	4x5	5	25	Difficult to recover
219 / 220	Concrete Mattress	Concrete	5x2x0.15	4	20	Difficult to recover
221 / 222	Concrete Mattress	Concrete	4x5	16	80	Difficult to recover
638	Concrete Mattress	Concrete	10x2x0.15	2	20	Difficult to recover
640	Concrete Mattress	Concrete	10x2x0.15	2	20	Difficult to recover
646	Concrete Mattress	Concrete	5x2x0.15	2	10	
980	Concrete Mattress	Concrete	5x2x0.15 & 10x2x0.15	48	260	Difficult to recover
644	Concrete Mattress	Concrete	10x2x0.15	1	10	Difficult to recover
			TOTAL	**79**	**445**	

SAFETY				
Offshore Personnel	Number	81	Man Hours	15,132
Diver Requirement	Number	3	Man Hours	1,152
Onshore Personnel	Number	20	Man Hours	6,239
Legacy Risk	Number	96	Man Hours	28,560
Impact to Other Users of the Sea (operational)	Number of Vessels Used	2	Duration of Operations	25
Impact to Other Users of the Sea (Legacy)	Number of Vessels Used	2	Duration of Operations	35
Potential for High Consequence Events	Low	**Comments**	Minimal lifting; For further details from the HAZID, see Ref. [4].	
Operational Risk Offshore	PLL	1.13E-03		
Operational Risk Diver	PLL	1.12E-03		
Operational Risk Onshore	PLL	1.15E-04		
Legacy Risk	PLL	2.14E-03		
Fishing Risk	PLL	N/A (No increase in risk over and above what currently exists for fishing)		
Overall Risk	**ΣPLL**	**4.51E-03**		

ENVIRONMENTAL				
Marine Impact (Vessels)	**Vessel Type**	**Number off**	**Duration**	**Activity**
	DSV	1	16	Destruct
	Trawler	1	9	Trawl Sweep
Marine Impact (Vessel Legacy)	**Vessel Type**	**Number off**	**Duration**	**Activity**
	Survey Vessel (Legacy)	1	30	Survey
	Rock Placement Vessel (Legacy)	1	5	Rock Placement
Vessel Noise	**Parameter**	**dB re 1mP**	**TPa²s**	
	Operational SEL	238	0.67	
	Legacy SEL	229	0.09	
Equipment Noise (Ops)	**Activity**	**Tool Use (days)**	**dB re 1mP**	**TPa²s**
	Suction Dredger	6.67	237	0.46
Energy Use (Total = Ops + Legacy)	**Fuel**	**CO_2**	**NOx**	**SO_2**
	1,537.4 Te	4,873.8 Te	90.7 Te	18.4 Te
Life Cycle Emissions (Disposal / Replacement of Material)	**CO_2 (Disposal Ops)**	**CO_2 (Replacement Ops)**		
	0.0 Te	391.6 Te		
Marine Impact (Seabed)	**Activity**	**Area (m^2)**	**Resources**	
	Rock Placement	N/A	N/A	
	MFE	N/A	N/A	
	Trenching	580	Trenching Spread	
Materials	**Parameter**	**Weight (Te)**	**Length (m)**	
	Recovered	0.0	N/A	
	Remaining	382.0	N/A	
Residuals	**Type**	**Left In-Situ**	**Returned**	
	LSA Scale	N/A	N/A	
	Hydrocarbon	N/A	N/A	
	Control Fluids	N/A	N/A	

TECHNICAL				
Technical Considerations	**Feasibility**	Low	**Concept Maturity**	Low
	Availability of Technology	Low - Likely to require new / novel technology		
	Track Record	Low - No track record for this technique		
	Risk of Failure	Med		
	Consequence of Failure	New decommissioning technique required		

SOCIETAL		
Societal Factors	**Commercial Fisheries Impact**	Med - Reasonable area of fishing ground temporarily lost
	Socio Economic	Low - No material returned to shore

ECONOMIC								
Economic Considerations	**Comparative Cost Operational**			£3.47	M			
	Comparative Cost Legacy			£1.30	M			
	Project Contingency (30%)			£1.43	M			
	Comparative Cost Total (inc. contingency)			£6.20	M			
Economic Risk	**Cost Risk**	High	**Factors**	New technology required No track record of method Alternative method required upon failure				

Appendix G.16 Group 14 – Option 5B Data Sheet

Area	Balmoral
Decision / Group	**Group 14: Mattresses (Other)**
Option	**Option 5b: Full Removal - ROV Removal**
Sequence of Works	Remove and recover mattresses
	Perform trawl sweep of site

