Wenlock pipelines (PL2355 and PL2356) Decommissioning Options Comparative Assessment

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Terms and Abbreviations

API	American Petroleum Institute (reference organisation used to define pipeline specifications)
BEIS	Department for Business, Energy & Industrial Strategy
BGT	Bacton Gas Terminal
CoP	Cessation of Production
DSV	Diving Support Vessel
FBE	Fusion Bonded Epoxy
MSV	Multi Support Vessel (typically a ROV and subsea crane vessel)
HDPE	High Density Polyethylene
Inde AC	Indefatigable Compression Platform

JNCC	Joint Nature Conservation Committee
KP	Kilometre Point (KP 0 at Wenlock platform, KP 36.1 at Inde AC)
MBES	Multi Beam Echo Sounder (seabed mapping equipment)
NFFO	National Federation of Fishermen's Organisations
NUI	Normally Unmanned Installation
OD	Outside Diameter
OGA	Oil and Gas Authority
OGUK	Oil and Gas UK
OPRED	Offshore Petroleum Regulator for Environment and Decommissioning
Piggy back blocks	Term given to formed rubber blocks used to attach a smaller pipeline to the back of a larger pipeline. Steel strapping is used to secure the blocks.
ROV	Remotely Operated Vehicle
SAC	Special Area of Conservation
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)
UHB	Upheaval buckling (the process where pipelines expand when filled with warm gas pushing the pipeline upward unless physically restrained by soil or rock above it)

1. EXECUTIVE SUMMARY

A Comparative Assessment of potential decommissioning options has been completed for the PL 2355 8" gas export pipeline and the PL2356 3" chemical injection line between the Wenlock and Inde AC platform. This Comparative Assessment is in support of Wenlock Decommissioning Programmes document APR-WEN-PMGT-008 which is further supported by the Wenlock Decommissioning Environmental Appraisal document APR-WEN-PMGT-011.

The Wenlock field is in the Southern Basin of the UKCS in licence P33 and P1062, block 49/12A and comprises one gas field which was first discovered in 1974. A three slot Normally Unmanned Installation (NUI) was installed on Wenlock in 2006 with a design life of 15 years and the first well was drilled and started production in 2007. Two subsequent wells were drilled and started production in 2008 and 2009. Production has since declined making the installation uneconomic and a Cessation of Production (CoP) application has been approved by OGA.

The pipelines are both 36.231km long welded carbon steel pipelines that run between the Wenlock NUI and the Inde AC platform where export gas is comingled with other fields gas and exported to shore. The Wenlock risers will remain in situ within the Inde jacket and be decommissioned along with the Inde AC jacket. The smaller PL2356 pipeline was installed strapped to the larger PL2355 pipeline and neither pipelines are concrete coated but are trenched into the seabed for the majority of the route. Rock dump, concrete mattresses and gravel bags were used to protect pipeline sections that were not trenched. 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 piggyback lines and a mid-line tee structure 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 pipeline sections in situ. Sub options for the pipeline approaches at each platform end and for the mid-line tee 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 Wenlock jacket to be removed and complete isolation at Inde AC to be achieved.

The options were assessed using the OPRED 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.

As a result of the assessment it is recommended that for both the PL2355 pipeline and the PL2356 pipeline that a partial removal option is adopted where the majority of the pipelines are left in situ. At the platform ends the sections of mattress covered pipelines shall be removed up until the point where the pipelines are either rock dumped or buried to greater than 0.6m. The protection mattresses shall also be recovered. At the mid-line tee location the recommendation was to remove the protection structure cover and leave the remaining infrastructure in situ flush with the natural seabed level. As part of the consultation process with OPRED they have confirmed that the mid-line tee protection structure is classed as an installation and is subject to international obligations for decommissioning under the terms of OSPAR Decision 98/3. Given these OSPAR requirements and the fact that full removal of the mid-line tee structure was also found to be an acceptable option within the Comparative Assessment, full removal of the mid-line tee protection structure will be undertaken.

2. INTRODUCTION

The purpose of this Comparative Assessment is to provide an assessment of potential decommissioning options available for the Wenlock PL2355 and PL2356 pipelines against a set of assessment criteria derived from BEIS guidance documents and in line with OGUK's '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 seabed sections of the pipelines are shown in table 2.1.

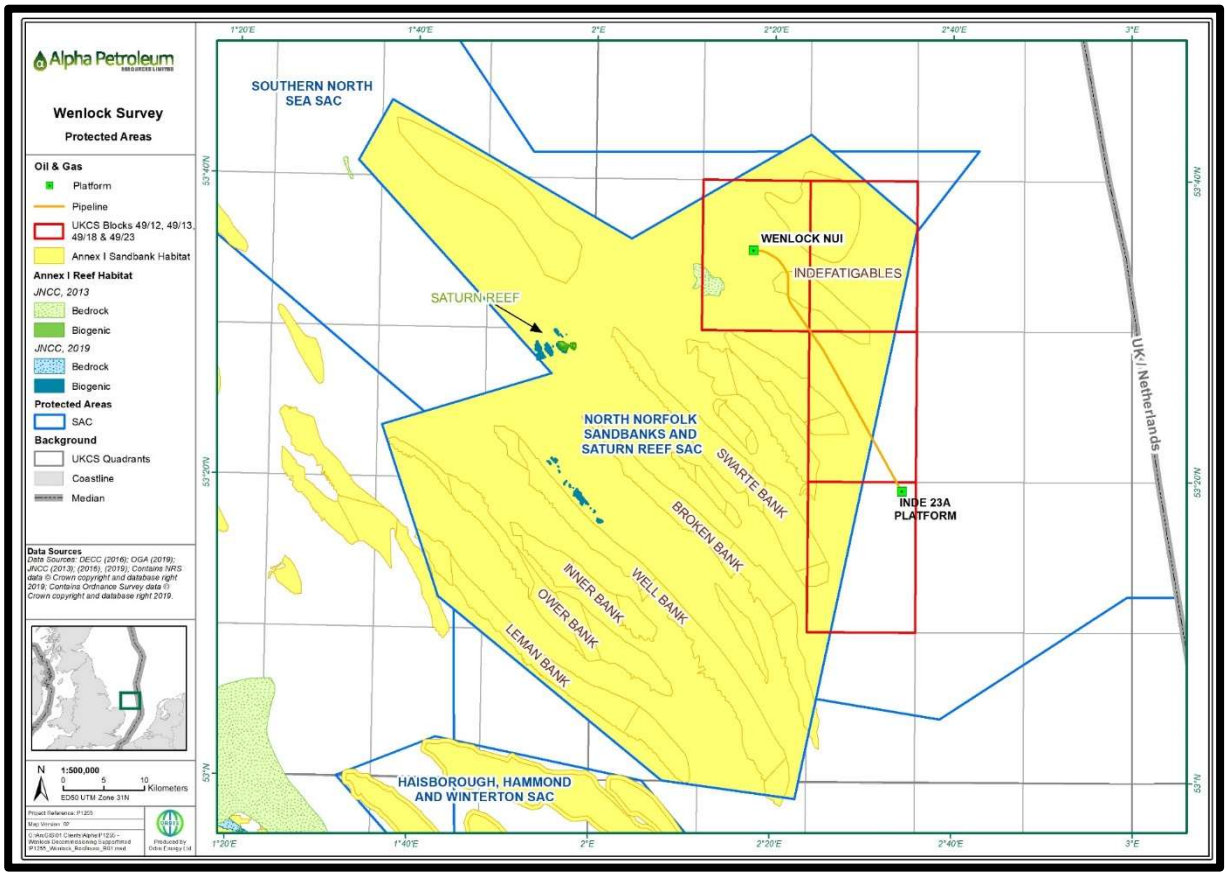
Pipeline	Size, OD	Length	Material	Wall Thickness	Corrosion coating	Design pressure	Burial status
PL2355	219.1 mm	36231 m	API 5L X65 carbon steel	14.3 mm	0.5mm FBE	296 barg	Trenched
PL2356	88.9 mm	36231 m	API 5L X65 carbon steel	7.6 mm	0.5mm FBE	296 barg	Trenched

Table 2.1 PL2355 and PL2356 pipeline data

Wenlock comprises of one gas field: 49/12A Wenlock (Block 49/12A) which is located 98km offshore North East from the Bacton Gas Terminal (BGT), 6.5kms north of the Viking A field and 36kms northwest of the Indefatigable field.

The Wenlock platform and approximately 28.6 km of the route of the Wenlock pipelines, including the mid-line tee structure, is located within the boundary of the North Norfolk Sandbanks and Saturn Reef Special Area of Conservation (SAC), designated for the protection of Annex I sandbanks and biogenic reef. In addition, the Wenlock platform and approximately 16.5 km of the route of the Wenlock pipelines, excluding the mid-line tee structure, is located within the boundary of the Southern North Sea SAC, designated for the protection of harbour porpoises (see Figure 2.1). Further details on the SACs can also be found in the supporting document Wenlock Decommissioning Environmental Appraisal APR-WEN-PMGT-011. The North Norfolk Sandbanks are the best example of linear sandbanks in UK waters. The banks are important not only as geological features, but they also support a variety of fish, seabirds and important communities of invertebrates like crabs, starfish and worms. The area is a feeding ground for thousands of birds who depend on the marine environment for their survival. In addition, the location is an important spawning and nursery ground for several different fish species. These include mackerel, herring, plaice, lemon sole, sandeel, sprat, Nephrops, whiting and cod which can be affected by disturbance to the seabed and discharges of chemicals or hydrocarbons. The Wenlock development is situated in an area of mainly sandy silty seabed with sandbanks and megaripples. Water depths vary from ~25m at Wenlock to ~18m over the Indefatigables sand bank to ~31m towards the southern Inde AC end and the seabed is generally of a flat nature with sand ripples.

