Kilmar Pipelines (PL2162 and PL2163)
Decommissioning Options Comparative Assessment

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Terms and Abbreviations

API	American Petroleum Institute (reference organisation used to define pipeline specifications)
CoP	Cessation of Production
CA	Comparative Assessment
DESNZ	Department for Energy Security and Net Zero
ESDV	Emergency Shut Down Valve
DSV	Dive Support Vessel
FBE	Fusion Bonded Epoxy
GVI	General Visual Inspection
GWA	Greater Wash Area
HDPE	High Density Polyethylene
HSE	Health and Safety Executive (Pipelines Inspectorate)
JNCC	Joint Nature Conservation Committee

KM	kilometres
KP	Kilometre Point (KP 0 at the Kilmar pipeline initiation point, ~KP 22.2 at Trent bottom riser flange)
LTI	Lost Time Incident
MCZ	Marine Conservation Zone
MBES	Multi beam echo sounder (seabed mapping equipment)
MEG	Monoethylene Glycol (used to prevent hydrates forming within pipework)
MPA	Marine Protected Area
MSV	Multi Support Vessel
NFFO	National Federation of Fishermen's Organisations
NORM	Naturally Occurring Radioactive Material
NSTA	North Sea Transition Authority
NUI	Normally Unmanned Installation
OD	Outside Diameter
ODEAM	ODE Asset Management (Operator of Tors installations and pipeline systems)
OEUK	Offshore Energies UK
OPRED	Offshore Petroleum Regulator for Environment and Decommissioning
PUK	Perenco UK Limited
ROV	Remotely Operated Vehicle
RWC	Restricted Work Case
SAC	Special Area of Conservation
SEAL	Shearwater Elgin Area Line
S lay	Term used to describe pipeline installation method where individual pipe sections are welded together on a vessel and laid in a string under tension onto the seabed
SNS	Southern North Sea
SPA	Special Protection Area
Spool goose necks	Term used to describe the bends on pipework that lifts the pipe off the seabed to a connection point above it (usually a riser flange)
Reel lay	Term used to describe pipeline installation method where pre welded pipe lengths are pulled off a large diameter reel and laid in a string under tension onto the seabed
Te	Tonnes (metric weight)
ToP	Top of Pipe (term used to describe the level below natural seabed of a buried pipeline or umbilical)
Tors	Combined field name for the Garrow and Kilmar reservoirs
UHB	Upheaval buckling (the process where pipelines expand when filled with warm gas pushing some prone sections of the pipeline upward when laterally restrained (buried of trenched) unless physically restrained by an overburden of soil or rock above it)
UKCS	United Kingdom Continental Shelf
WDT	Weather Down Time
3LPP	3 layer polypropylene (anti-corrosion coating system for steel)

1 Executive Summary

A Comparative Assessment of potential decommissioning options has been completed for the PL2162 12" gas export pipeline and the PL2163 3" service pipeline between the Trent Compression platform and the Kilmar NUI platform. This Comparative Assessment is in support of Kilmar Decommissioning Programme document APR_TORS_PMGT_026 which is further supported by the Kilmar Decommissioning Environmental Appraisal document APR-TORS-PMGT-027.

The Kilmar field is in the Southern Basin of the UKCS, across block 43/22a and comprises one gas field which was first originally developed in 2005. The Field is covered by licence P683. The development consists of a NUI with 3 wells, tied back to the PUK owned and operated Trent platform complex. The wells are completed with dry production trees and the pipeline systems run between the riser isolation valves, upstream of the ESDV's, on the topsides of the Trent and Kilmar Installations. Kilmar also received gas from the Garrow field and Garrow gas was comingled with Kilmar gas and exported onward to the Trent platform complex via the PL2162 pipeline. Production has been shut in since July 2020 as a result of PUK's decision to shut down production and export via Trent as a result of low gas pricing. At this time the Kilmar pipelines and facility was put into gas safe mode. Trent has since begun their Cessation of Production (CoP) process. Remaining reserves in Kilmar are not sufficient to support an investment to return the facilities to production and cover the costs of an alternative export solution.

The pipelines are both ~21.3 km long and are a welded carbon steel pipeline construction. The 3" service pipeline PL2163 was installed simultaneously to the larger PL2162 pipeline as a piggyback and lies within the same protection trench for the majority of the route. The pipelines were trenched and backfilled to 1.4-1.8m below seabed. Approximately 97.6% of the route is trenched with 1.6% surface laid at the platform approaches and at the SEAL crossing. The remainder of the pipelines are in the jacket risers and topsides pipe sections. Of the surface laid sections ~45% is mattress protected and ~55% is rock dump protected. In total <1.9% of the route is rock protected either within or outside the trenched sections. Neither pipelines are concrete coated but are corrosion coated with 3 layer polypropylene (3LPP) for the majority of their lengths. This report presents a description of the potential decommissioning options considered, the method used to complete the Comparative Assessment and the findings of the work undertaken.

Three main options have been considered:

- Complete removal – this involves the full removal of both pipelines including the de-burial of the pipelines and return to shore of the materials used.
- Partial removal – this involves the removal to shore of various elements of the pipelines and protection materials but leaves the majority of the trenched sections in situ. Sub options for the pipeline approaches at each platform end have also been considered.
- Full leave in situ – this option involves leaving in place all pipeline sections and protection materials other than short sections of the riser spools that will be cut and returned to shore to allow the Trent Compression and Kilmar jackets to be removed.

The options were assessed using the DESNZ Decommissioning Guidance Notes and project specific guidelines developed for a detailed assessment workshop. During the assessment process, evaluations were made principally on a qualitative basis, however, where quantitative data was available this has been used. The following components were assessed from a short-term (project) and longer-term (legacy) perspective:

- Safety;
- Environmental;
- Technical;
- Societal;
- Economic.

Following the detailed assessment workshop, it is recommended for both the PL2162 and PL2163 pipelines that a partial removal option is adopted for the decommissioning work. Option 2b as further detailed in this report is the preferred option. This reflects recovery of the surface laid sections of pipeline and spool sections and their respective protective concrete mats at the Trent and Kilmar platform approaches. The remainder of the pipelines, including at the SEAL pipeline crossing location, that are either buried under rock dump or below 0.6m of natural seabed material will be left in situ.

2 Introduction

The purpose of this Comparative Assessment is to provide an assessment of potential decommissioning options available for the Kilmar PL2162 and PL2163 pipelines against a set of assessment criteria derived from DESNZ Guidance Documents and in line with the OEUK 'Guidelines for Comparative Assessment in Decommissioning Programmes: Issue 1: Oct 2015'. The output of this Comparative Assessment will assist in identifying the preferred decommissioning options and methods and supports the submission of the decommissioning programme to OPRED.

Details of the pipelines are shown in table 2.1.

Pipeline	Size, OD	Length	Material	Wall Thickness	Corrosion coating	Design pressure	Burial status
PL2162	323.9 mm (12")	21260 m	API 5L X65 carbon steel	15.9 mm	3 LPP and epoxy paint	115 barg	Trenched, mat/rock dumped at ends
PL2163	88.9 mm (3")	21260 m	API 5L X65 carbon steel	7.6 mm	3 LPP and epoxy paint	296 barg	Trenched, mat/rock dumped at ends

Table 2.1 PL2162 and PL2163 pipeline data

Kilmar comprises of one gas field (Block 43/22a) which is located approximately 94km offshore to the north-east of the nearest landfall at Flamborough Head, on the east coast of England. The nearest international boundary to the development is the UK/Dutch median line, which lies approximately 95 kilometres to the east of the Kilmar platform.

Figure 2.4 shows the Kilmar location relative to nearby marine protected areas. The Kilmar NUI and pipeline routes are located within the boundary of the Southern North Sea SAC, designated for the protection of harbour porpoises (see Figure 2.4 below).

The development lies in an area of sandbanks, which form a series of ridges parallel to the coast, with channels between them. Water depth along the proposed pipeline route varies between 40.9 metres and 56.7 metres and is approximately 48.1 metres at the Trent Compression platform location and 54.8 metres at the Kilmar NUI location. The seafloor along the route generally comprises featureless sands and areas of megarippled sands. Three sand waves exist along the Trent to Kilmar pipeline route. Seabed surveys carried out in the vicinity indicate they are mainly comprised of very loose to loose fine sands, becoming dense to very dense as they reach a depth of 2 to 10 meters below seabed. The area appears to be supported by the Bolders Bank Formation, overlying very stiff to hard clay.

Gas was exported from Kilmar to Trent via PL2162. MEG for hydrate and corrosion inhibition was supplied from Trent via the PL2163. The PL2163 pipeline was installed simultaneously to the larger PL2162 pipeline into the same protection trench for the majority of the route. The two only separate at the final approaches to the Trent and Kilmar platforms but both are protected by the same rock berms and concrete mattresses.

Kilmar production is currently shut in following the closure of the Trent export route. Remaining reserves are not sufficient to support an alternative export route investment or ongoing maintenance and operating costs.

Prior to decommissioning activities commencing the PL2162 and PL2163 pipelines will be flushed and cleaned and left filled with filtered seawater.

This document will be used to help determine the scope of work for decommissioning activities associated with the Kilmar pipelines.