ID No.	Type	Material	Size (m)	Number	Total Weight (Te)	Status
218	Concrete Mattress	Concrete	4x5	5	25	Difficult to recover
219 / 220	Concrete Mattress	Concrete	5x2x0.15	4	20	Difficult to recover
221 / 222	Concrete Mattress	Concrete	4x5	16	80	Difficult to recover
638	Concrete Mattress	Concrete	10x2x0.15	2	20	Difficult to recover
640	Concrete Mattress	Concrete	10x2x0.15	2	20	Difficult to recover
646	Concrete Mattress	Concrete	5x2x0.15	2	10	
980	Concrete Mattress	Concrete	5x2x0.15 & 10x2x0.15	48	260	Difficult to recover
644	Concrete Mattress	Concrete	10x2x0.15	1	10	Difficult to recover
			TOTAL	**79**	**445**	

SAFETY				
Offshore Personnel	Number	81	Man Hours	15,132
Diver Requirement	Number	0	Man Hours	0
Onshore Personnel	Number	20	Man Hours	3,855
Legacy Risk	Number	0	Man Hours	0
Impact to Other Users of the Sea (operational)	Number of Vessels Used	2	Duration of Operations	25
Impact to Other Users of the Sea (Legacy)	Number of Vessels Used	0	Duration of Operations	0
Potential for High Consequence Events	Med	**Comments**	Significant lifting; Assumed mattress integrity; For further details from the HAZID, see Ref. [4].	
Operational Risk Offshore	PLL	1.13E-03		
Operational Risk Diver	PLL	5.59E-04		
Operational Risk Onshore	PLL	1.29E-04		
Legacy Risk	PLL	0.00E+00		
Fishing Risk	PLL	N/A (No increase in risk over and above what currently exists for fishing)		
Overall Risk	**ΣPLL**	**1.82E-043**		

ENVIRONMENTAL				
Marine Impact (Vessels)	**Vessel Type**	**Number off**	**Duration**	**Activity**
	CSV	1	16	Destruct
	Trawler	1	9	Trawl Sweep
Marine Impact (Vessel Legacy)	**Vessel Type**	**Number off**	**Duration**	**Activity**
	Survey Vessel (Legacy)	0	0	N/A
	Rock Placement Vessel (Legacy)	0	0	N/A
Vessel Noise	**Parameter**	**dB re 1mP**	**TPa²s**	
	Operational SEL	238	0.67	
	Legacy SEL	N/A	N/A	
Equipment Noise (Ops)	**Activity**	**Tool Use (days)**	**dB re 1mP**	**TPa²s**
	Suction Dredger	N/A	N/A	N/A
Energy Use (Total = Ops + Legacy)	**Fuel**	**CO_2**	**NOx**	**SO_2**
	791.5 Te	2509.1 Te	46.7 Te	9.5 Te
Life Cycle Emissions (Disposal / Replacement of Material)	**CO_2 (Disposal Ops)**	**CO_2 (Replacement Ops)**		
	442.0 Te	0.0 Te		
Marine Impact (Seabed)	**Activity**	**Area (m^2)**	**Resources**	
	Rock Placement	N/A	N/A	
	MFE	N/A	N/A	
	Trenching	N/A	N/A	
Materials	**Parameter**	**Weight (Te)**	**Length (m)**	
	Recovered	405.0	N/A	
	Remaining	0.0	N/A	
Residuals	**Type**	**Left In-Situ**	**Returned**	
	LSA Scale	N/A	N/A	
	Hydrocarbon	N/A	N/A	
	Control Fluids	N/A	N/A	

TECHNICAL				
Technical Considerations	**Feasibility**	Med	**Concept Maturity**	Med
	Availability of Technology	High - Off the shelf		
	Track Record	Med - Mattress removal has been performed previously		
	Risk of Failure	High - Ability to successfully remove materials considered low		
	Consequence of Failure	New decommissioning technique required		

SOCIETAL		
Societal Factors	**Commercial Fisheries Impact**	Med - Reasonable area of fishing ground temporarily lost
	Socio Economic	Med - Material returned to shore and processed. Potential re-use options

ECONOMIC								
Economic Considerations	**Comparative Cost Operational**			£7.4	M			
	Comparative Cost Legacy			£0.00	M			
	Project Contingency (30%)			£2.23	M			
	Comparative Cost Total (inc. contingency)			£9.65	M			
Economic Risk	**Cost Risk**	High	**Factors**	Achievability uncertain; Alternative decommissioning method required upon failure				