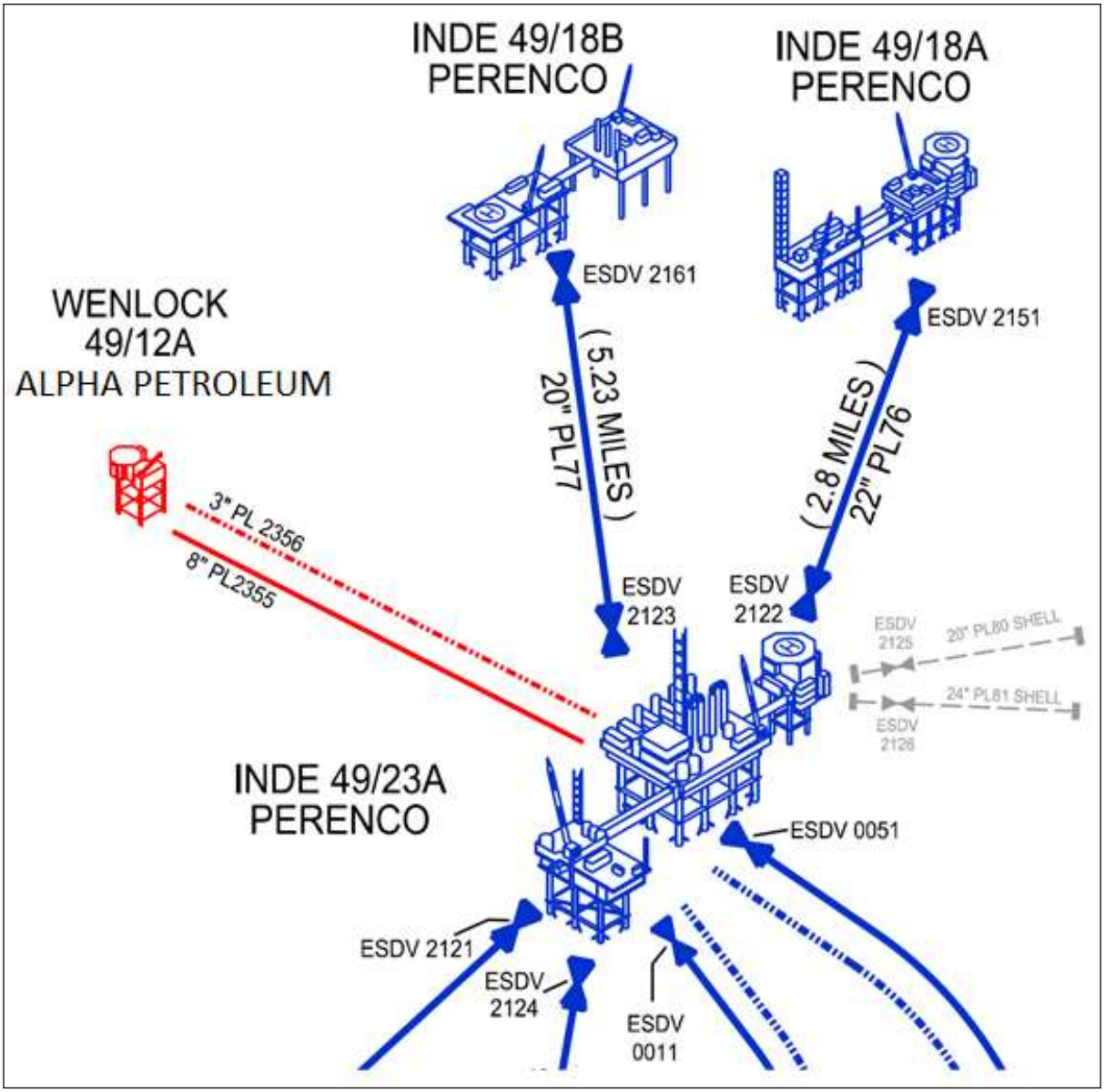
Fig 2.1 Sandbank and SACs chart



A three slot not normally manned platform was installed on Wenlock in 2007 and is linked back to the Perenco UK Limited operated Inde AC platform via the 8-inch PL2355 and 3-inch PL2356 pipelines. After processing on Inde AC, the gas is exported back to the Perenco operated Bacton Gas Terminal via the Indefatigable platform complex offtake pipeline PL22. Chemicals for hydrate and corrosion inhibition are supplied from Inde AC via the dedicated 3-inch pipeline, which is piggy-backed to the gas export line. See Figure 2.2.

Wenlock production has since declined making the installation uneconomic such that a declaration of Cessation of Production (CoP) for Wenlock is in 2021. This document will be used to help determine the scope of work for decommissioning activities associated with the Wenlock pipelines.

Fig 2.2 Wenlock Infrastructure



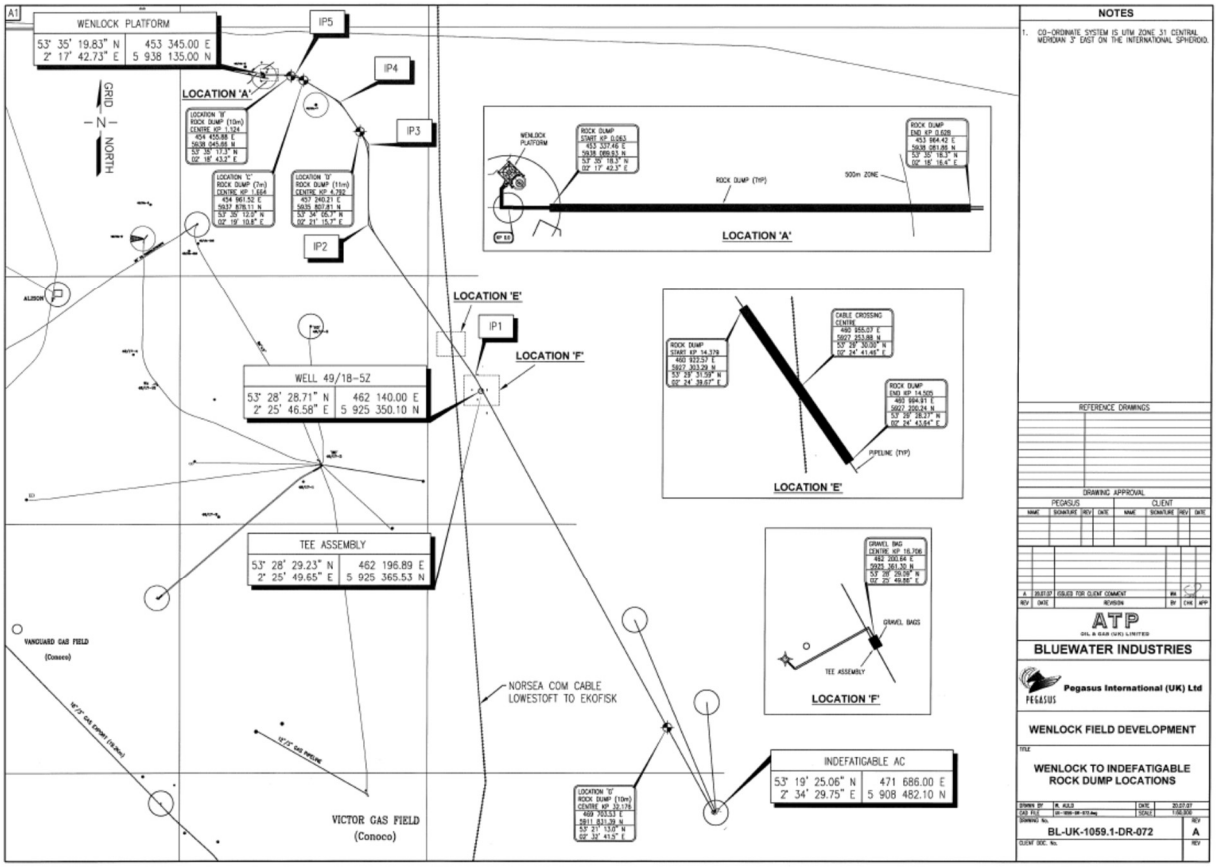
3. STATUS OF THE INFRASTRUCTURE

This section contains a summary of the overall pipelines route and key features along it. Survey charts and video footage of the platform approaches and mid-line tee are available on request along with the full route as trenched charts and intermediate Multi Beam Echo Sounder (MBES) survey data.

3.1 Overall layout

An overall field layout of the pipeline routes is shown below.

Figure 3.1 Overall Wenlock field layout



The pipelines were installed as piggyback pipelines and trenched to a depth of approximately 1.5m. Where the pipelines were not trenched (at the platform approaches or cable crossing) either concrete mattresses or rock dump was installed over the pipelines to provide protection. In addition, several locations along the route were rock dumped as well as being trenched, in order to provide down force on the pipelines to prevent UHB on the pipelines during their operational life.

3.2 Burial status

Based upon the original as trenched 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 1.0 and 1.5m deep with the exception of the following locations:

- Pipeline approaches at both platform ends
- Cable crossing at KP 14.373 – KP 14.530

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

The Wenlock pipelines run approximately parallel to some large-scale sandbanks in the area and in particular cross the Indefatigable sand bank closer to the Wenlock end (around KP 5.5 – 9.5). Fig 2.1 shows these. Water depth comparisons for the original as trenched survey in 2007, an operational interim survey in 2015 and the pre decommissioning survey in 2020 have shown no migration of the sandbanks is occurring. These comparisons are detailed in Appendix A.

From the surveys it can also be seen that the seabed has megaripples of approximately 0.2m in height throughout pipelines routes. Although no evidence from the various surveys shows that these miggaripples are migrating along the seabed surface it has been known for megaripples to do so in other locations. Given the burial depths of the pipelines even if this does occur the pipelines will remain buried below 0.6m. Appendix A shows further illustrations of the impact of potential megaripple migration.

The PL2355 and the PL2356 lines are made of carbon steel, API grade 5L X65 with a 0.5mm FBE coating. The PL2355 line also has it's offshore welded pipe joints covered with a sheet of HDPE as an outer coating overlapping with the FBE coating. As part of the design for the pipeline systems, stability and upheaval buckling calculations were performed to ensure no movement of the pipelines during operational life was expected. In this operational condition the gas export pipeline was filled with warm gas which is significantly more buoyant than water. In a water flooded condition (as would be the decommissioned left in situ state) both pipelines are significantly negatively buoyant and so no upward movement of the pipelines would be expected during their decommissioned lifetime.

3.3 Crossings

The pipelines at the NorSea communications cable crossing location at KP 14.450 were not trenched over a section directly above the cable. The cable is located at a depth of approximately 0.5m below seabed. Concrete mats were laid below the Wenlock pipelines to provide separation between the cable and pipelines before the un-trenched section of pipeline was rock dumped to provide protection over an approximate 160m length. Subsequent surveys have shown this rock dump to be very stable on the seabed. Appendix A has further detail on the cable crossing status.

3.4 Spools at Wenlock and Inde AC approaches

The pipeline spool sections at the Wenlock approaches are laid on the seabed surface and protected with concrete mats and gravel bags. At the riser to spool goose necks the pipelines are exposed. Beyond the spool sections there is a short section of the pipelines (~15m) that are also laid on the seabed and protected with concrete mats. At KP 0.063 the pipelines have been rock dumped to provide a minimum of 0.8m cover. This continues through the pipeline trench transitions where the pipelines are then buried 1.0-1.5 m below the adjacent seabed level.

The last ~70m of pipelines and the spool sections at the Indefatigable platform complex are in the trench transition zone and then laid on the surface and protected with concrete mats and gravel bags up to the start of protective rock dump close to the Inde AC platform. Where the pipeline spools cross over the Indefatigable pipelines PL76 and PL77, concrete mat supports

were built below the Wenlock spools to ensure the pipelines had separation between them. These sections of spool pipeline were then rock dumped to provide protection of the whole area.

Layouts of both platform approaches are detailed in Appendix A.

3.5 Mid-Line Tee

At approximately KP 16.690 a tie in tee and associated valve pipework was installed in each of the Wenlock pipelines after the trenching of the pipelines was completed. The post trenching depths are depicted in fig A.12 within Appendix A. To enable tee valve pipework and a protection frame to be installed a 2m deep pit was excavated in the seabed around the pipelines to expose the pipeline. Following installation of the tee valve pipework (see the middle sketch of fig A.13 in Appendix A) a mid-line tee protection structure (right hand sketch of fig A.13) 4.5m x 2.8m x 2.2m / 5.4Te was installed over the exposed pipeline and valve pipework. Gravel bags and 4 concrete mats were also installed to partially fill the excavated pit and prevent any seabed snagging hazards. Fig A.14 in Appendix A shows the as installed configuration.

Over the operational life of the field the excavated pit area appears to have naturally filled in, to the extent that only the top cover of the protection frame appears visible. The internal area of the protection structure shows the level of natural in fill to be at the same level as the surrounding natural seabed level.

OPRED have confirmed that the mid-line tee protection structure is classed as an installation and is subject to international obligations for decommissioning under the terms of OSPAR Decision 98/3.

3.6 UHB locations

Rock dump was placed at the following locations set out in table 3.1 with a top width of 1m and side slopes with a 1:4 gradient. Heights were determined based upon UHB calculations and varied between 0.2m and 1.5m. No erosion or displacement has been noticed on or around these locations during the operational life of the Wenlock field.