Figure 2.1 Tors location

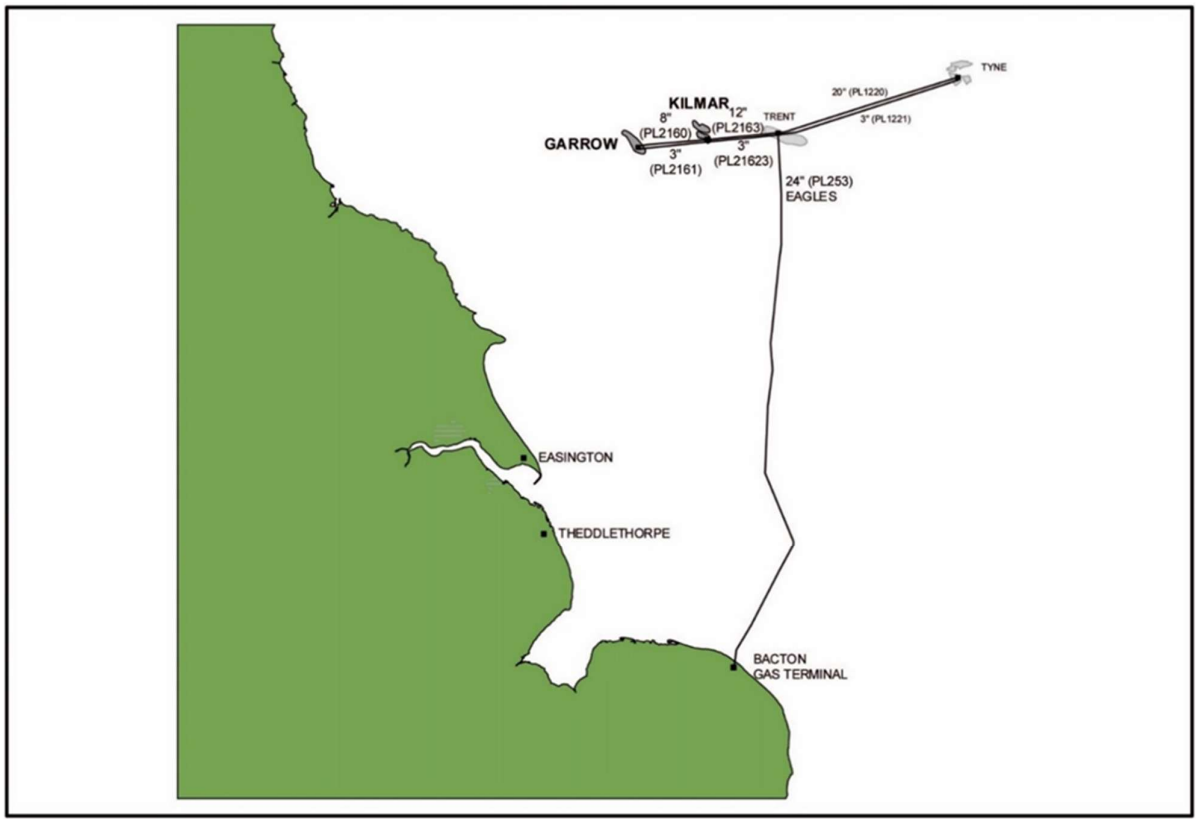


Figure 2.2 Overall field layout

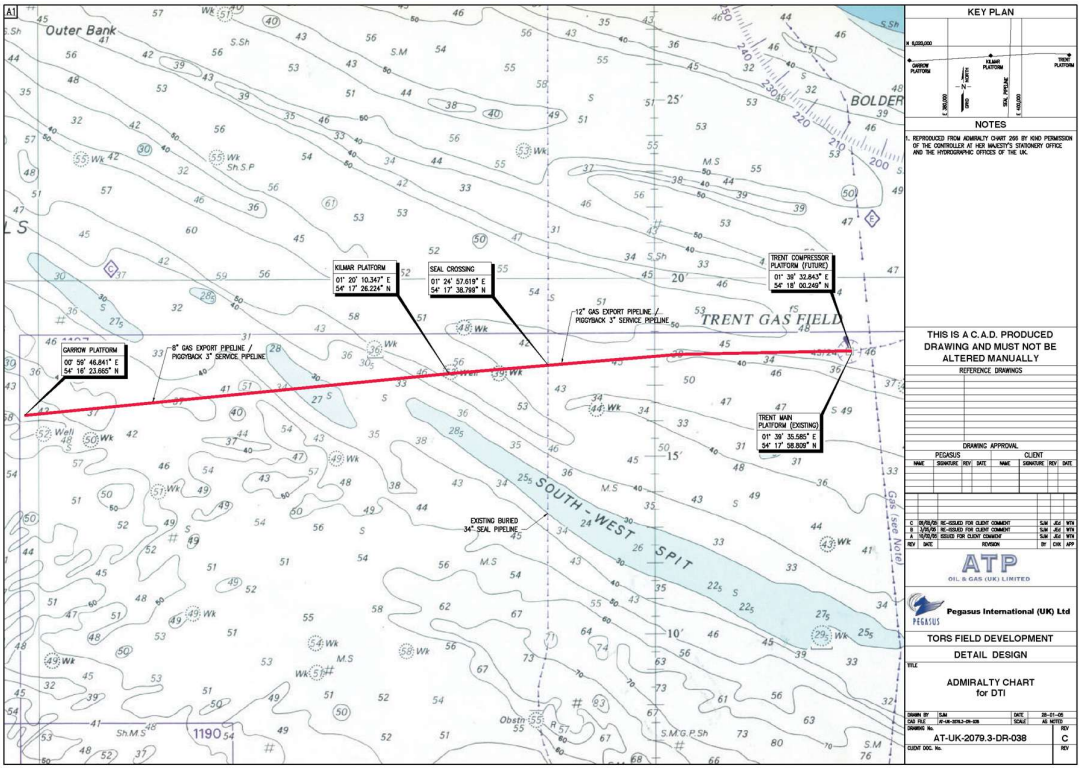


Figure 2.3 Kilmar Field layout

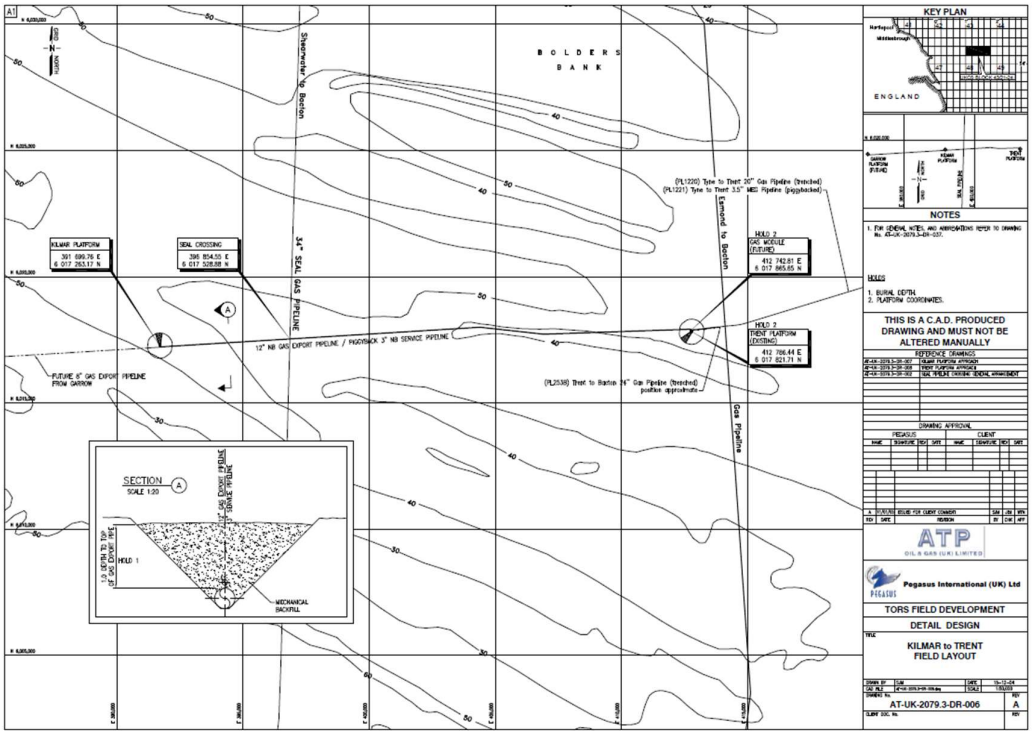
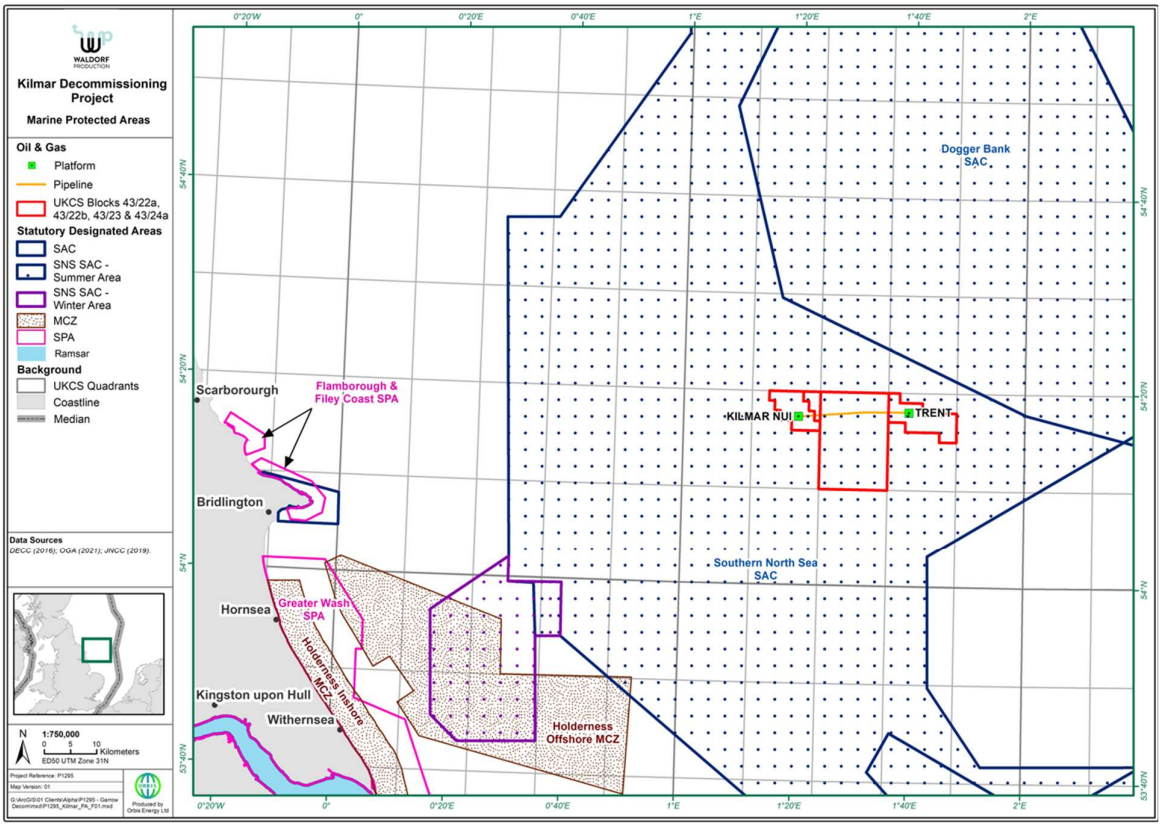


Figure 2.4 Marine Protected Areas in the Kilmar proximity



3 Status of Infrastructure

This section contains a summary of the overall pipeline route and key features along it. Survey charts and video footage of the platform approaches are available on request along with the full route as trenched charts and intermediate MBES survey data

3.1 Overall Layout

The two pipelines were installed as piggyback pipelines and trenched to a target depth of 1.8m. The trench was then subsequently backfilled with a backfill plough. Where the pipelines were not trenched (at the platform approaches) a combination of concrete mattresses and rock dump were installed over the pipelines to provide protection. A total of 29 mattresses were used on the Kilmar pipelines.

3.2 Burial Status

Based upon the original as backfilled surveys and operational life interim general inspection surveys it can be concluded that the full length of pipelines are currently buried to a depth well in excess of 0.6m and normally between 1.4m and 1.8m deep with the exception of the following locations:

- Pipeline approaches at the platform ends
- 34” PL1570 SEAL pipeline crossing

The status at these locations are detailed in sections 3.3 and 3.4 below.

The latest operational survey of the full route was completed in September 2022 with the latest visual inspections of the mattress protection sections at Kilmar in March 2022 and at Trent in September 2020. Interim operational surveys have been carried out in 2008, 2010, 2013 and 2016 on the full route with visual mattress surveys also in 2010, and 2016. These surveys have been considered in preparing this document. A further pre-decommissioning environmental baseline survey for Kilmar was completed in April 2023.

The development lies in an area of shallow sandbanks which are mainly comprised of very loose to loose fine sands, becoming dense to very dense as they reach a depth of 2 to 10 meters below seabed. Water depth comparisons for the original as backfilled survey in 2005 and the most recent operational survey in 2022 show no significant movement of the seabed throughout the pipeline routes. No pipeline exposures have been seen in any of the interim operational surveys in 2008, 2010, 2013 and 2016. These comparisons are detailed in Appendix A, figures A1-A4.

From the surveys it can also be seen that the seabed has a number of ripples of around 0.2m in height with 5-15m wavelengths throughout the route of the pipelines. It has been known for megaripples to migrate along the surface of the seabed. Given the burial depths of the pipelines even if this does occur the pipelines will remain buried below 0.6m. Appendix A, figure A5 shows further illustrations of the impact of potential ripple migration.

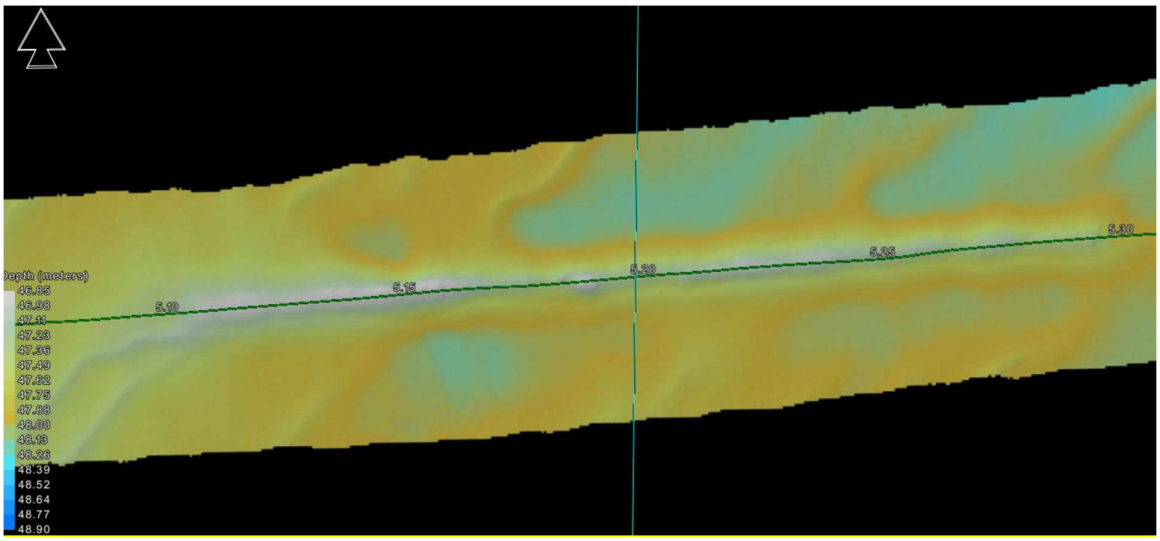
The PL2162 and PL2163 lines are made of carbon steel, API grade 5L X65 with a 0.5mm FBE and 3LPP coating. They also have offshore welded pipe joints covered with a sheet of HDPE as an outer coating overlapping with the FBE and 3LPP coating. As part of the design for the pipeline system, stability and upheaval buckling calculations were performed to ensure no movement of the pipeline during operational life was expected. In this operational condition the gas export pipeline was filled with warm gas which is more buoyant than water. In a water flooded condition both pipelines are

significantly negatively buoyant and so no upward movement of the pipeline would be expected in a left in situ condition when the pipelines are filled with filtered seawater.

3.3 Crossings

There is one crossing of the TotalEneries E&P UK Ltd operated 34" PL1570 SEAL pipeline along the Kilmar pipeline routes. At the crossing location the PL2162 and PL2163 pipelines were laid over preinstalled mattress bridges to ensure separation between the 2 pipeline systems. This section of the Kilmar pipelines was subsequently left untrenched and the exposed lengths of pipelines were rock dumped over approximately 193m. Figure A10 in Appendix A shows the engineering detail at the crossing location. Figure A11 shows the as installed separation mat locations and Figure A12 details the rock dump specifications.

Figure 3.1 Rockdump protecting the pipeline at SEAL pipeline crossing (MBES image from the 2022 survey)



3.4 Pipelines and Spools at Trent and Kilmar Platform Approaches

The pipeline spool sections at the Trent and Kilmar approaches are laid on the seabed surface and protected with concrete mats. At the riser to spool goose necks the pipelines were indicated to have fronded mats placed underneath the goose necks, however, the latest inspection surveys show no indication of these mats below the pipelines. Beyond the spool sections running away from the platform, there are short section of the pipelines (~35m at Trent, ~40m at Kilmar) that are also laid on the seabed and protected with concrete mats. At each platform approach where the mat protection ends on the outboard side from the platforms, the pipelines have been rock dumped to provide a minimum of 0.8m cover. This continues for ~100m through the pipeline trench transitions where the pipelines are then buried and backfilled. Of the total surface laid pipeline and spool sections (225m), ~70m of pipeline are rock protected, ~75m of pipeline are mat protected, ~80m of spools are mat protected.

Layouts of both the Trent and Kilmar platform approaches are detailed in Appendix A figures A6 to A9. Rock dump details are shown in Appendix A figure A12.

3.5 UHB Locations

There are no UHB rock dump locations along the pipeline routes. Sufficient backfill was put in place to prevent any upward pipe movement during operational conditions.

4 Comparative Assessment Process

The CA has been undertaken in line with DESNZ Guidance Documents. Comparative assessment decisions have also been made broadly in line with principals set out in the OEUK guidance report 'Guidelines for Comparative Assessment in Decommissioning Programmes: Issue 1: Oct 2015'.

A two-stage process with an early option screening assessment to narrow options to a manageable number followed by a detailed comparative assessment of selected options has been adopted.

Stage 1: Option screening

A list of potential decommissioning options was developed for each pipeline which included an option for full removal of pipeline by reverse reeling and cut and lift methods, leave full pipeline in situ (including buried, rock dumped and mattressed sections) option and several partial removal options.

Potential reuse options of the pipelines were considered including use of the pipelines as part of a possible alternative export route for the Kilmar field, however, these options were found to be uneconomic or not in the same time frames for possible near vicinity 3rd party field development programmes.

In a desktop exercise each of these options was then evaluated against the categories and considerations detailed in Table 4.1. They were then given a traffic light rating where green represents an acceptable solution, amber represents a solution that may be acceptable with appropriate actions or control measures and red represents an unacceptable option. Each option was then reviewed across all categories to establish whether the option should be selected for a more detailed comparative assessment. The outcome of this desktop exercise was then peer reviewed by an independent subsea specialist from Subsea and Sea Limited and was shared with OPRED to ensure agreement that all potentially viable options were considered as part of the stage 2 detailed assessment.

Table 4.1 Categories and Considerations considered during stage 1 option screening.

Category	**Considerations**
Safety	
Risk to other users (post ops)	Snagging, collision, seabed movement, scouring, inspection survey risks
Risk to those offshore (during ops)	Dropped objects, number of lifts involved, sea fastening of retrieved items, contamination, NORM, duration of offshore vessel days
Risk to 3rd parties (during ops)	Collision, snagging
Durations of diving intervention	Manual operations, ROV operations, confined space working
Risk to those onshore (during ops)	Handling of recovered items, volume of road transportation, extent of marine growth
Environmental	

Discharges	Chemical or hydrocarbon leaks, erosion due to high volume flows, sewage/food waste
Seabed disturbance	Volume of disturbance, durations for seabed to recover, impact on flora and fauna (smothering), Impact to SAC.
Impact on Marine protected areas	Impact on qualifying features of southern North Sea SAC (harbour porpoises).
Energy usage (during and post ops)	Fuel consumption required; type of fuel used
Atmospheric emissions	Vessel emissions, onshore emissions
Noise (underwater and onshore)	Disassembly onshore, cutting operations offshore, excavation techniques
Accidental spills	Duration of ROV work, onshore contamination, vessel lubes/chemicals
Technical	
Technical challenge	Difficulty level of operations, established technology or not, access to work locations, seabed currents, consumables required, integrity of protection materials
Weather sensitivity	Limiting sea states, susceptibility to fog, tidal current limitations, duration of working windows required
Risk of major project failure	Break up of items being recovered during recovery operation, damage to other infrastructure (on and offshore)
Societal	
Access to site for other users	Any restrictions to fisheries during or post ops, impact to merchant shipping during ops
Community disturbance (onshore)	Visibility of materials brought onshore, traffic volume increase, job creation, any benefit from use of recycled materials, volume of disposal materials
Economic	
Cost of work	Fixed cost or what is the range of cost outcome, any scrappage value/resale of equipment
Ongoing cost liabilities	Any inspection surveys required post ops; any further intervention required at later stage

Stage 2: Detailed assessment

Following development and approval of the 'Kilmar pipelines (PL2162 and PL2163) Terms of Reference for Stage 2 Comparative Assessment Workshop, document number APR_TORS_PMGT_031' a workshop with available stakeholders and previous Field Operator, Waldorfs' decommissioning project team members was held. The workshop was conducted in the Waldorf Aberdeen offices and via MS Teams. Attendees included representations from JNCC, TotalEnergies (SEAL pipeline crossing operator), Energean (Kilmar field partner) and OPRED. HSE and NFFO were not able to attend directly but have reviewed the Terms of Reference document, workshop output and this Comparative Assessment document. This process, along with pre

workshop reading material and post workshop sharing of the output result worksheets ensured all relevant parties input to the assessment was captured.
In order to rate the impact of the selected options a review against each of the below criteria set out in Table 4.3 was carried out. Each subcategory was initially allocated a red, green, or amber rating code for each option. A guide table to the ratings codes is included as Appendix B. It should be noted that for this initial impact rating the colour allocation indicates the relative impact of each option and does not define acceptability/non acceptability at this stage. Once the impacts were allocated the workshop attendees assigned an overall rating for each Category along with a degree of definition based on;

1. High certainty (high understanding of the methods to be used, status of the infrastructure, equipment required, public opinion perception and any hazards)
2. Mid certainty
3. Low certainty (low understanding of the methods to be used, status of the infrastructure, equipment required, public opinion perception or any hazards)

The workshop group initially reviewed the 3 main options. Complete removal (option 1), partial removal (option 2b) and complete leave in situ (option 3b).

On completion of the sheets the workshop group reviewed the option summaries and allocated a final colour rating to each option in line with the below table 4.2.

Table 4.2 Final rating options

Preferred solution	
Broadly acceptable	
Tolerable not preferred	
In tolerable, not acceptable	

Table 4.3 Categories and Considerations reviewed during the detailed assessment workshop.

Category	**Considerations**
Safety	
Risk to other users (post ops)	Snagging, collision, seabed movement, scouring, inspection survey risks
Risk to those offshore (during ops)	Dropped objects, number of lifts involved, sea fastening of retrieved items, contamination, NORM, duration of offshore vessel days
Risk to 3rd parties (during ops)	Collision, snagging,
Durations of diving intervention	Manual operations, ROV operations, confined space working
Risk to those onshore (during ops)	Handling of recovered items, volume of road transportation, extent of marine growth
High consequence event	Event needing de/re-mobilisation of vessel(s) or yard, significant delay to work, etc
Environmental	

Discharges	Chemical or hydrocarbon discharges, erosion due to high volume flows, sewage/food waste
Seabed disturbance	Volume of disturbance, durations for seabed to recover, impact on water column, impact on seabed communities (physical loss, smothering etc.)
Impact on Marine protected area (Southern North Sea SAC)	Impact on qualifying feature of Southern North Sea SAC (harbour porpoises) or their supporting habitats / prey.
Impact on Marine Protected area (Greater Wash Area SPA)	Amount of Marine traffic and duration in the SPA. Is the marine traffic limited to shipping lanes? Impact to Red Throated Diver bird.
Energy usage (during and post ops)	Fuel consumption required; type of fuel used
Atmospheric emissions	Vessel emissions, onshore emissions, dust (onshore)
Noise (underwater and onshore)	Disassembly onshore, cutting operations offshore, excavation techniques
Accidental spills	Duration of ROV work, onshore contamination, vessel lubes/chemicals
Smell (onshore)	Amount of marine growth decay at disassembly yard
Waste processing	Tonnage sent to landfill
Technical	
Technical challenge	Difficulty level of operations, established technology or not, access to work locations, seabed currents, consumables required, integrity of protection materials
Weather sensitivity	Limiting sea states, susceptibility to fog, tidal current limitations
Risk of major project failure	Break up of items being recovered during recovery operation, damage to other infrastructure (on and offshore)
Repurposing opportunity	Pipeline availability in full or part for a repurposing use after decommissioning. Is this opportunity available for a short or long term period
Regulatory Compliance	Are the decommissioned facilities in compliance with regulations and guidance. Is there any subjectivity about the compliance.
Societal	
Access to site for other users	Any restrictions to fisheries during or post ops, impact to merchant shipping during ops
Community impact (onshore)	Visibility of materials brought onshore, traffic volume increase, job creation, any benefit from use of recycled materials, volume of disposal materials

Reputational Impact	Are Companies seen to be setting good or poor precedents, are stakeholders representing their interests, how visible in the public eye is the project
Economic Cost of work	Fixed cost or what is the range of cost outcome, any scrappage value/resale of equipment
Ongoing cost liabilities	Any inspection surveys required post ops; any further intervention required at later stage

5 Comparative Assessment Screening (Stage 1 Results)

The below table shows the outcome of the comparative assessment screening for the pipelines PL2162 and PL2163.

Table 5.1 Kilmar pipelines Comparative Assessment option screening.

Number	Option	Safety	Environment	Technical	Societal	Economic	Selected for further study
1	Leave full pipeline in situ (including buried, rock dumped and mattressed sections)						SELECTED
2	Partial removal of pipeline (see below for sub options considered)						SELECTED
3	Full removal of pipeline by reverse reeling/S lay and cut and lift methods						

Number	Sub Options	Safety	Environment	Technical	Societal	Economic	Selected for further study
1a	Rock dump all mattress protection areas and leave in situ						
2a	Leave pipeline as is but remove all surface laid pipeline sections (including rock removal at platfrom approaches and SEAL crossing)						
2b	Leave pipeline as is but remove only mat covered pipeline and spool sections						SELECTED
3a	Remove by combination of reverse reeling/S lay and cut and lift (but leave in situ rock dumped sections at platform approaches and SEAL crossing)						SELECTED

Given the pipelines have been laid together with the PL2163 pipeline piggybacked to the 12” pipeline the assessment screening is the same for both pipelines.

Full removal option (options 3 and 3a)

A full recovery of all infrastructure for each pipeline has been considered in the screening assessments. For most of the pipeline lengths the most appropriate option considered for this was the removal by reverse reeling or reverse S lay. The platform approach sections would require separate recovery solutions, which have also been considered in the screening exercise as separate sub options to the partial removal. Full recovery by cutting and lifting of separate sections over the full 21.26 km would involve significantly greater vessel time and risk so was not identified as a viable option for screening.

As a consequence of the burial condition of the pipeline prior to reverse reel or S lay recovery the vast majority of the length of the pipelines would require de-burial (*mostly 1.4-1.8 m deep with full natural backfill*). This would require extensive disturbance of the seabed likely using a mass flow technique. Large volumes of sediment would be put into suspension. It is also likely to leave a temporary trench along the route for a period of time until natural backfill occurs. This carries a risk of smothering of benthic animals, however, given the mobile nature of the sandy seabed this is not considered to be critical as an element of seabed movement and smothering occurs naturally and so has been assessed as amber in the Environmental category (where rock is left in situ, option 3a).