Table 3.1 UHB rock dump locations

KP from	KP to	Max height (m)	Length (m)
0.063	0.522	1.5	459
0.531	0.538	0.4	7
0.585	0.594	0.2	9
0.609	0.628	0.9	19
1.119	1.129	0.2	10
1.660	1.667	0.2	7
4.790	4.801	0.2	11
32.171	32.181	0.3	10

4. COMPARATIVE ASSESSMENT PROCESS

The CA has been undertaken in line with Department for Business, Energy and Industrial Strategy (BEIS) 'Guidance Notes: Decommissioning of Offshore Oil and Gas Installations and Pipelines under the Petroleum Act 1998' (November 2018). Comparative assessment decisions have also been made broadly in line with principals set out in the Oil and Gas UK's 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 recovery of all infrastructure, a leave all infrastructure in situ option and several partial removal options of specific elements. In a desktop exercise each of these options were 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 Alpha Petroleum Limited staff not directly involved with Wenlock decommissioning planning 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 SACs, impact on flora and fauna (smothering)
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
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 'Wenlock pipelines (PL2355 and PL2356) Terms of Reference for Stage 2 Comparative Assessment Workshop, document number APR_WEN_PMGT_015' a virtual workshop with available stakeholders and Alpha decommissioning project team members was held. The workshop was conducted via MS Teams as a result of the Covid-19 pandemic. This, 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 sub category 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, partial removal (option 2b and 2c as a base case for partial removal) and complete leave in situ. Following the main options, the sub options related to the partial removal option were reviewed.

On completion of the sheets the workshop group reviewed the option summaries and allocated a final colour rating to each option/sub 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	Major collisions, dropped object leading to pressure release or injury to personnel, fall from height, incident involving public onshore
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 areas	Impact on qualifying features of North Norfolk Sandbanks & Saturn reef SAC (Annex 1 sandbank habitat and *Sabellaria spinuolsa* reef) and 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
Waste processing	Tonnage of material returned to shore, recyclability of materials
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)
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 two pipelines PL 2355 and PL 2356.

Table 5.1 Wenlock pipelines Comparative Assessment option screening. `

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

Number	Sub Options	Safety	Environment	Technical	Societal	Economic	Selected for further study
1a	Rock dump to bury above seabed tee sections						
1b	Rock dump all mattress protection areas and leave in situ						
2a	Leave pipeline as is but remove tie in spools sections (including rock removal)						
2b	Leave pipeline as is but remove only mat covered spool sections						SELECTED
2c	Leave pipeline as is but remove mid line tee protection structure						SELECTED
2d	Leave mid line tee manifold piping and protection structure as is						SELECTED
3a	Remove by reeling (but leave in situ rock dumped sections)						SELECTED
3b	Removal of rockdump at crossings to remove above seabed pipe sections						

Given the two pipeline systems have been laid together with the 3" pipeline piggybacked to the 8" pipeline the assessment screening is the same for both pipelines.

Full removal option

A full recovery of all infrastructure for each pipeline has been considered in the screening assessments. For most of the pipeline length the most appropriate option considered for this was the removal by reeling. The platform approach sections and the mid-line tee sections would require separate recovery solutions but have also been considered in the screening exercise as separate options. Other full recovery solutions could exist such as cutting and recovery of separate sections or reverse S lay but as these would involve significantly greater vessel time and risk, these were not identified as viable options for screening.

As a consequence of the burial condition of the pipelines prior to reverse reel lay recovery of the pipelines the full length of the pipelines would require de-burial (*mostly 1.5m deep with full natural backfill and numerous rock dump locations for trench transitions, the cable crossing and UHB prevention along the route*). This would require extensive disturbance of the seabed likely using a mass flow technique. Large volumes of sediment would be put into suspension within a SAC area. This carries a high risk of smothering of benthic animals and so has been assessed as a red unacceptable option in the Environmental category. Similarly, 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 was also given a red ranking in the Economic category. There is also a higher safety risk associated with reeling back the 2 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 process. These will further be considered in the detailed assessment workshop.

Removal of rock-dump at the cable crossing and at the trench transitions and platform approaches before subsequent recovery of the Wenlock pipelines sections would require a similar mass flow excavation process to remove the rock, carrying with it similar environmental concerns. However, as this is only over much reduced sections of pipeline route length (~500m as opposed to 36km for the full pipeline recovery option) it was assessed as amber within the Environmental category. To remove the exposed pipeline length and separation mattresses, however, would require multiple cut and lift operations above the crossed cable and Indefatigable pipelines PL76 and PL77. This would involve significant vessel time and has

higher Safety risks and Economic costs. These options (3b and 2a) were therefore not selected for stage 2 comparative assessment.

Rock dump and leave in situ option (options 1a and 1b)

The option to rock dump areas covered by protection mattresses was identified as an option for screening (1b) but is highly likely to be opposed by some stakeholders. It is only likely to be considered by all stakeholders as an acceptable solution where no other viable option exists. This is not the case for the Wenlock pipelines and therefore the rock dump solution has not been carried forward to the detailed assessment stage. Similarly, option 1a to rock dump the tee structure and leave in situ has not been selected for further assessment.

6. SELECTED OPTIONS COMPARATIVE ASSESSMENT (Stage 2 results)

The full impact assessment worksheets with all main and sub category ratings are included in Appendix C for reference, however, the following is a brief 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 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 Wenlock and Indefatigable pipeline ends. Safety risks and onshore impacts are therefore low. 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 is some legacy snagging risks associated with this option, however, the risk is considered low and impact relatively small. No known snagging events or damage to the mid-line tee protection structure or mats has been seen during the operational life of the pipeline systems. 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 but did not think this is of high concern to prevent the option being considered.

Partial removal (Base case)

The base case partial removal option (2b and 2c combined) was found to be broadly acceptable and the preferred solution of the main options. In addition to the riser to spool goose neck sections of pipeline this considered removal of the concrete protection mats and underlying pipeline sections at the Wenlock and Indefatigable platform approaches and removal of the mid-line tee protection structure. 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. For this reason the option was given a medium risk rating in the safety category. Equipment and technologies required to recover and break up the materials are well known to the industry and are not technically challenging. It is estimated that 7 days vessel time would be required to recover the mats and underlying pipe sections with a further 3 days required to recover the tee protection structure. 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.

Other than the areas where rock dump overlies the pipelines, the seabed surface is expected to be returned to it's natural status along the entire area impacted by the Wenlock facilities. Given the stable nature of the seabed no left in situ facilities would be expected to be seen over time at the seabed surface.

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 costs for this option are expected to be approximately 3 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.

Partial removal (option 2b & 2d)

Similarly, to the base case partial removal option this involves the removal of the riser to spool goose neck sections of pipeline and considers removal of the concrete protection mats and underlying pipeline sections at the Wenlock and Indefatigable platform approaches. The mid-line tee protection structure and pipeline protection materials around it are fully left in situ. This option was found to be tolerable but not a preferred option.

There are slightly less offshore vessel days involved (3 days less) during the decommissioning work than the partial removal base case option, less surface area impacted and less materials returned to shore but these are not significantly less to change the overall impact ratings from those allocated to the base case partial removal option for the categories associated with the decommissioning operations.

With the tee structure fully left in place the protection structure cover will remain approximately 0.5m above the natural seabed level until full corrosion of the steel tubulars has taken place. This will present a small area of potential snagging hazard and would require periodic surveys to confirm its condition over a number of years. The legacy costs associated with these surveys are therefore greater than for the base case partial removal option. Safety and environmental impacts are also marginally increased over the base case partial removal as a result of these surveys. Leaving the structure would require a minor deviation to the OSPAR derogation guidelines and a medium rating has therefore been given to the legacy reputational impact.

Partial removal (option 2c only)

This partial removal option considered the full leave in situ of the Wenlock and Indefatigable approach mats and underlying pipelines but the removal of the mid-line tee structure. As such the option had similar ratings to the full leave in situ option and was found to be broadly acceptable.

Although the durations of vessel operations and number of subsea lifts are greatly reduced compared with the combined mat and tee structure removal (option 2b & 2c) they are not reduced enough to drop the safety impact rating to a low risk. Similarly, although the legacy snagging risk associated with the tee structure has been removed there remains a snagging and legacy survey implication associated with the mats. Removal of the mid-line tee structure

only reduces the seabed surface area not returned to its natural state slightly from the full leave in situ option. Uncertainty around the public perception associated with not removing infrastructure and the subsequent impact this may have on stakeholders remains with this option although again the workshop team did not think this is of high concern to prevent the option being considered.

The decommissioning costs for the option are more than 50% higher than the leave in situ option and so have a medium impact rating whereas the legacy survey costs are only marginally reduced compared to the full leave in situ option.

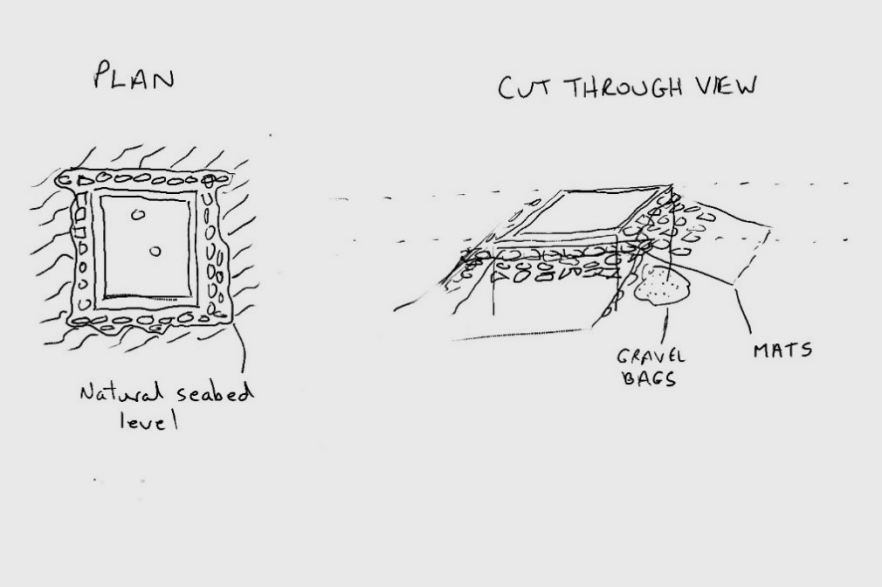
Partial removal (option 2c variance 1)

This variance considered the removal of the mid-line tee protection structure cover only rather than the full protection structure. The protection cover has locking pins that can be unlatched allowing it to be lifted separately to the buried protection frame itself leaving the protection frame flush with the natural seabed level. This option was considered by the workshop team to be the preferred option for the mid-line tee structure.

Post Assessment note : *As part of the post Comparative Assessment consultation process with OPRED they have confirmed that the mid-line tee protection structure is classed as an installation and is subject to international obligations for decommissioning under the terms of OSPAR Decision 98/3. Given these OSPAR requirements and the fact that full removal of the mid-line tee structure was also found to be an acceptable option within the Comparative Assessment, full removal of the mid line tee protection structure will be undertaken*.

Overall vessel durations at the mid-line tee are reduced with this variance and the need to carry out dredging work to expose protection frame lifting point locations and cut locations on the ROV valve extensions have been removed. It has also removed the requirement to use hydraulic shears to cut the valve extensions. The legacy snagging risk at the tee structure has been further reviewed post workshop and is also considered low. Fig A.14 in Appendix A shows a cross section of the protection structure with cover and the natural seabed level. Fig 6.1 shows the configuration with the cover removed. In the event trawl gear or other dragged equipment is pulled over the mid-line tee location potentially digging below the seabed surface level the concrete mats are angled up towards the protection structure top tubulars and as such would deflect the gear up and over the tubulars. The lower edges of the mats furthest away from the structure are 1-1.5m below seabed level and are highly unlikely to get snagged. The overall safety risk rating with this variance is therefore considered low.

Fig 6.1 Sketch of mid-line tee protection structure with cover removed.



Seabed disturbance is reduced with this variance as the cover is not being lifted through any seabed material. The seabed surface area is also almost returned to its natural status with only the top of the structure tubulars remaining at the seabed surface. This combined with the reduced vessel time required resulted in a low overall environmental impact rating.

Costs for the removal work are reduced compared to the full structure removal option and there are no additional legacy survey requirements.

Partial removal (Option 2c variance 2)

This variance considered the full removal of the mid-line tee protection structure and full removal of the 4 concrete mats and gravel bags buried around the protection structure. This variance was considered tolerable but not preferred.

To enable ROV or diver access to the mats and gravel bags a significant amount of dredging would be required to re-excavate the pit in which the protection structure was original installed. There would be some uncertainty over the natural stability of this pit and the speed to which the pit will subsequently naturally backfill after removal works. This increases the duration the vessel and divers are required to be on site. It also introduces an additional diver risk of having to work in a confined pit area with potentially unstable slopes. The technical uncertainty for this variance is also increased as the volume to be dredged and the condition of the gravel bags under the mats will not be known until they are uncovered.

The re-excavation work would either be performed by localised subsea dredging units or with a mass flow technique. Both methods will create significant seabed disturbance and temporarily put the dredged soils into solution which may have some smoothing impact on seabed communities. The overall environmental rating for this variance was therefore given a medium impact rating.

Costs for this variance have increased in line with the additional vessel durations required and the need to periodically re survey the pit area until such time as it has naturally backfilled itself and returned to a flat natural seabed level.

Full removal (Option 3a)

This option considers leaving the pipeline sections protected by rock dump in situ 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, mat recovery and cut and lifting of the platform approach sections of the pipelines. The option was considered to be in tolerable and will not be undertaken.

A number of safety concerns that may occur during the removal work were highlighted at the workshop. These include those associated with reverse reeling the pipelines where the remaining wall thickness of the pipelines and therefore their residual strength in the pipelines is not a definitive number. When applying tension to the pipeline to recover it back to the reel 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 low certainties to the level of definition in the technical and economic 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. Overall, this option was given a high impact 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. 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. 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 a high impact rating in the environmental category.

Technically each of the operations required for this option are feasible and are within the industries capabilities, however, the combination of the activities are not common practise for the industry and would require new procedures and risk assessment processes. 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 also 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 operations.

The workshop group felt that a full recovery option for a well buried and stable pipeline system would set an unwelcome precedent within the industry and would negatively effect the reputation of the stakeholders involved. The community impact onshore was given a medium impact rating due to 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. Overall, the societal category was given a medium rating.

The cost for the decommissioning work with this option is over eight times that of the lowest cost option and over 4 times that of the workshop's preferred option. Legacy surveys may be reduced but would still be required to confirm that the excavated pipeline trench has naturally backfilled itself close to or to the natural surrounding seabed level.

7. RECOMMENDATIONS OF THE COMPARATIVE ASSESSMENT PROCESS

The below summary table shows the final outcome of the detailed assessment with a recommendation to adopt the partial removal option (2b and 2c Variance 1). This represents removal of the concrete protection mats and underlying pipeline sections at the Wenlock and Indefatigable platform approaches and removal of the mid-line tee protection structure cover. The remainder of the buried and rock dumped pipeline sections should be left in situ along with the buried section of the mid-line tee protection structure and surrounding mats and gravel bags..

Table 7.1 Final detailed assessment ratings table

	Main Options			Partial removal mid line tee options					
Aspect	**Complete removal (option 3a)**	**Partial removal (option 2b & 2c)**	**Full leave in situ (option 1)**	**Remove mats leave tee (option 2b & 2d)**	**Remove tee structure leave mats (option 2c)**	**Remove tee cover only (option 2c Variance 1)**	**Remove full tee protection (option 2c Variance 2)**	**comments**	**Actions**
Safety overall rating									
Safety overall definition	2	1	1	1	1	1	2		
Environmental overall rating									
Environmental overall definition	1	1	1	1	1	1	1		
Technical overall rating									
Technical overall definition	3	1	1	1	1	1	2		
Societal overall rating									
Societal overall definition	2	2	2	2	2	2	1		
Economic overall rating									
Economic overall definition	3	1	1	1	1	1	1		
Final rating			*i)*	*i) ii) iii)*	*i)*			*i), ii) & iii) below*	

Comments
i) JNCC position noted that clear seabed is optimal for the SAC.
ii) Noted that significantly lower surface area of infrastructure within SAC left in situ.
iii) OPRED or other stakeholder uncertainty over legal/guideline positions

Post Assessment note : *As part of the post Comparative Assessment consultation process with OPRED they have confirmed that the mid-line tee protection structure is classed as an installation and is subject to international obligations for decommissioning under the terms of OSPAR Decision 98/3. Given these OSPAR requirements and the fact that full removal of the mid-line tee structure was also found to be an acceptable option within the Comparative Assessment, full removal of the mid-line tee protection structure will be undertaken.*

8. REFERENCES

1. APR-WEN-PMGT-008 Wenlock Decommissioning Programmes
2. APR-WEN-PMGT-011 Wenlock Decommissioning Environmental Appraisal
3. Department for Business, Energy and Industrial Strategy (BEIS) 'Guidance Notes: Decommissioning of Offshore Oil and Gas Installations and Pipelines under the Petroleum Act 1998' (November 2018)
4. OGUK's, Guidelines for Comparative Assessment in Decommissioning Programmes: Issue 1: Oct 2015
5. Benthic Solutions Limited (BSL) (2020) Wenlock & PL2355/PL2356 – Pre Decommissioning Environmental Baseline Survey Report (Report Reference Number: 2010_WEN-PL2355_EBS).
6. JNCC North Norfolk Sandbanks and Saturn Reef MPA. http://jncc.defra.gov.uk/page-6537
7. JNCC Southern North Sea MPA. https://jncc.gov.uk/our-work/southern-north-sea-mpa/
8. APR_WEN_PMGT_015 Wenlock pipelines (PL2355 and PL2356) Terms of Reference for Stage 2 Comparative Assessment Workshop
9. Benthic Solutions Limited (BSL) (2020b) Wenlock & PL2355/PL2356 – Pre Decommissioning Habitat Assessment Survey Report (Report Reference Number: 2010_WEN-PL2355_HAS_00)

APPENDIX A

Water depth comparisons

Water depths along the route have been compared from the original as installed surveys (2007), the interim 2015 operational survey and the latest pre decommissioning surveys (2020) to establish if any migration of the seabed over the sandbanks or other areas along the route have occurred. Fig A.1 below shows the 2007 as trenched survey chart over the Indefatigable sand bank area. The green line shows natural seabed level and the blue lines show the as trenched pipeline positions. Red is the seabed level above the pipe immediately after trenching indicating much of the trench backfilled itself very quickly. It should be noted that the chart scales are highly exaggerated to emphasise features on what is essentially a flat seabed. The horizontal scale is in kilometres versus a vertical scale in metres.

From the interim operational surveys, no evidence of any trench can now be seen with the trench depressions filling back in to return the seabed to it's natural level. Comparison sections of the natural seabed found in the 2015 operational survey (darker green) and 2020 pre decommissioning survey (darker blue) have been imposed onto the as trenched chart in Fig A.2 at the relevant sections at the peak of the Indefatigable sand bank and on its slope. No significant migrations of the seabed can be seen even within the small peaks over the top of the sand bank. Given the similarities in seabed profiles the slight discrepancies in absolute depths between the 2007, 2015 and 2020 surveys are most likely due to survey tolerances, especially as almost the same discrepancy is seen throughout the route. Note that the 2015 and 2020 survey profiles have had their vertical scales offset for ease of comparison.

Full route survey data from the original as trenched charting, the interim 2015 operational survey and the 2020 pre decommissioning survey are available on request.

Fig A.1 2007 As Trenched survey chart

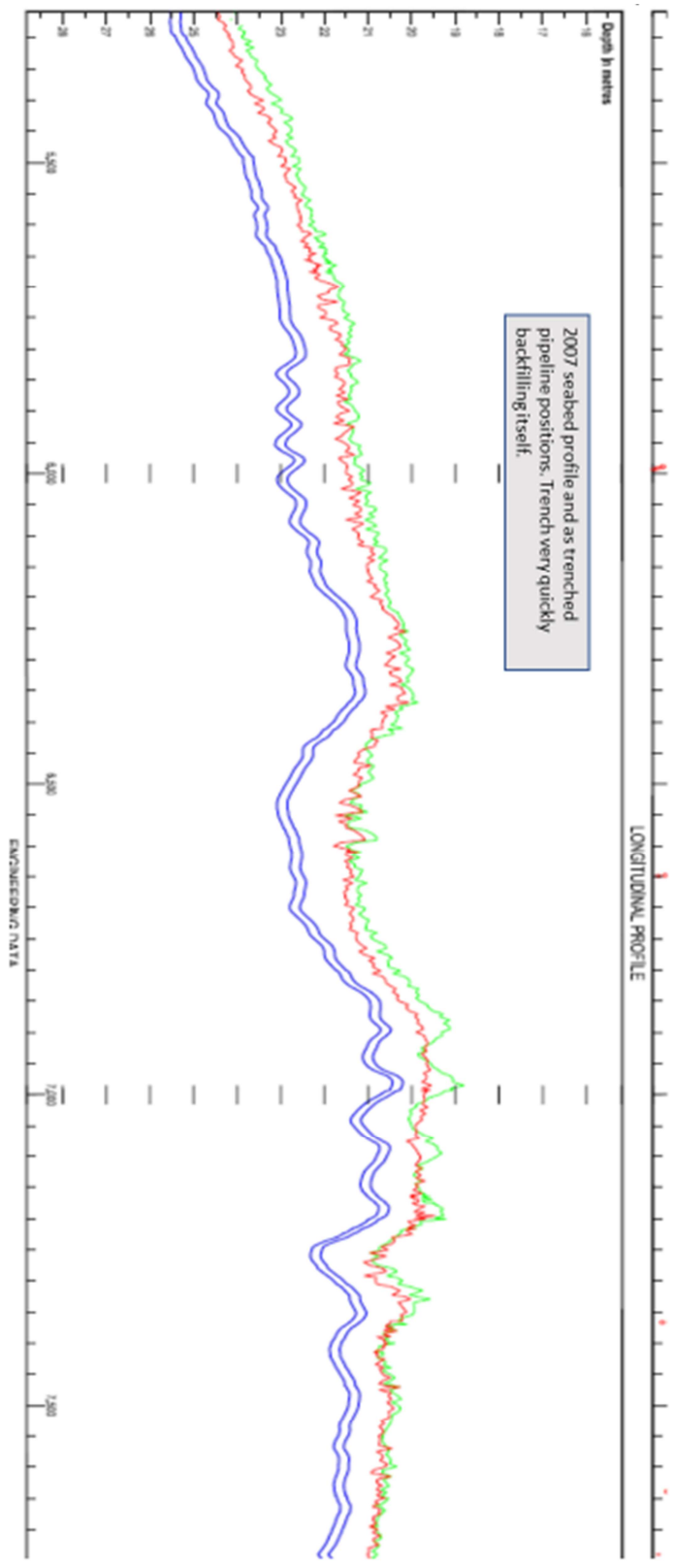
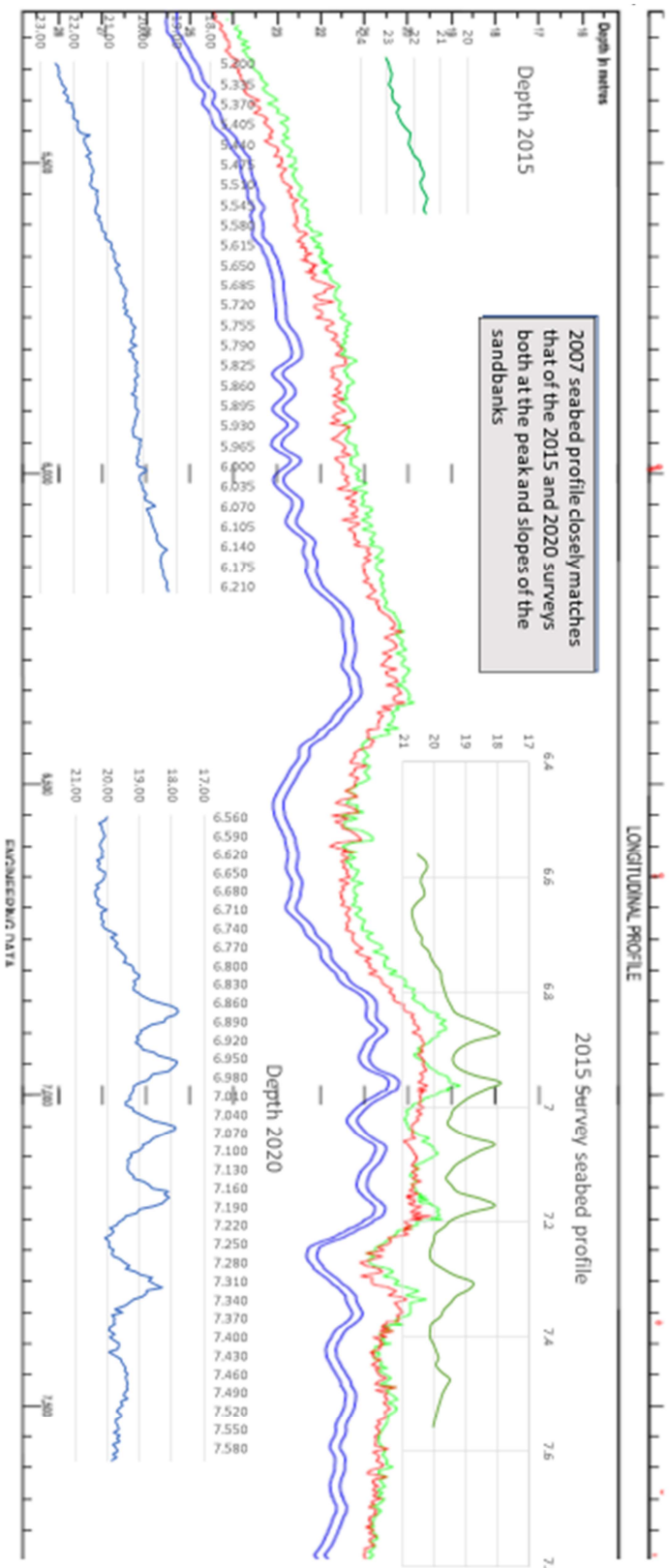