At the two platform approach sections and the SEAL crossing location the trench transition areas and initial pipeline end sections have been rock dumped for protection. To recover the full pipeline lengths (option 3) these rock dump sections would require excavation prior to pipeline recovery. It is likely that this would be carried out using mass flow techniques, but the pressures and flow rates required to remove the rock will be much greater than for the natural sandy seabed. As a result, it is highly likely that larger irregular trenches would be created in these sections and the rock would be distributed across the seabed over a much wider area of seabed than it currently covers. The assessment raises the rating to red in the Environmental category for this rock dump removal option. It should also be noted that in exposing the PL2162 and PL2163 pipelines at the SEAL crossing location there is a risk of creating a freespan and potential scour under the existing 34” SEAL pipeline. For this reason, an almost full recovery sub option (3a) has been considered which would leave the sections of pipeline buried under the rock in situ but recovers all other sections. Given that the rock dump sections are of graded rock with profiled side slopes to allow passage of any fishing

gear and show no evidence of migration or of damage to/from fishing gear (see sections 3.3 and 3.4), no concerns have been raised about leaving this rock in situ.

migration or of damage to/from fishing gear (see sections 3.3 and 3.4), no concerns have been raised about leaving this rock in situ.

There is also a higher safety risk associated with reeling back or S lay recovering the pipelines given the unknown level of corrosion through the pipe wall. Where the pipe has a thinner wall thickness there is an increased risk that the pipeline may part in an uncontrolled manner during the re-reeling or S lay process. In addition, the condition of the strapping attaching the two pipelines together is unknown and they may part causing risks in recovering the two products on the stern ramp of the reel or S lay vessel. These will further be considered in the detailed assessment workshop. It should also be noted that the pipelines were installed by the Seaway Falcon pipelay vessel which used a hybrid of S lay, and reel lay techniques. The Seaway Falcon is now no longer in service. The pipeline wall thicknesses are therefore not specifically designed for existing reel vessels and after detailed engineering an S lay technique may be the only option technically acceptable for full recovery. This option has been given a red ranking in the safety category.

The high number of vessel days and subsequent onshore handling of materials involved in this option mean the cost associated with it is extremely high. It is estimated that ~45 vessel days is required for the full removal options compared to <15 for partial and leave in situ options and almost 3000T of material will be returned to shore compared to <130T for other options. It was given a red ranking in the Economic category.

Based on the above and the preference to review at least one full recovery option in the detailed assessment stage, Option 3a is the almost full recovery option carried forward into the detailed assessment.

Partial removal option (options 2a and 2b)

Sub option 2a involves the removal of rock dump prior to recovering the pipeline sections underneath. This would require similar mass flow excavations of the rock as for the full removal options described above. There is less total disturbance to the seabed however than for the full removal option. Rankings in the Environmental, Social and Economic categories were assessed as amber.

Option 2b leaves these rock dump sections in situ and therefore has a reduced seabed disturbance, less lifts and less materials returning to shore. It has been assessed with a green ranking in the Environmental, Technical and Societal categories.

Options 2a and 2b would also not involve working below the natural seabed level as the pipelines were laid on the seabed before being rock dumped or matted in these areas. The techniques involved are well known and the lengths involved and the subsequent number of lifts to a vessel are limited. Option 2b was therefore given a green ranking in the Safety category.

Option 2a still carries the risk of creating a freespan and scour risk under the SEAL pipeline and was consequently given an amber ranking. As a result, it is not recommended to carry the rock dump removal option 2a forward to the detailed assessment stage.

Full leave in situ and Rock dump and leave in situ options (options 1 and 1a)

During the operational life of the field no interventions have been required and no issues with other sea users have been reported. There is no evidence of any protection features moving or creating a

snagging impact with fishing gear. Option 1 to leave all stabilisation features and pipelines as is will therefore be further assessed during the detailed assessment.

The option to rock dump areas covered by protection mattresses was identified as an option for screening (1a) but is highly likely to be opposed by some stakeholders. An additional ~1350m2 of seabed area would be covered in rock dump as opposed to being returned to its natural seabed condition in the post decommission status. It would not prevent other users accessing the area but would change the condition of the seabed over the area. It is only likely to be considered by all stakeholders as an acceptable solution where no other viable option exists. This does not appear to be the case for the Kilmar pipelines and therefore the rock dump solution has not been carried forward to the detailed assessment stage.

6 Selected Options Comparative Assessment (Stage 2 Results)

The full impact assessment worksheets with all main and subcategory ratings are included in Appendix C for reference, however, the following is a brief narrative overview of each of the assessed options.

Leave in situ (option 1)

The full leave in situ option was found to be broadly acceptable. This option has the least decommissioning scope and impact during decommissioning activities with the work limited to the cutting and removal of the exposed riser to spool goose neck sections of pipeline at the Trent and Kilmar platform jacket bases. Safety risks and onshore impacts are therefore low during the work. Legacy surveys are likely to be required over a longer time frame to ensure the status of the left in situ infrastructure does not change and create hazards to other users.

Given the relatively small surface area of the mats and the stable fully buried nature of the majority of the pipeline it is felt this option would not adversely impact the existing seabed communities or other users of the area. There are some legacy snagging risks associated with this option with the potential for a high consequence legacy event. As a result of this the option was given an amber/medium overall safety rating. No known snagging events or damage to the mats has been seen during the operational life of the pipeline systems with some mats at least partially buried by natural seabed material deposition and marine growth. The removal work and ongoing surveys that would be required are well within existing technologies for the industry and this option represents the lowest cost of the options taken into the detailed assessment stage.

The workshop group felt there is some uncertainty around the public perception associated with not removing infrastructure and the subsequent impact this may have on stakeholders reputation, hence the option was given an amber rating in the Legacy Impact on Stakeholders category. The workgroup did not think this is of high enough concern to prevent the option being considered.

The option, however, does not meet OPRED's expectation that mats not buried to greater than 0.6m should be removed. As a result, the workshop group felt that option 2b was a preferred option given that both options were broadly acceptable.

Partial removal (Option 2b)

The partial removal option 2b was found to be broadly acceptable and the preferred solution of the detailed workshop options. In addition to the riser to spool goose neck sections of pipeline being removed (as in option 1) this considered removal of the concrete protection mats and underlying pipeline sections at the Trent and Kilmar platform approaches. The remainder of the buried and rock dumped pipeline sections would be left in situ. In order to recover the mats and cut sections of pipework an MSV or DSV will be required to make a significant number of lifts to the deck of the vessel. It is anticipated that the mats will be stacked subsea and bulk lifted to deck reducing the number of lifts required and the risk of break up of individual mats during the recovery process. Similarly, there will be a significant number of lifts required onshore for the break up and recycling of the recovered materials. Although throughout the operational life the seabed and pipelines have been very stable there is still a remote possibility that the left in situ pipelines may become exposed over time and create a snagging hazard. For these reasons the option was given a medium risk rating in the safety category. It is estimated that 13.5 days vessel time would be required to recover the mats and underlying pipe sections. A greater volume of emissions and waste is associated with these vessel days compared to the leave in situ option. There are also some localised seabed disturbances associated with the recovery work. As a result, there are some medium ratings

associated with this option in the environmental category, however, given the short term and temporary impacts on seabed and/or marine communities the workshop group felt an overall low environmental impact is associated with this partial removal option.
Equipment and technologies required to recover and break up the materials are well known to the industry and are not technically challenging. The work group gave a green ranking in the overall technical category.

Other than the areas where rock dump overlies the pipelines, the seabed surface is expected to be returned to its natural status along the entire area impacted by the Kilmar facilities. It should be noted that at the cut ends of the recovered spool / pipe sections that any exposed ends, if not covered by rock will be covered by a remaining mat and will be flush with seabed and overtrawlable. Again, the workshop group felt there is some uncertainty around the public perception associated with not removing all infrastructure although any impact is less than for the full leave in situ option and should not impact the partial removal options being considered. The overall societal rating was green.

The costs for this option are expected to be approximately two times those of the leave in situ option but given the high level of available survey information, the on seabed location and known condition of the infrastructure a high level of definition is expected with this cost outcome.

Full removal (Option 3a)

This option considers leaving those pipeline sections protected by rock dump in situ (including at the SEAL crossing location) but recovering the remainder of the pipelines in their entirety. This would be done most likely by a combination of mass flow excavation to expose buried pipelines, hydraulic cutting of pipe at the burial points of rock dump sections, reverse reeling, or reverse S lay, mat recovery and cut and lifting of the platform approach sections of the pipelines. Overall the option was considered to be intolerable mainly due to safety, technical and cost issues and the higher levels of uncertainty associated with the option.

A number of safety concerns that may occur during the removal work were highlighted at the workshop. These include those associated with reverse reeling/s-lay of the pipelines where the remaining wall thickness of the pipelines and therefore the residual strength in the pipelines is not a definitive number. When applying tension to the pipeline to recover it back to the lay vessel deck there will be a chance of pipeline failure with an associated sudden release of tension. The unknown ‘suction’ effect of pulling up the pipelines through the excavated trench will also increase the risk of a pipeline failure during recovery. The status of the piggyback attachment mechanism is also unknown and there is a significant risk that attachment straps may have corroded. There is therefore a risk that the 2 pipelines separate during recovery or that the 2 pipelines need to be recovered separately after having 1st cut any remaining attachment straps. These concerns also led the workshop group to assign a medium certainty to the level of definition in the economic category and high uncertainties to the safety and technical categories.

There is a high level of lifts required with this option both offshore and onshore along with working at height issues associated with personnel working on the reel lay vessel ramp to detach piggyback blocks and strapping. Where the pipelines are cut at the rock dump transition ends it is likely that divers will need to work within the excavated trench to attach recovery wires to the pipeline ends. Overall, this option was given a red rating in the safety category.

The environmental impacts associated with this option are also much higher. The area of seabed disturbance is vastly increased in comparison with other options and volume of seabed material put into temporary solution (smothering risk) is a lot higher, although not in a highly sensitive location. Fuel usage, emissions and noise are increased as a result of the increased durations of vessels and cutting operations that are required for the option. 43.5 vessel days are estimated to be required (on the assumption that both pipelines can be simultaneously recovered) but these durations also have

a high uncertainty associated with them. Although the recycling tonnage is increased the associated waste tonnages and landfill are also increased as most of the pipeline materials are all returned to shore. This will have more visibility and impact to the public onshore. Overall, the workshop group gave the option an amber impact rating in the environmental category.
In the Technical category, on paper, each of the operations required for this option might be feasible and within the industry's capabilities, however, the combination of the activities required would be new to the industry and would require engineering confirmation, new procedures and risk assessment processes before the option could be confirmed as viable. No engineering of the recovery process has been carried out at this stage and so whether or not the pipelines can be reverse lay recovered together is an unknown and may not be feasible after detailed engineering is performed. The condition of the piggyback blocks and straps is also unknown at this stage which may preclude simultaneous recovery of the pipelines. The requirement to subsequently attach the reel vessel abandonment and recovery winch line to severed sections of pipeline may preclude the use of hydraulic cutters which would flatten the pipeline sections at the cut location preventing the use of ball grab type recovery tools. Other recovery techniques would need to be specifically engineered for the operation(s) and may involve diving operations. Full recovery of the pipelines clearly also prevents any repurposing opportunity for the pipelines. The option was therefore given an overall red risk rating with high uncertainty in the technical category.

The workshop group felt that a full recovery option for a well buried and stable pipeline system (as is the case for the Kilmar pipelines) would set an unwelcome precedent within the industry and would negatively affect the reputation of the stakeholders involved. The option was therefore ranked amber in the legacy stakeholder reputation category. The community impact onshore was given a green impact rating although there are both positive and negative impacts associated with the option. The higher tonnages being return to shore create a boost to the local economy, however, increased traffic, noise and landfill need to be accounted for. The creation of new jobs is likely to have a positive impact on stakeholder reputations during the work. Overall, the societal category was given a green rating but with a medium level of certainty.

The cost for the decommissioning work with this option is approximately seven and a half times that of the lowest cost option and over 3 and a half times that of the workshop's preferred option. It also carries a significant risk for cost escalation. Legacy surveys would still be required to confirm that the excavated pipeline trench has naturally backfilled itself close to or to the natural surrounding seabed level. The option was given a high impact rating with high uncertainty in the economic category.

7 Recommendations of the Comparative Assessment Process

The below summary table shows the final outcome of the detailed assessment with a workshop group recommendation to adopt the partial removal option (2b). This represents removal of the concrete protection mats and underlying pipeline sections at the Trent and Kilmar platform approaches. The remainder of the buried and rock dumped pipeline sections should be left in situ.

Table 7.1 Final detailed assessment ratings table

	Main Options			
Aspect	**Complete removal (option 3a)**	**Partial removal (option 2b)**	**Full leave in situ (option 1)**	**Comment**
Safety overall rating				
Safety overall definition	3	1	1	
Environmental overall rating				
Environmental overall definition	1	2	2	
Technical overall rating				
Technical overall definition	3	1	1	
Societal overall rating				
Societal overall definition	2	2	2	
Economic overall rating				
Economic overall definition	2	1	1	
Final rating				1., 2.