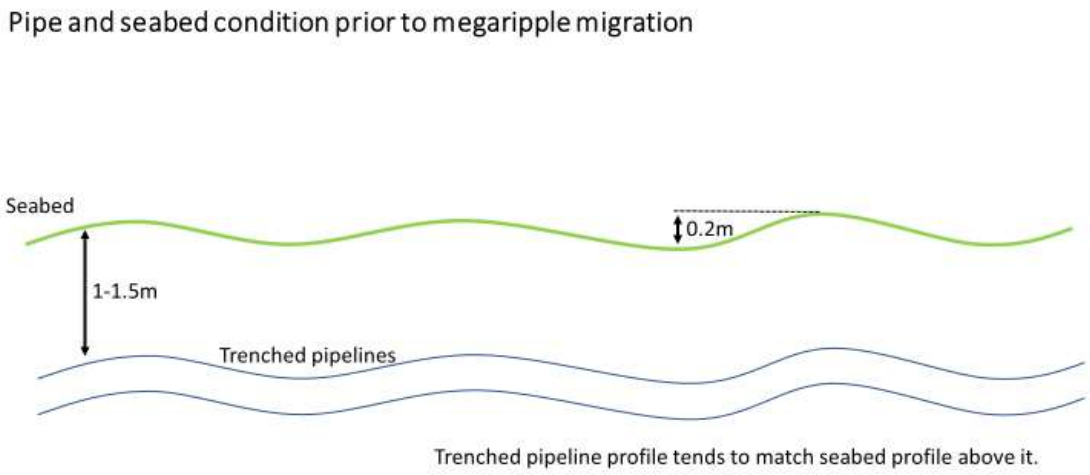
Fig A.2 2007, 2015 and 2020 seabed survey profile comparisons

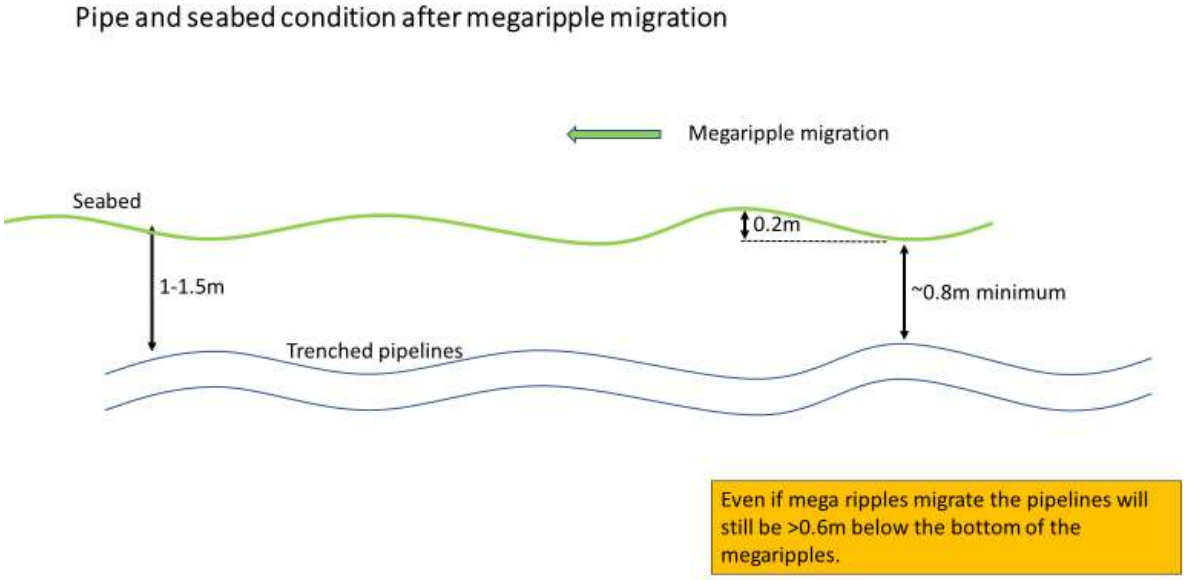


Potential mega ripple migration impact on burial depths

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

Fig A.3 Minimal burial depths after megaripple migration





Cable crossing status

The as trenched chart section below shows the section of pipeline at seabed level and the 2015 MBES image below shows the rock dump section currently over the area.

Fig A.4 As trenched chart through cable crossing section.

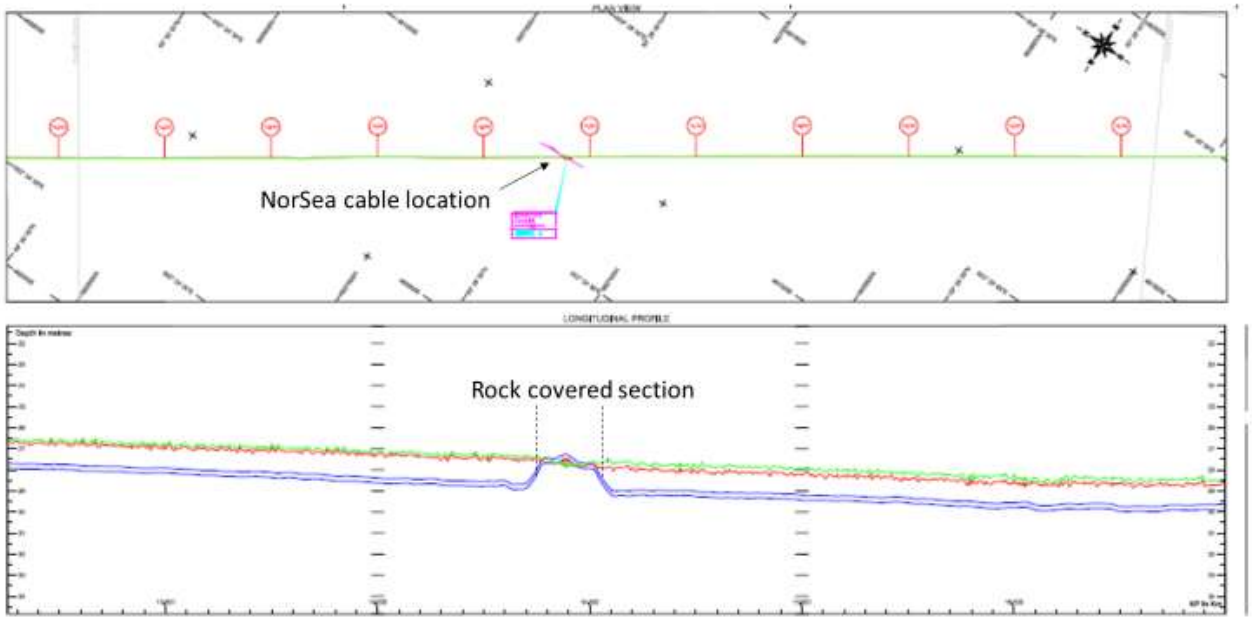


Fig A.5 2015 MBES image showing rock dump profile.

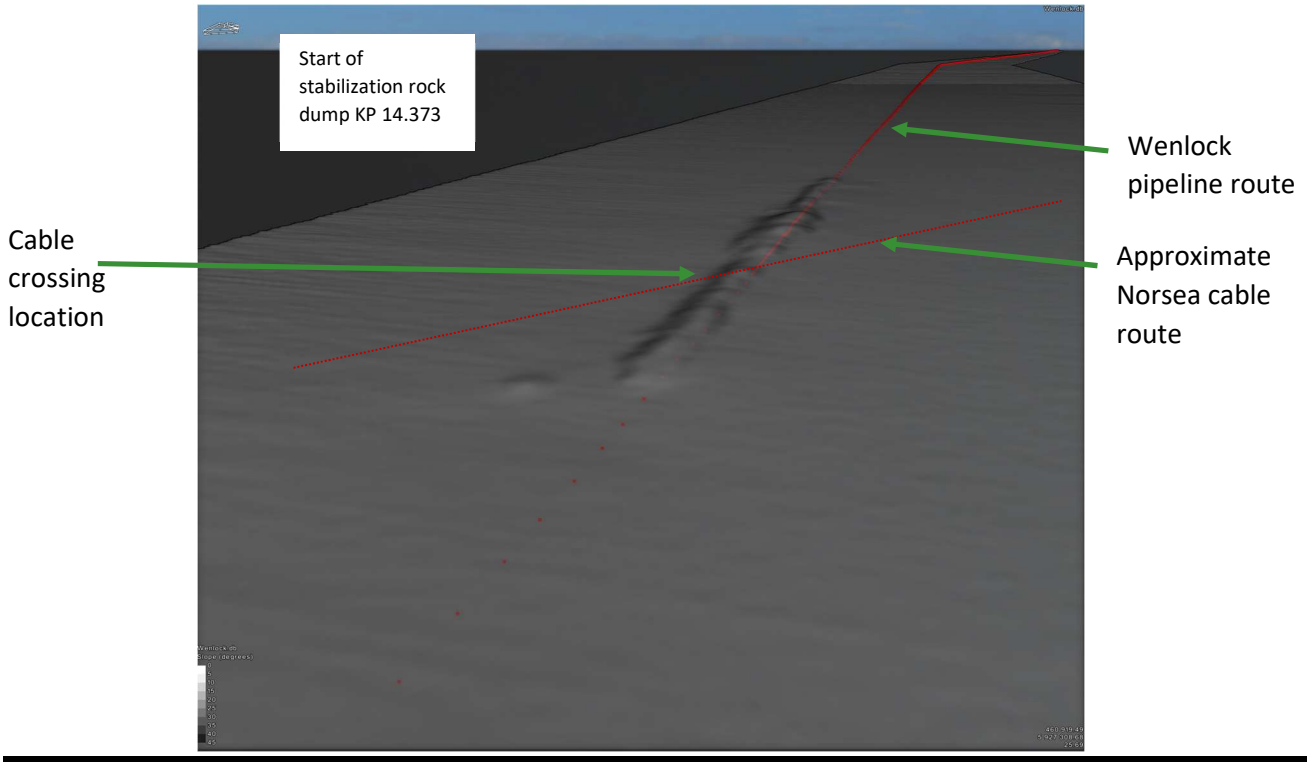
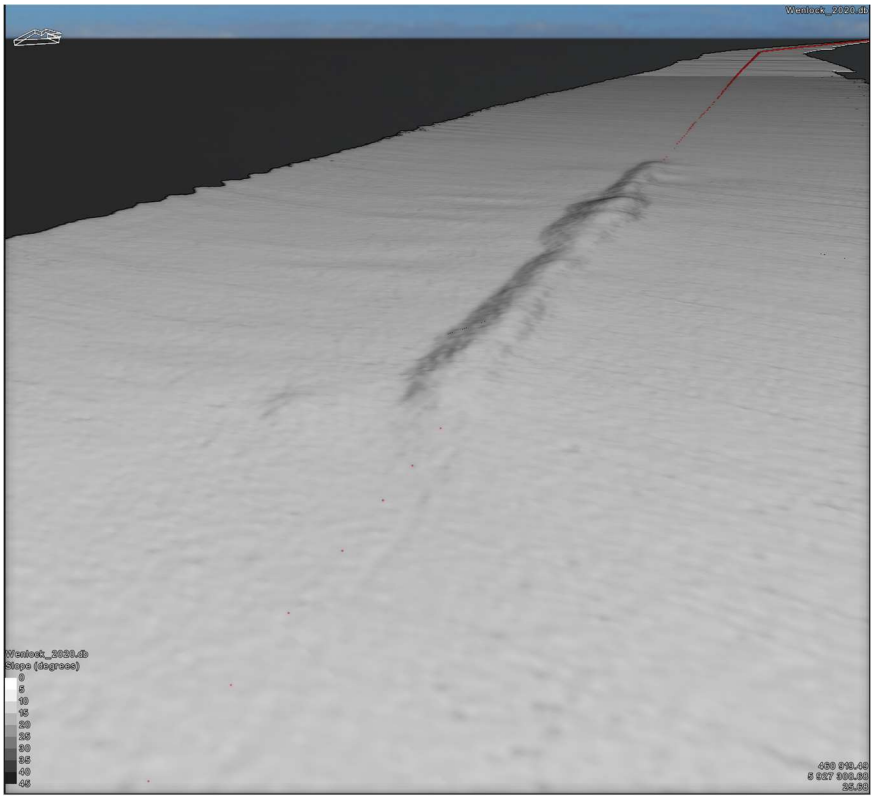


Fig A.6 below also shows the cable crossing location from the 2020 pre decommissioning survey with very little difference in the rock dump protection heaps. It appears that the rock is very stable in seabed currents and after fishing activity over the area.

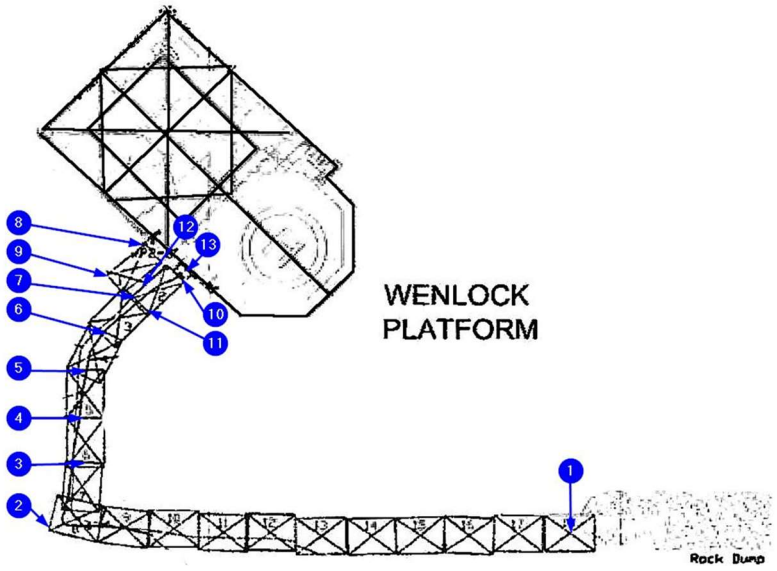
Fig A.6 2020 MBES crossing image



Platform approaches

Fig A.7 shows the current concrete mattress locations from the 2020 pre decommissioning survey.

Fig A.7 Mattress layout at Wenlock



The below 2015 MBES image shows this approach section.

Fig A.8 MBES image of Wenlock approaches

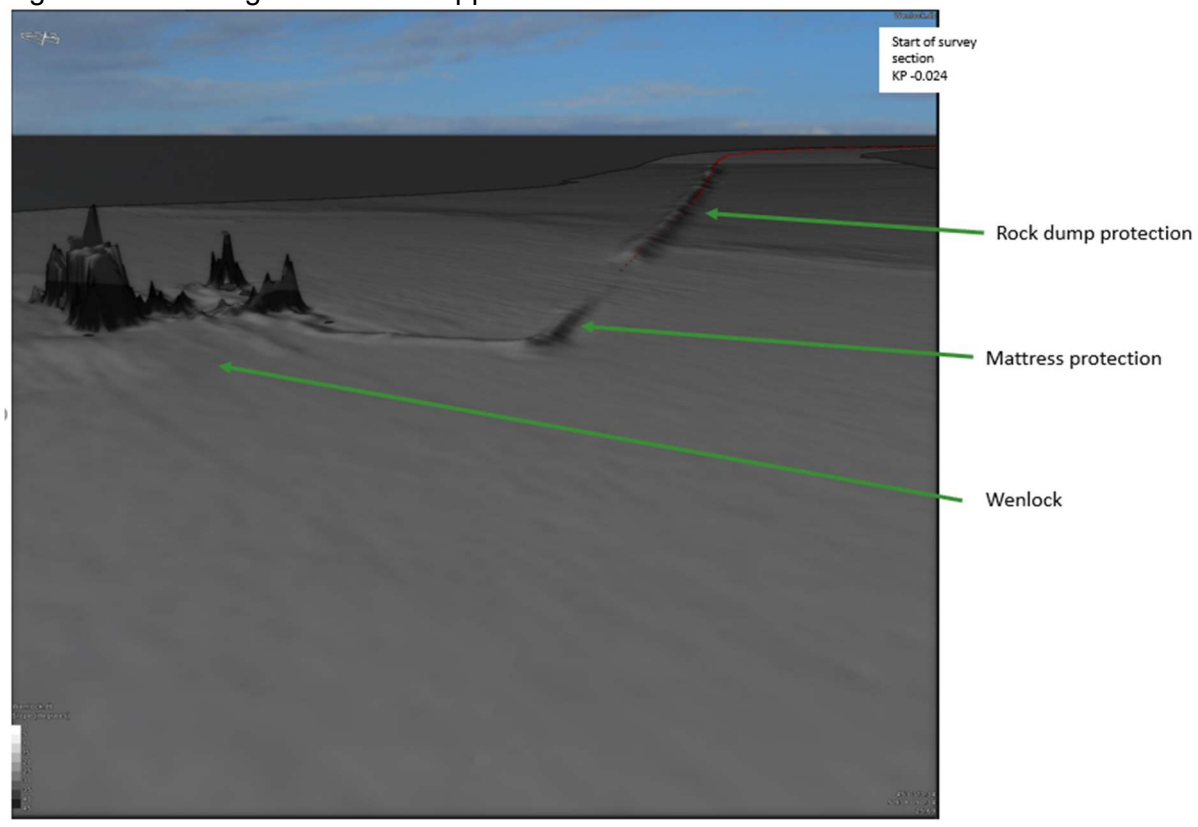


Fig A.9 Inde AC platform approach layout

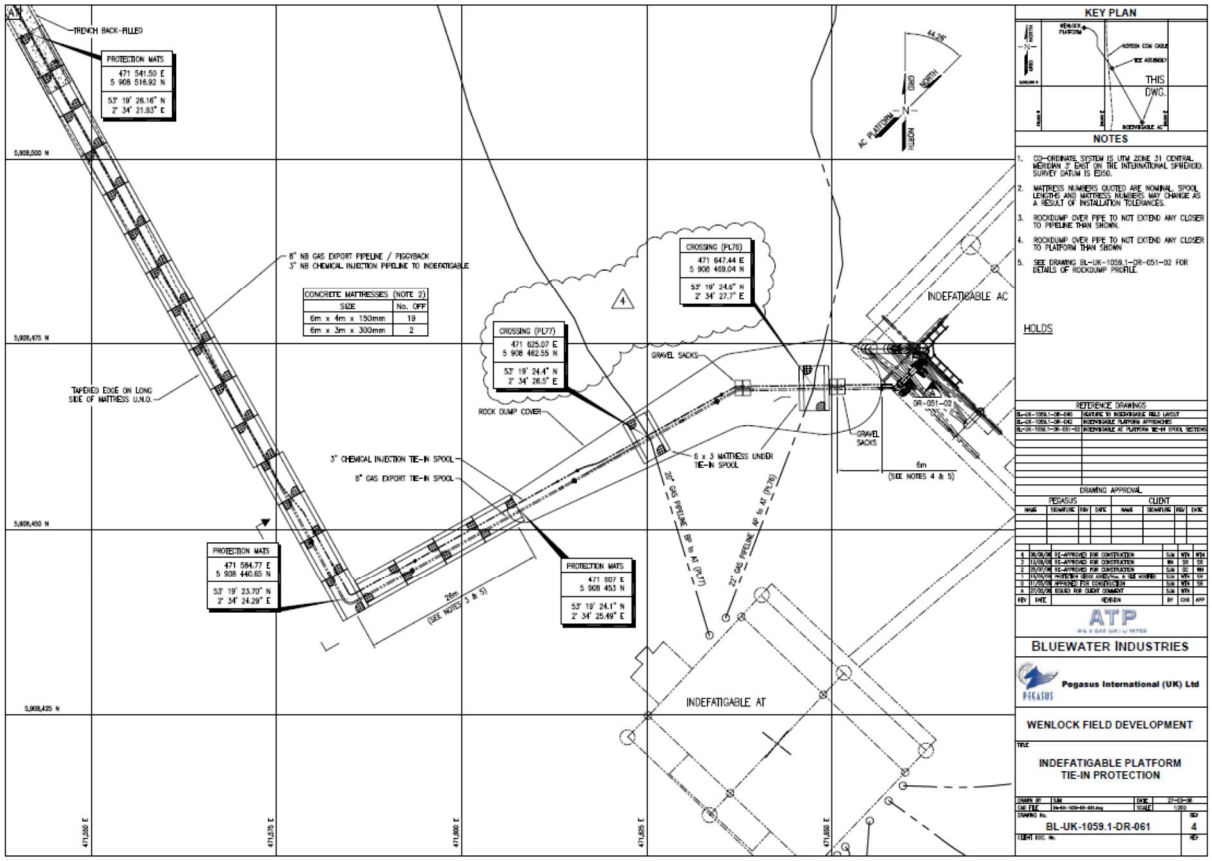


Fig A.10, as rock dump chart shows the Wenlock pipeline profile through the spool section between the concrete mats and Inde AC platform. At the riser to spool connection locations the pipelines are exposed and spanning for short sections.