Comments

1. OPRED expectation is that mats with <0.6m burial are recovered. Option 2b complies with this where as option 1 does not.
2. Options 2b and 1 require no commercial agreements with SEAL pipeline operator as no work will be carried out within 200m of the SEAL pipeline.

Final rating Key

Preferred solution	
Broadly acceptable	
Tolerable not preferred	
In tolerable, not acceptable	

1 high certainty
2 mid certainty
3 low certainty

8 References

1. APR-TORS-PMGT-026 Kilmar Decommissioning Programmes

2. APR-TORS-PMGT-027 Kilmar Decommissioning Environmental Appraisal

3. Department for Business, Energy and Industrial Strategy (DESNZ) 'Guidance Notes: Decommissioning of Offshore Oil and Gas Installations and Pipelines under the Petroleum Act 1998' (November 2018)

4. OEUK's, Guidelines for Comparative Assessment in Decommissioning Programmes: Issue 1: Oct 2015

5. 230325-ADW-011-R01 02 Kilmar Pre-Decommissioning Survey Environmental Baseline Report

Appendix A Status of Infrastructure Further Detail

Water depth comparisons

Water depths and burial condition along the route have been compared from the original as installed surveys (2005) with the most recent 2022 inspection survey to establish if any migration of the seabed along the route has occurred. Figure A.1 below shows the 2005 as backfilled survey chart over a sand wave section of the pipelines route between KP 3.7 and KP 5.2. It should be noted that the chart scales are highly exaggerated to emphasize features on what is essentially a flat seabed. The horizontal scale is in kilometers versus a vertical scale in meters. The natural seabed level indicated on the chart is the average of 2 locations either side of the trench (indicated in green on the below Figure A.1). The pipeline depth of burial can clearly be seen and is a similar burial consistency along the entire route. The extent of backfilling can also clearly be seen to completely fill the trench with some slightly higher mounds immediately above the pipelines where excess backfill sand will have been pushed. These mounds will have been levelled out by natural currents quite quickly in time. Figure A.2 shows the full route profile from the 2022 survey with the location of 2 snapshot locations at the crest of sandwaves that are shown in more detail within Figures A.3 and A.4.

Figure A.3 shows the same as backfilled chart as in Figure A.1 with the 2022 operational survey seabed profile superimposed onto it. As can be seen the seabed does not appear to have had any significant movement over the 17 year period. The SEAL crossing at the far right of the figure also remains an extremely good match indicating no scour or loss of protection around the crossing location.

Figure A.4 shows a similar as backfilled chart at the 2nd snapshot location with the 2022 operational survey seabed profile superimposed through the highest sand wave section of the route. Again the 2005 and 2022 profiles are an extremely good match.

Full route survey data from the original as backfilled charting and the interim operational surveys are available on request.

Figure A.1 2005 As Backfilled survey chart extract (KP 3.7 – KP 5.2)

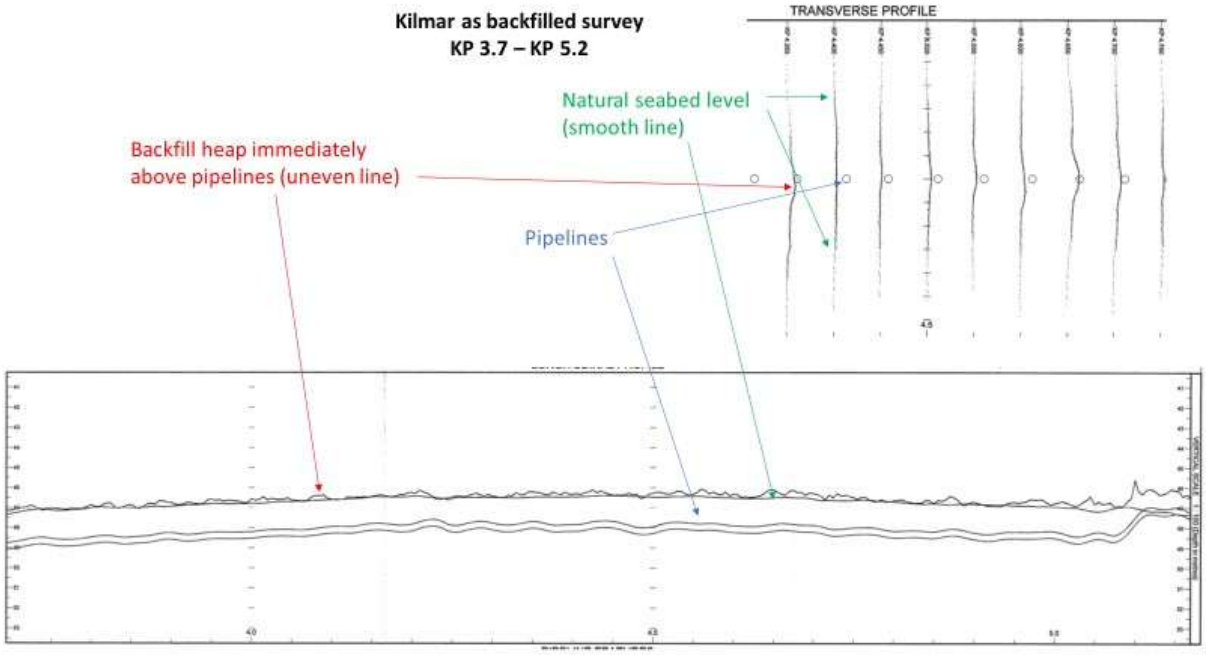


Figure A.2 Seabed profile along PL2162/3 pipeline route

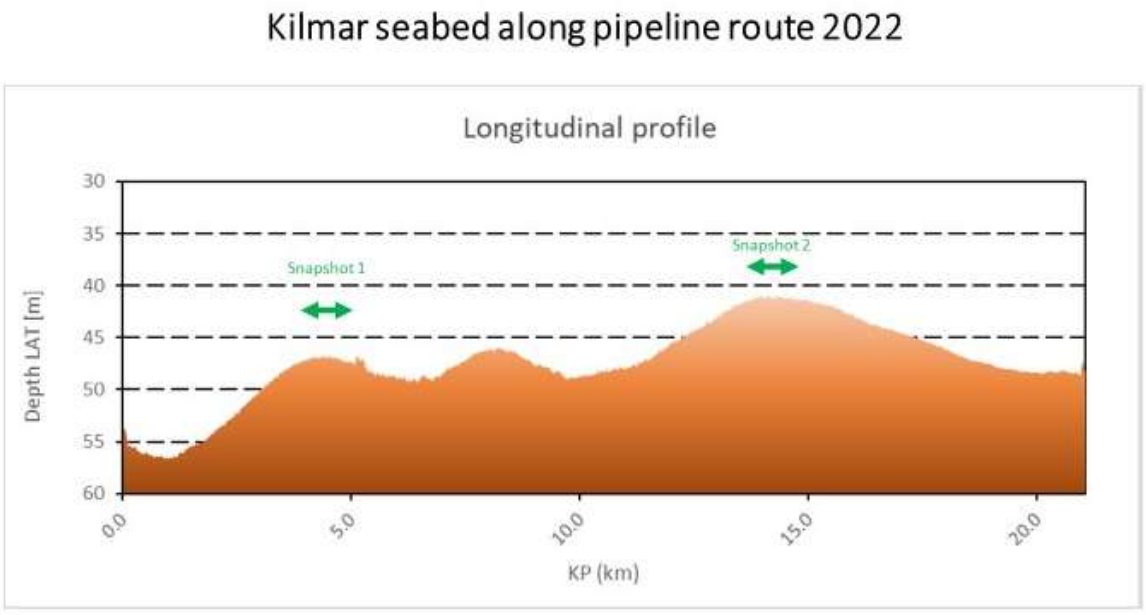


Figure A.3 As Backfilled chart and 2022 operational survey profiles (KP3.75– KP 5.15)

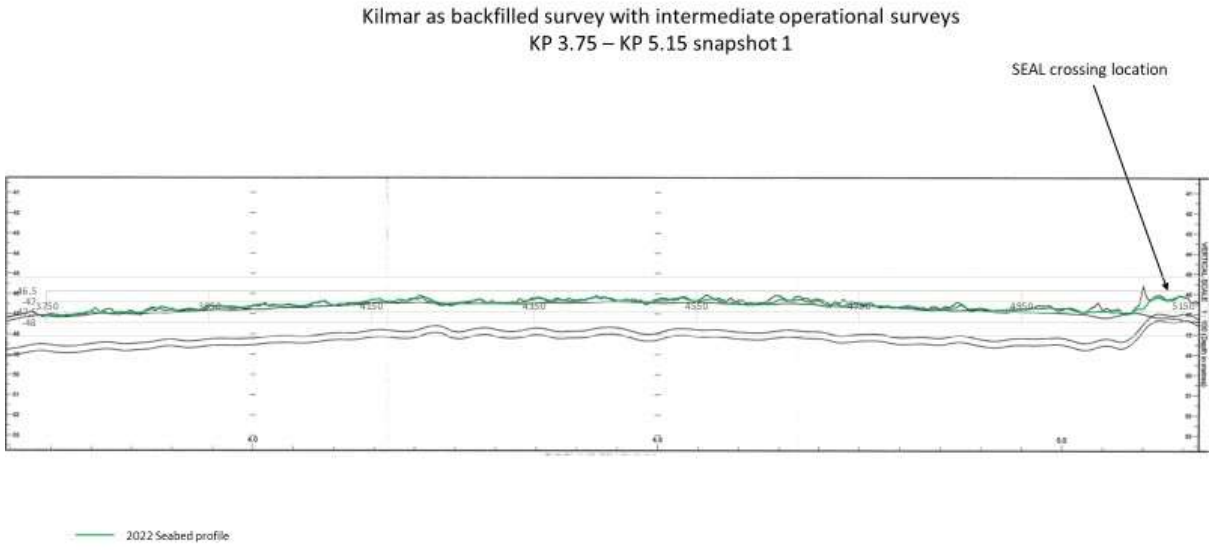
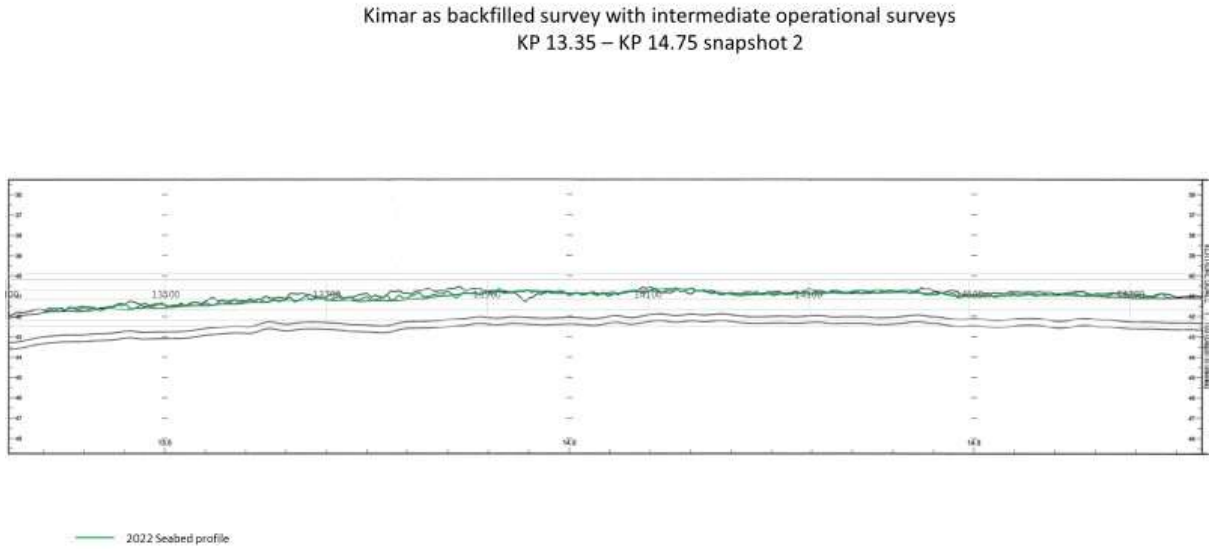


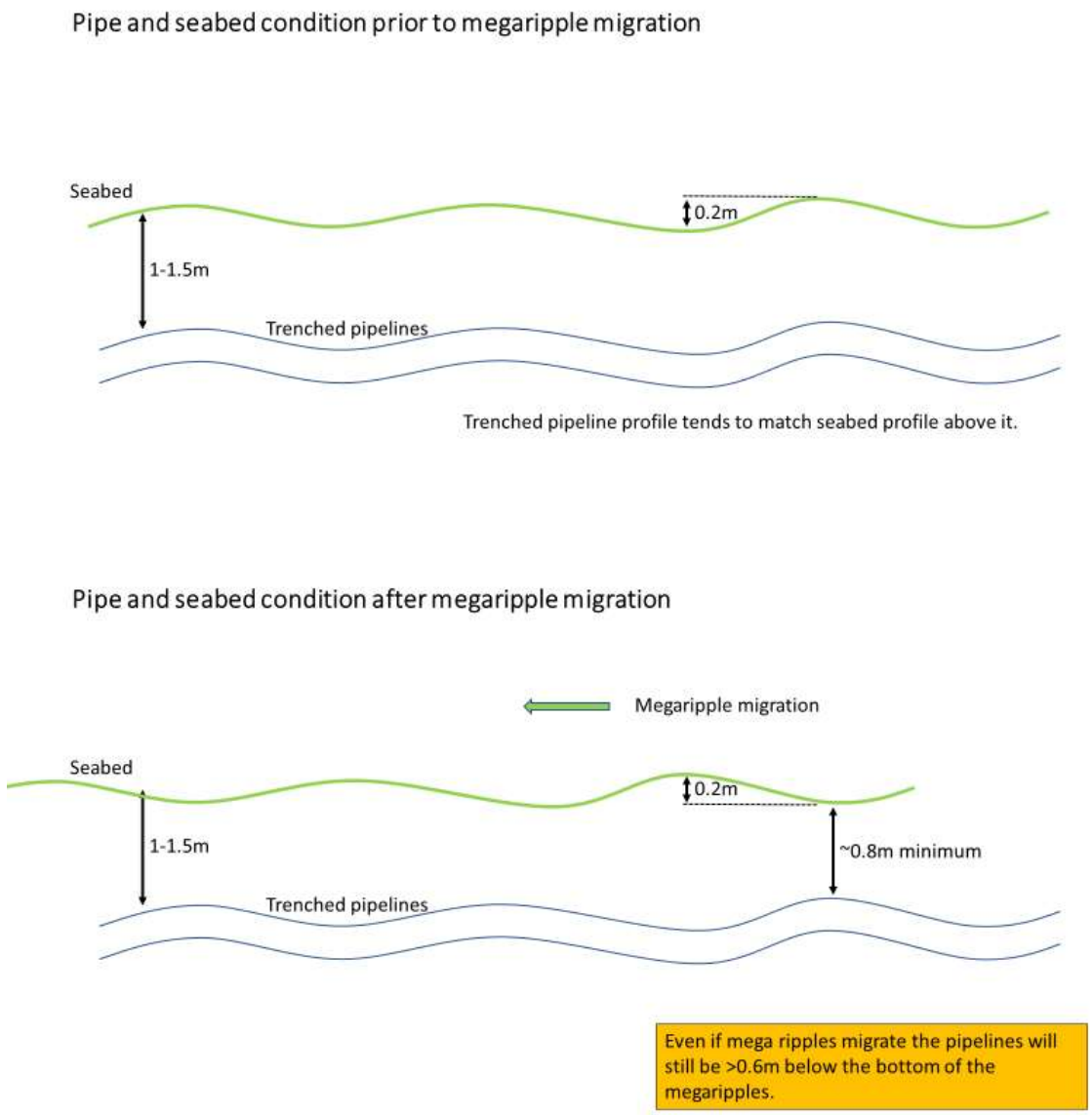
Figure A.4 As Backfilled chart and 2022 operational survey profiles (KP13.35– KP 14.75)



Potential mega ripple migration impact on burial depths

The below figures show the minimum remaining burial depth even should Kilmar experience megaripple migration and a megaripple trough matches with the peak from the as trenched pipeline profile.

Figure A.5 Minimal burial depths after megaripple migration



Trent Compression and Kilmar Platform approaches

Fig A.6 and A.7 below shows the platform approaches. Note the 8” and 3” pipelines to the West of the Kilmar platform in Fig A.7 are PL 2160 and PL 2161 and are not part of this Comparative Assessment or the Kilmar Decommissioning Programme. PL 2160 and PL 2161 are included in the separate Garrow Decommissioning Programme. The March 2022 GVI surveys have confirmed the platform approaches remain in this condition.

Figure A.6 Trent Compression platform approach mattress layout

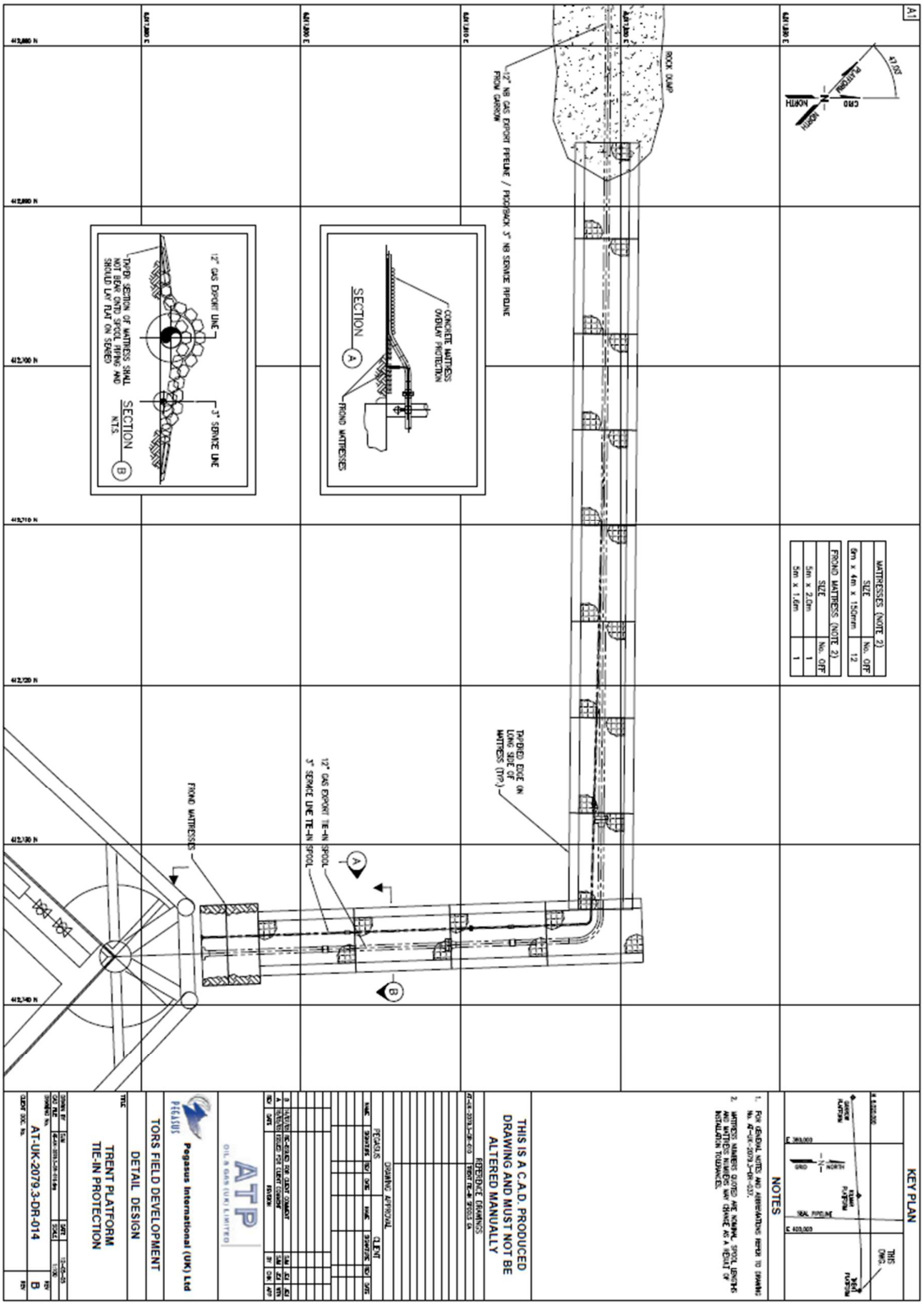


Figure A.7 Kilmar platform approach mattress layout.

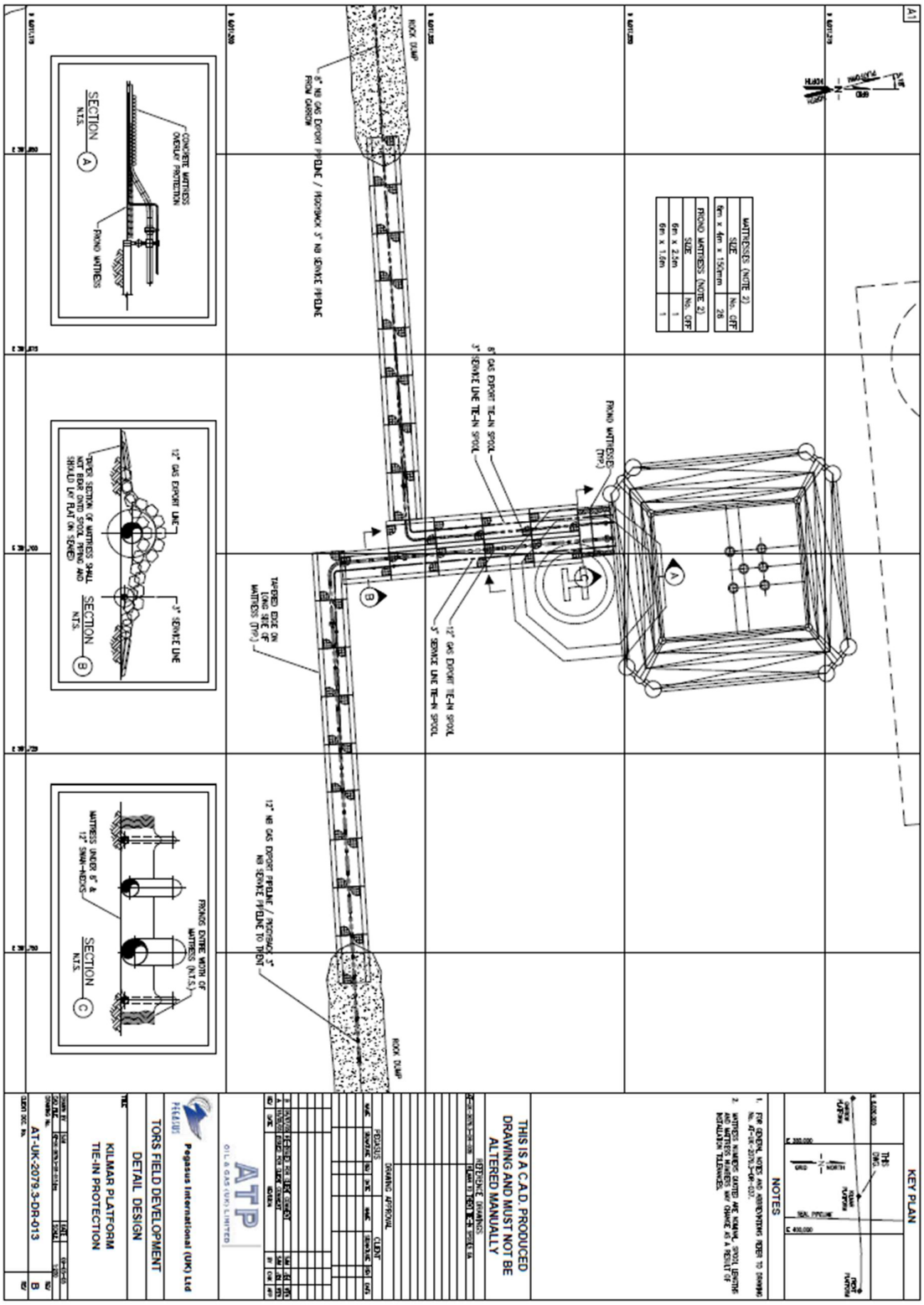


Figure A.8 Trent Compression platform approach layout.