Fig A.10 As built rock dump chart of Wenlock pipe spool crossings at Inde AC platform.

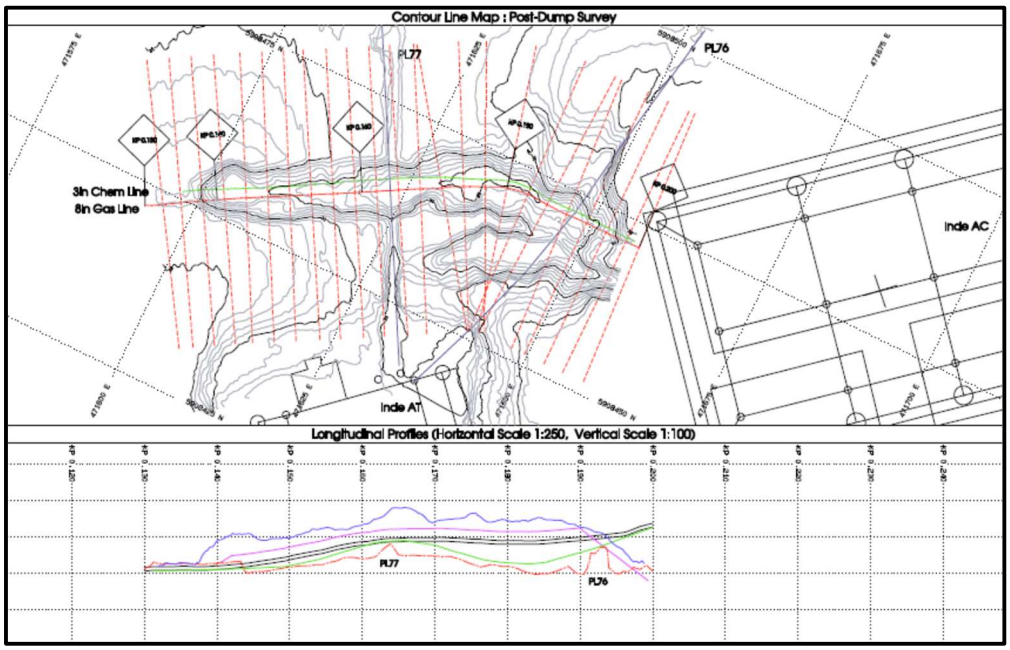
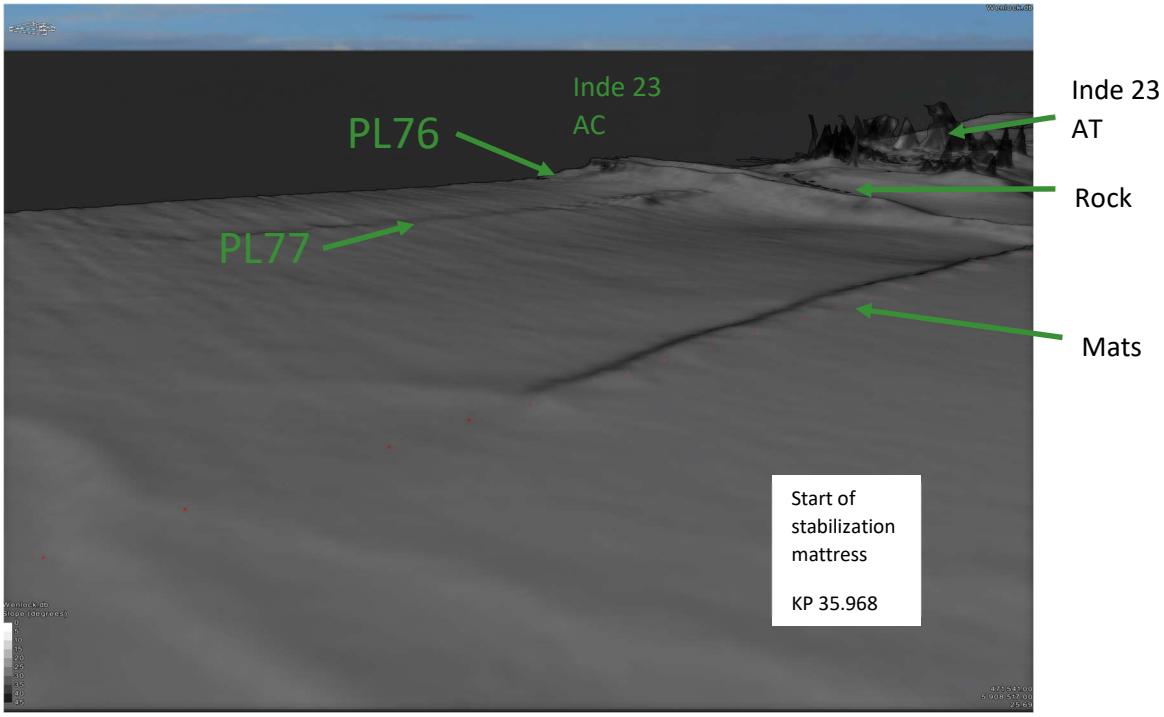


Fig A.11 2015 MBES image of Inde AC platform approaches



The 2020 pre decommissioning survey also confirmed the same status of mats and rock on the Inde AC approaches. The mattresses at both platform ends appear to have a very thin sediment covering with most concrete block rope linking loops visible.

Mid-line Tee location

Fig A.12 Mid-line tee as trenched chart

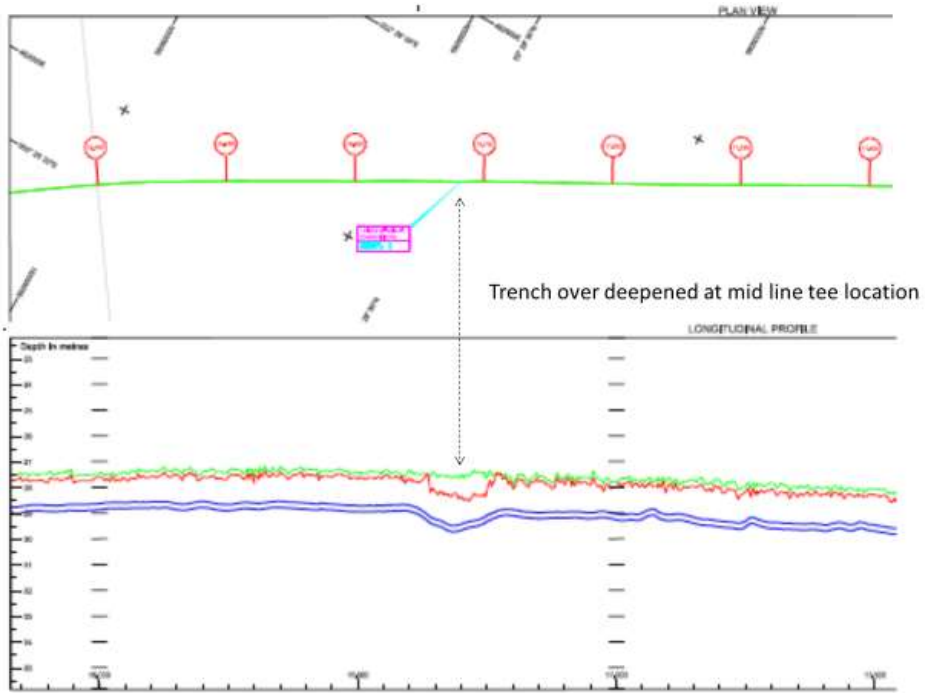


Fig A.13 Mid-line tee plan and sketches

Figure 2-5 Tie-In Structure at KP16.7 plan view (Ref.4)

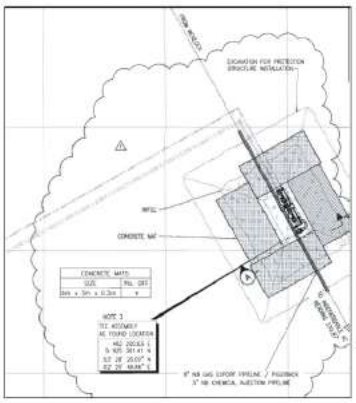


Figure 2-6 Tie-in Tee Assembly (Ref.5)

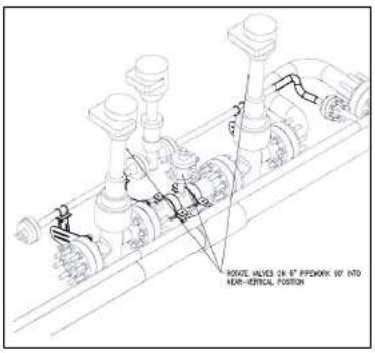


Figure 2-7 Tie-in Tee Protective Structure (Ref.6)