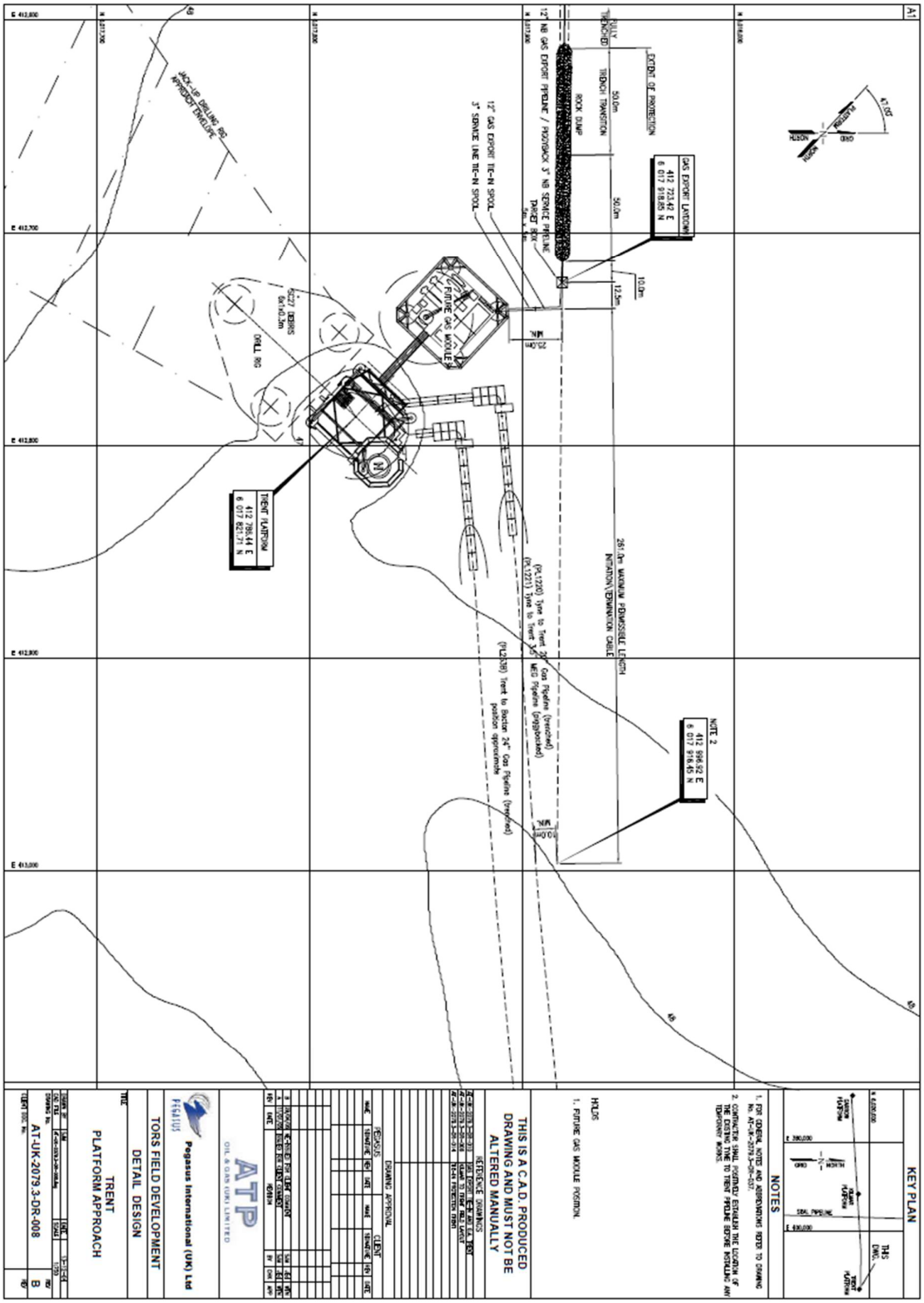


Figure A.9 Kilmar platform approach layout.

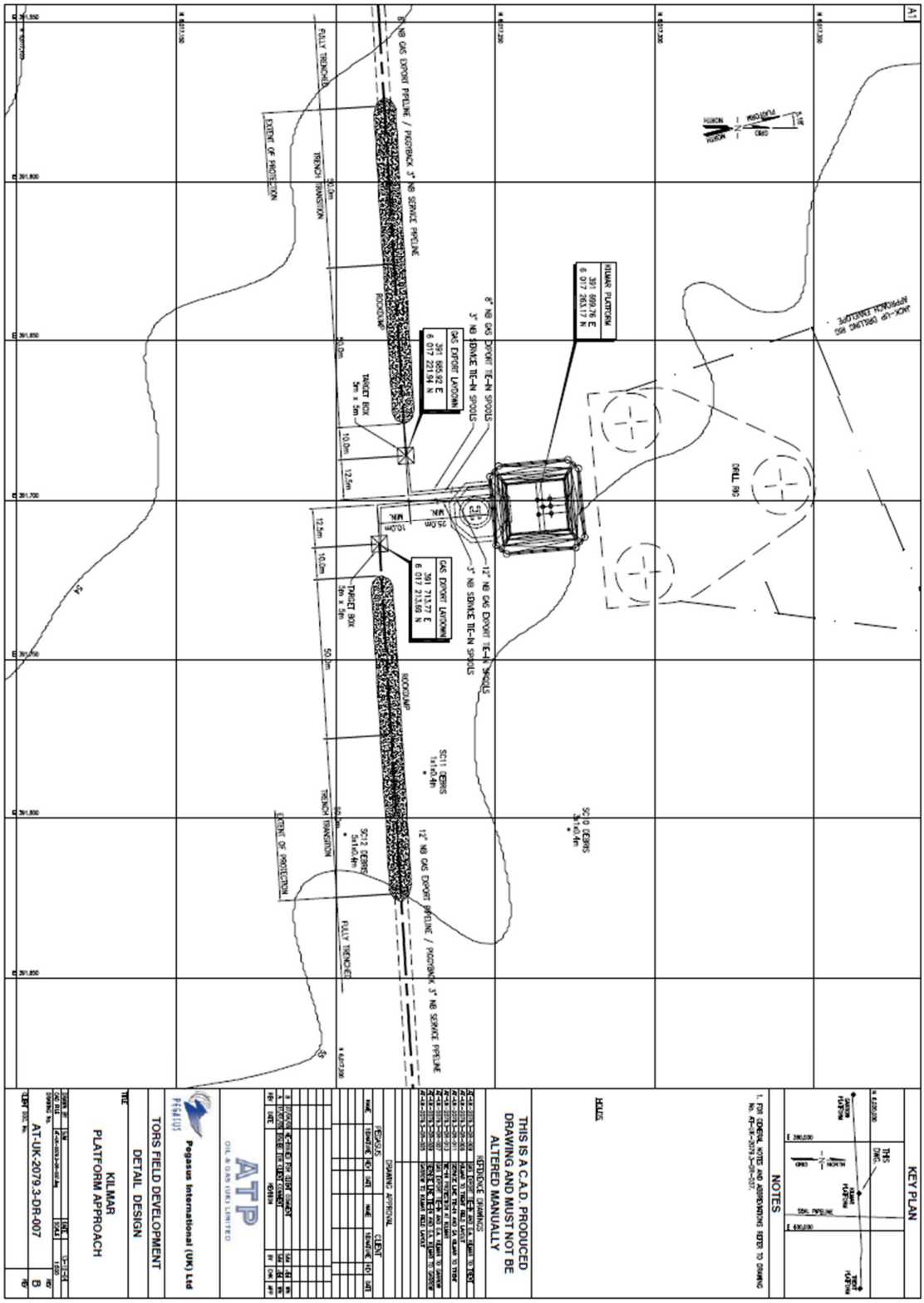


Figure A.10 SEAL pipeline crossing drawing

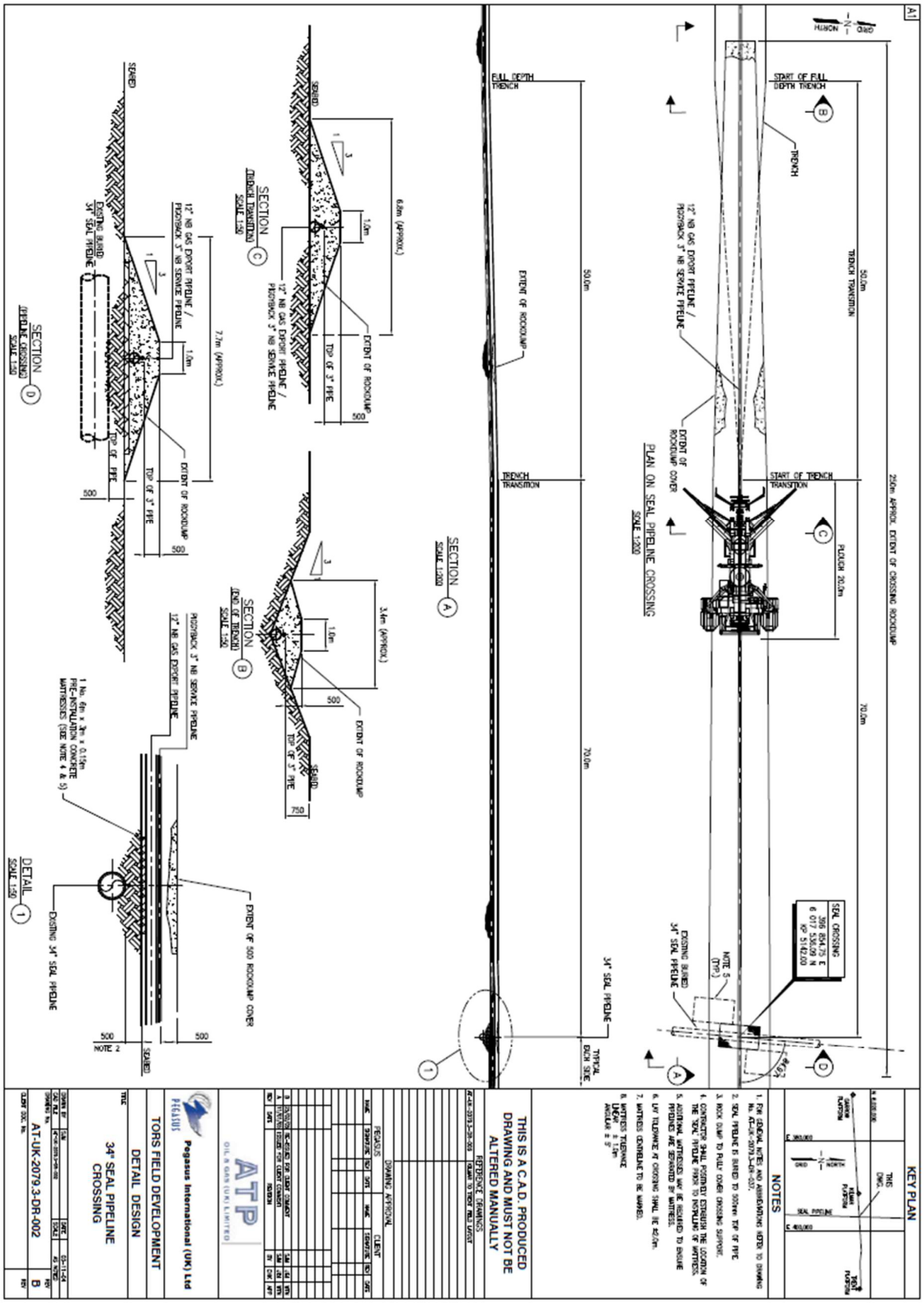


Figure A.11 As installed mattresses at SEAL crossing

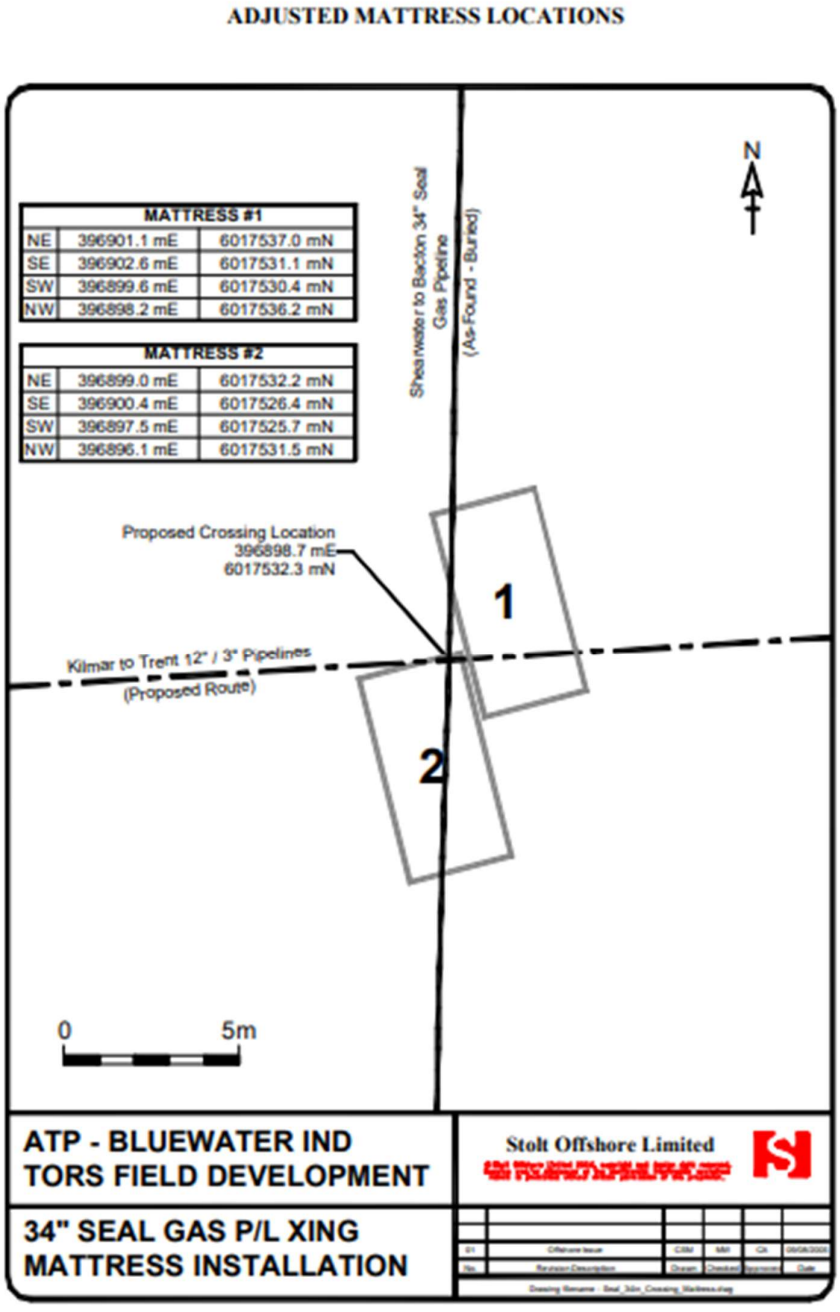


Figure A.12 Rock dump details (from as built records)