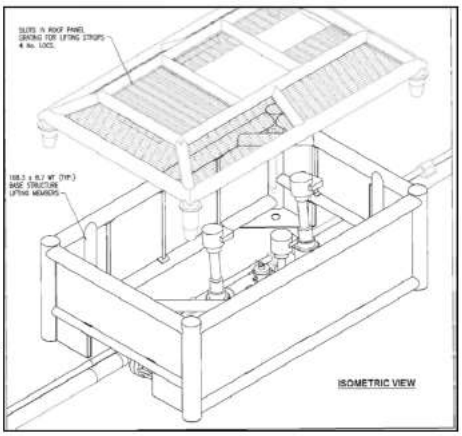
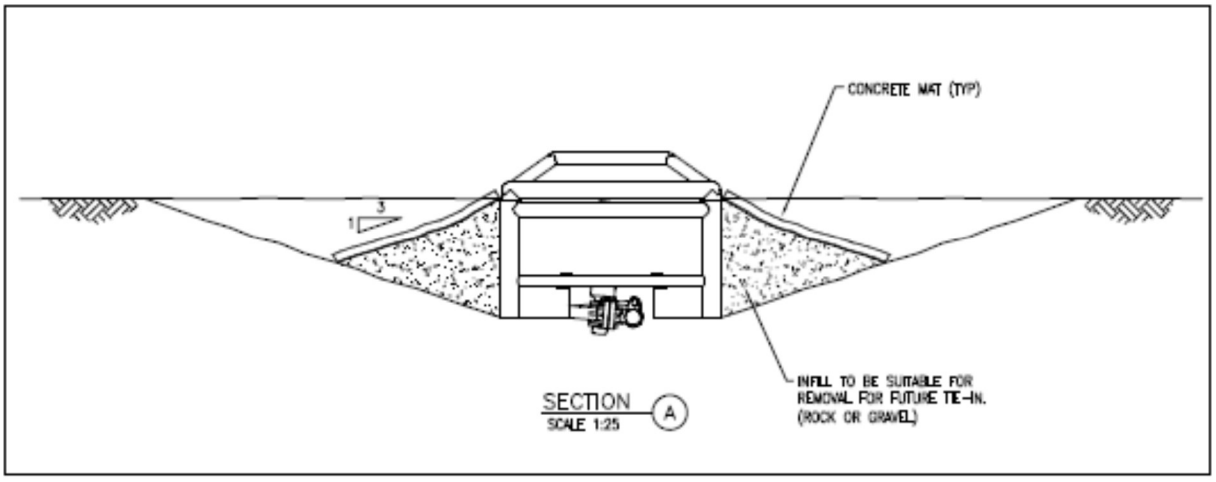
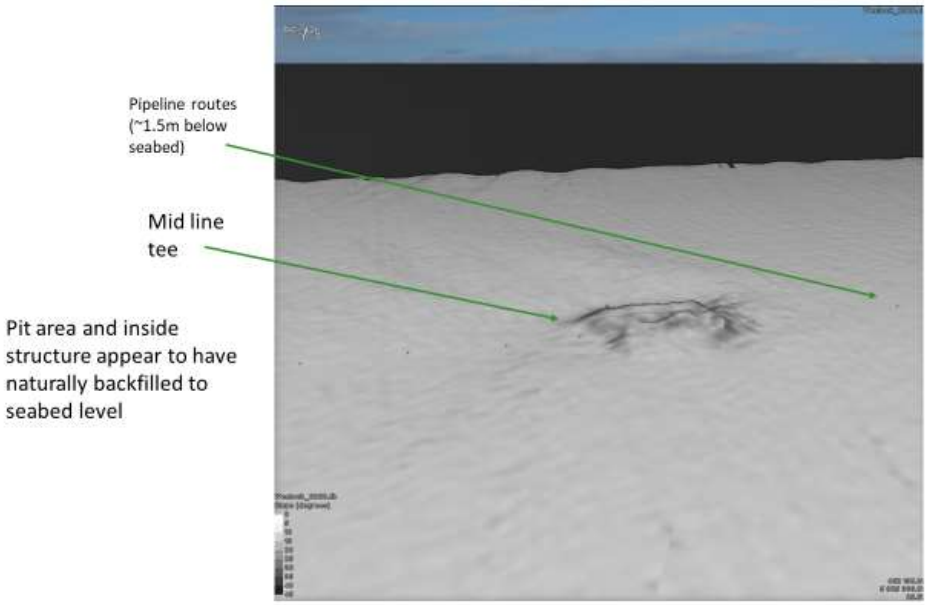


Fig A.14 Mid-line tee section diagram



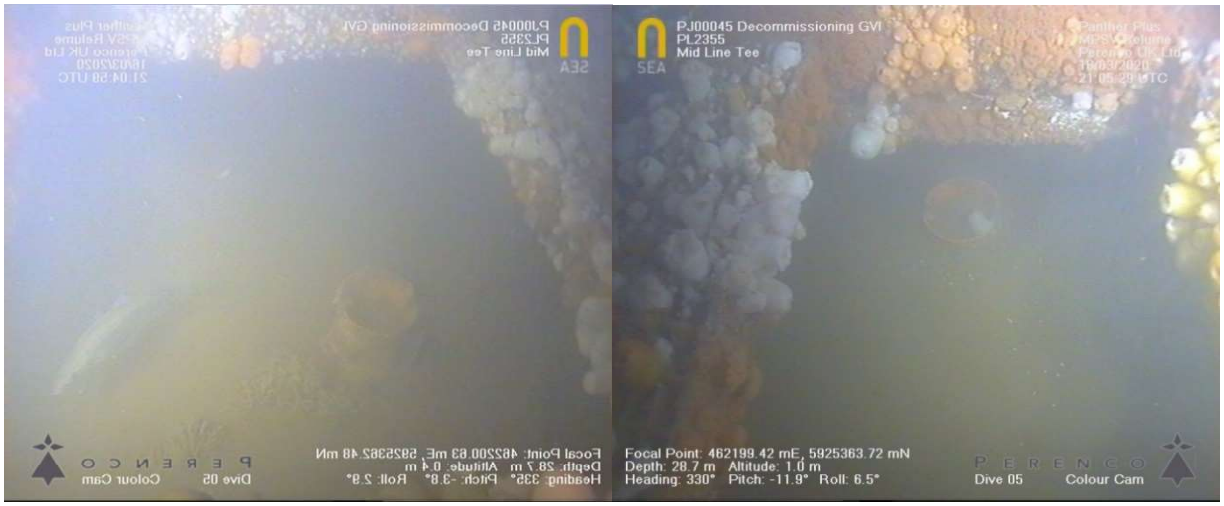
The 2020 pre decommissioning survey MBES image below indicates the current status of the mid-line tee infrastructure.

Fig A.15 2020 pre decommissioning survey MBES image of mid-line tee



Video stills from the 2020 pre decommissioning survey of the internal structure shows the level of natural in fill to be at the same level as the surrounding natural seabed level.

Fig A.16 2020 pre decommissioning survey mid-line tee internal pictures



APPENDIX B

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 2 vessel days reqd, low number of lifts to deck, no recovery of hydrocarbon contacted surfaces, no hot work reqd (seafastening)	3-10 vessel days, <20 deck lifts, recovery of cleaned pipework sections to deck (<200m of sections), minor hot work (e.g. cutting seafastening)	>10 vessel days, >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 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	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)
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	Localised disturbance up to 100% of the in situ equipment footprint, limited seabed material put into solution, short	Wide area of disturbance >100% of equipment footprint, Large volumes of seabed material put into solution (dredging

	low impact on seabed communities	term impact on seabed communities from smothering	or mass flow excavation equipment reqd), risk of smothering and loss of seabed communities
Impact on Marine protected areas (MPAs)	No or negligible impact to the qualifying features of the MPA.	Minor impacts which will not result in likely significant effects to the qualifying features of the MPA.	Minor impacts which will not result in likely significant effects to the qualifying features of the MPA.
Energy usage (during and post ops)	None to 10 vessel days in field, low energy equipment reqd (e.g. surveys)	11- 30 vessel days in field, some short term high energy equipment required (e.g. crane lifts, hydraulic cutters)	>30 days in field, high energy equipment used (e.g. 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 1000te fuel consumed, short term onshore odour	>30 days in field, >1000Te fuel consumed, weeks of onshore odour
Noise (underwater and onshore)	Low levels of subsea cutting/piling, minimal onshore handling/crushing/ cleaning of materials	Some subsea cutting/piling activities, short term noise from onshore activities	High levels of subsea 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
Waste processing	<50T returned to shore, materials readily recyclable, no or negligible landfill	50-500T returned to shore, partially 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
Societal			

Access to site for other users	No or minimal access restriction to site, <100m^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
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	Very low project visibility, no 'new' precedents, costs within acceptable benchmark ranges, all regulator & stakeholder interests addressed in CA	Minor deviations from OSPAR derogation guidelines (e.g. small protection structure left in situ, <20m^2 area)	High project visibility, new precedents, low or high costs, some regulator stakeholder interests not addressed
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

Aspect	Sub Category	Timing (D-during decom work L-post decom legacy)	Complete removal (option 3a)	Partial removal (option 2b & 2c)	Full leave in situ (option 1)	Comments	Action
Safety	Risk to those offshore performing the work	D					
	Risk to other offshore users	D					
	Risk to other offshore users	L	*i)*	*i)*		*i) below*	
	Durations of diving interventions	D					
	Risk to those onshore	D					
	High consequence event	D/L				*ii) below*	
Safety overall rating							
Safety definition level			2	1	1		
Environmental	Discharges	D					
	Seabed disturbance	D					
	Seabed disturbance (scour or other)	L					*a) below*
	Impact on Marine Protected areas	L					*b) & c) below*
	Impact on Marine Protected areas	D					
	Energy useage	D					
	Energy useage	L					
	Atmospheric emissions	D/L				*iii) below*	
	Noise (underwater and onshore)	D					
	Accidental spills	D					
	Waste processing	D					*d) below*
Environmental overall rating				*iv)*		*iv) below*	
Environmental definition level			1	1	1		
Technical	Technical challenge	D					
	Weather sensitivity	D					
	Risk of major project failure	D				*ii) below*	
Technical Overall rating							
Technical definition level			3	1	1		
Societal	Access to site for other users	D					
	Community impact (onshore)	D					
	Impact on reputation of stakeholders	D	*v)*			*v) below*	
	Impact on reputation of stakeholders	L			*vi)*	*vi) below*	
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			3	1	1		

Comments

i) View is that pit will naturally in fill relatively quickly (in days) based on operational survey observations
ii) line or category added post ToR
iii) some overlap with energy useage
iv) categories with green impact are considered predominent
v) Other operators/SEPA may be unhappy to set full removal precedent
vi) OPRED or other stakeholder uncertainty over legal/guideline positions

Actions

a) add comment to overall CA to state that coding has been based on actual surveys during operational life (no spans observed during operational life) - Alpha
b) share/discuss Wenlock survey data in relation to cobbles with JNCC. -Alpha/JNCC
c) arrange meeting offline (JNCC to share slide pack) - Alpha/JNCC
d) add some impact assessment criteria for final CA report - Alpha

Sub Options Worksheet

Aspect	Sub Category	Timing (D-during decom work L-post decom legacy)	Remove mats leave tee (option 2b & 2d)	Remove tee structure leave mats (option 2c)	Remove tee cover only (option 2c Variance 1)	Remove full tee protection (option 2c Variance 2)	comments	Actions
Safety	Risk to those offshore performing the work	D						
	Risk to other offshore users	D						
	Risk to other offshore users	L			*a)*			*a) below*
	Durations of diving interventions	D						
	Risk to those onshore	D						
	High consequence event	D/L						
Safety overall rating								
Safety definition level			1	1	1	2		
Environmental	Discharges	D						
	Seabed disturbance	D						*b) below*
	Seabed disturbance (scour or other)	L						
	Impact on Marine protected areas	L						
	Impact on Marine protected areas	D						
	Energy useage	D						
	Energy useage	L						
	Atmospheric emissions	D/L						
	Noise (underwater and onshore)	D						
	Accidental spills	D						
	Waste processing	D						
Environmental overall rating								
Environmental definition level			1	1	1	1		
Technical	Technical challenge	D						
	Weather sensitivity	D						
	Risk of major project failure	D	*i)*				*i) below*	
Technical overall rating			*i)*				*i) below*	
Technical definition level			1	1	1	2		
Societal	Access to site for other users	D						
	Community impact (onshore)	D						
	Impact on reputation of stakeholders	D	*ii)*	*ii)*	*ii)*		*ii) below*	
	Impact on reputation of stakeholders	L	*iii)*	*iii)*	*iii)*		*iii) below*	
Societal overall rating								
Societal definition level			2	2	2	1		
Economic	Cost of the work	D						
	Ongoing cost liabilities	L						
Economic overall rating								
Economic definition level			1	1	1	1		

Comments

i) based on recent visual inspections risk of mat break up is considered low

ii) OPRED or other stakeholder uncertainty over legal/guideline positions

iii) minimal material left in situ not likely to make significant impact on reputations

Actions

a) review potetnial for snagging hazards - Alpha

b) Review of rockdump left in situ areas with JNCC to be undertaken - Alpha/JNCC