Rock

The rock material that will be used for the armour will have the following characteristics:

- freshly crushed rock : Granite / Gneiss
- rock grading : 2" - 8" D10 = 40 - 75 mm
  D50 = 100 - 150 mm
  D90 = 155 - 190 mm

Specific density : Approximately 2.65 ton/m3

Base Scope							
OD Pipeline [m]	**Total Dumping length [m[**	**Trench Transition [m]**	**Length on MSBL [m]**	**Dumping height Top of Pipe [m]**	**Top width [m]**	**Slopes [1:x]**	**Quantity approx. [ton]**
34" Shearwater to Bacton [SEAL] Gas Pipeline Crossing							
0.47	280	100	170	0.5	1.0	3	2,650
12/3" Pipeline Approach at Kilmar Platform							
0.37	90	50	30	0.5 – 0.65	1.0	3	850
12/3" Pipeline Approach at Trent Platform							
0.37	90	50	30	0.5 – 0.65	1.0	3	850

Appendix B Detailed Assessment Impact Assessment Criteria

Category	Impact Assessment criteria		
	Low	Medium	High
Safety			
Risk to other users (post ops)	None to minor snagging, no personal injuries likely	Snagging hazard if protection deteriorates or is moved, minor damage or loss to equipment (fishing gear), minor injury (1st aid case to RWC)	Full loss of fishing gear and/or damage to vessel, 1 LTI to multiple fatalities or long term injuries
Risk to those offshore (during ops)	None to 5 vessel days reqd in field, low number of lifts to deck, no recovery of hydrocarbon contacted surfaces, no hot work reqd (seafastening)	6-20 vessel days in field, <20 deck lifts, recovery of cleaned pipework sections to deck (<200m of sections), minor hot work (eg cutting seafastening)	>20 vessel days in field, >20 deck lifts, multiple lifts to deck or working at height reqd, recovery of uncleaned hydrocarbon contacted surfaces or NORM contaminated equipment, welding, or multiple hot work
Risk to 3rd parties (during ops)	None to 10 vessel days in field (zero to 7 days work outside marked 500m zones), no seabed obstructions left unattended during removal work,	11- 30 vessel days in field (8-14 outside marked 500m zones), snagging obstructions on seabed for short durations (port calls, WDT)	>30 days in field (>15 outside marked 500m zones), Obstructions left for long period unmarked on seabed.
Durations of diving intervention	None (tasks can be performed by remote tooling)	Intervention work by diver requiring no tools or structure entry	Multiple diver time required with equipment left in situ over more than 1 dive
Risk to those onshore (during ops)	Zero to 50T returned to shore, minimal break up required before recycling/disposal	50-500T returned to shore, some break up and double handling of materials reqd	>500T returned to shore, multiple lifting, transportation and break up reqd as part of recycling/disposal
High consequence event (during ops)	Low probability of collision dropped object or pressure release near personnel. No working at height required	Some short term working at height, no lifts above 10Te, short term working with pressure or high voltage equipment	Major regular lifts required to deck, regular working at height, vessels working in congested areas (close to platforms)

High consequence event (post ops)	No realistic scenario for remaining infrastructure to trigger event	Remote, highly unlikely scenarios could be envisaged for remaining infrastructure/seabed status to give rise to an event	Credible scenarios exist where remaining infrastructure/seabed status may give rise to an event
Environmental			
Discharges	No or negligible discharge	Discharges may cause short term change to the ecosystem but with good recovery potential	Discharges cause long term or permanent change to the ecosystem
Seabed disturbance	No or negligible disturbance. Short term seabed clouding from ROV/diver/equipment movement, no or very low impact on seabed communities	Localised disturbance up to 100% of the in situ equipment footprint, limited seabed material put into solution, short term impact on seabed communities from smothering	Wide area of disturbance >100% of equipment footprint, Large volumes of seabed material put into solution (dredging or mass flow excavation equipment reqd), risk of smothering and loss of seabed communities
Impact on Marine protected areas (SNS SAC)	No or negligible impact to the qualifying features of the MPA.	Minor impacts which do not prevent the site's conservation objectives from being met	Impacts that are likely to adversely affect the integrity of the MPA and are not in line with the site's conservation objectives
Impact on Marine protected areas (GWA SPA)	No work in or minimal marine traffic passing through SPA	<10 transits through SPA or <30 restricted to shipping lanes	Work located within SPA. >10 transit through or >30 restricted to shipping lanes
Energy usage (during and post ops)	None to 10 vessel days in field, low energy equipment reqd (eg surveys)	11- 30 vessel days in field, some short term high energy equipment required (eg crane lifts, hydraulic cutters)	>30 days in field, high energy equipment used (eg trenching or mass flow excavators, multiple lifting)
Atmospheric emissions	None to 10 vessel days in field, up to 250Te fuel consumed, low onshore odour	11- 30 vessel days in field, up to 500te fuel consumed, short term onshore odour	>30 days in field, >500Te fuel consumed, weeks of onshore odour
Noise (underwater and onshore)	Low levels of subsea cutting/piling, minimal	Some subsea cutting/piling	High levels of subsea

	onshore handling/crushing/ cleaning of materials	activities, short term noise from onshore activities	cutting/piling, mass onshore handling/crushing/ cleaning of materials
Accidental spills	Zero to 10l of low hydrocarbon concentrations/ chemicals or very gradual release (drips/bubbles)	11l to 10 cu m of low hydrocarbon concentrations/ chemicals	>10 cu m of low hydrocarbon concentrations/ chemicals
Smell (onshore)	No or short term smell. <10 days to process materials returned to shore	Period of smell from returned materials up to 1 month	Long term exposure to smells >1 month to process materials
Waste processing	<50T returned to shore, materials readily recyclable, no or negligible landfill	50-500T returned to shore, majority recyclable materials	>500T returned to shore, some materials non-recyclable, significant landfill anticipated
Technical			
Technical challenge	Regular construction tasks involved with common procedures, track record of similar tasks, tasks relatively independent of seabed conditions	Some new task specific procedures required; tasks partly influenced by seabed conditions	Untried working practise(s), Tasks volume/complexity vary with seabed conditions
Weather sensitivity	Generally workable operations for average operational downtime statistics for time of year	Small number of tasks require reduced weather window for short periods	Sustained periods of reduced weather required to complete tasks
Risk of major project failure	Standard equipment used; equipment spares readily available	Material break up or equipment failure leads to delay of up to 3 months	Likely break up of materials during recovery, requires new mobilisation with new equipment/procedures, major equipment damage incurred, delay in excess of 3 months
Regulatory compliance	Full compliance with guidelines or minor subjective deviation (such as partially buried mat left in situ, damaged gravel bag left in situ)	Minor noncompliance (e.g. short parts of pipeline buried but not to >0.6m, average > 0.6m)	Significant noncompliance, such as subsea structure left in place, large amount of infrastructure left exposed on seabed.

Repurposing opportunity	Full length of pipeline is available for others to use for up to 5 years	Full length or partial length of pipeline is available at time of decommissioning but may corrode quickly without intervention	None or very limited length of pipeline available for reuse.
Societal			
Access to site for other users (during ops)	No or minimal access restriction to site for less than a month, <1000m^2	Short term access restriction over a wide area during decommissioning work, permanent access restriction <1000m^2	Permanent access restrictions over a wide area >1000m^2
Access to site for other users (post ops)	No or minimal access restriction to site, <100m^2	Partial restriction over an area >100m^2 but <1000m^2	Permanent access restrictions over a wide area >1000m^2
Community impact (onshore)	Low or positive impact (jobs without significant noise/traffic/dust/odour impact)	Short term impact during material handling (noise/traffic/ dust/odour)	Long term impact, significant volume of landfill, eyesore, sustained noise/traffic/ dust/odour
Reputation impact (during and post ops)	Very low project media visibility, no 'new' precedents, costs within acceptable benchmark ranges, all regulator & stakeholder interests addressed in CA	Minor deviations from OSPAR derogation guidelines (eg small protection structure left in situ, <20m^2 area)	High project media visibility, new precedents, low or high costs, some regulator stakeholder interests not addressed. Significant media interest.
Economic			
Cost of work	Within 50% of lowest option, high certainty of cost outcome (likely lump sum work)	50-300% of lowest option, likely part lump sum part reimbursable work	>300% of lowest option, low certainty of cost outcome
Ongoing cost liabilities	Zero to £100,000	£100,000 - £500,000	>£500,000

Appendix C Main Options Worksheet

Main Options Worksheet

Aspect	Sub Category	Timing (D-during decom work L-post decom legacy)	Complete removal excluding rock dump sections (option 3a)	Partial removal (option 2b)	Full leave in situ (option 1)	Comments	Action
Safety	Risk to those offshore performing the work	D				*1. (option 3a)*	
	Risk to other offshore users	D					
	Risk to other offshore users	L				*2. (option 3a)*	
	Durations of diving interventions	D				*3. (option 3a)*	
	Risk to those onshore	D					
	High consequence event	D					
	High consequence event	L				*11. (option 1)*	
Safety overall rating							
Safety definition level			3	1	1	*10. (option 3a)*	
Environmental	Discharges	D					
	Seabed disturbance	D					
	Seabed disturbance (scour or other)	L					
	Impact on Marine Protected areas (SNS SAC)	D					
	Impact on Marine Protected areas (SNS SAC)	L					
	Impact on Marine Protected areas (GWA SPA)	D				*4*	
	Impact on Marine Protected areas (GWA SPA)	L				*4*	
	Energy useage	D					
	Energy useage	L					
	Atmospheric emissions	D					
	Atmospheric emissions	L					
	Noise (underwater and onshore)	D				*5. (option 3a)*	
	Accidental spills	D					
	Smell (onshore)	D					
	Waste processing	D					
Environmental overall rating							
Environmental definition level			1	2	2		
Technical	Technical challenge	D				*10. (option 3a)*	
	Weather sensitivity	D					
	Risk of major project failure	D					
	Regulatory compliance	L					
	Repurposing opportunity	L					
Technical Overall rating						*6*	
Technical definition level			3	1	1	*10. (option 3a)*	
Societal	Access to site for other users	D					
	Access to site for other users	L					
	Community impact (onshore)	D					
	Impact on reputation of stakeholders	D				*7. (option 3a)*	
	Impact on reputation of stakeholders	L				*8., 9.*	
Societal overall rating							
Societal definition level			2	2	2		
Economic	Cost of the work	D					
	Ongoing cost liabilities	L					
Economic overall rating							
Economic definition level			2	1	1		

Comments

1. There is increased risk to personnel and equipment on the recovery vessel handling pipelines/strapping that may have residual tension and unknown wall thickness integrity.
2. May require additional survey/and or rock dump to ensure crossing location cut pipeline is not left exposed for any significant period of time
3. Any work within the proximity of the crossing at SEAL would require agreement and a vessel/technical assurance process.
4. Best practise will be to use main shipping lanes when transiting through GWA SPA especially during winter months (when birds over wintering).
5. Amber rating driven by onshore noise, not a concern for SAC
6. Technical challenge is considered higher weighting than repurposing opportunity
7. Additional onshore jobs created hence green
8. Full removal scored amber as full removal would set an industry 1st.
9. Full leave in situ considered amber as precedent would be set to leave unburried mats in situ
10. Full removal has not been performed and is unproven technique (see note 8 also).
11. Snagging event on mats/spools underneath mats although highly unlikley was seen as a possible scenario that could lead to a high consequence event.