Calder, Dalton & Millom Decommissioning

Pipeline Comparative Assessment

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A6	Various	Various	Minor edits to improve consistency and to reflect feedback on Decommissioning Programmes

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Figures and Tables

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Table of Abbreviations	
Abbreviation	**Description**
~	Approximately
3LPP	3-Layer Polypropylene, coating used for carbon steel pipelines and pipework
acoustic monitoring	An acoustic monitoring survey examines whether the pipelines are exposed, the extent of any exposures and whether any freespans are present but does not examine the depth of burial
ALARP	As Low As Reasonably Practicable
approaches	Refer to pipelines, umbilicals and electrical cables as they come nearer to the installations or pipeline structures.
AP1	Accommodation Platform 1 (part of South Morecambe Hub), bridge linked to CPP1
BEIS	The Department for Business, Energy and Industrial Strategy
CA	Comparative Assessment
CCUS	Carbon Capture, Usage and Storage
CI	Chemical Injection
CPP1	Central Processing Platform 1
CSA	Cross Sectional Area (refers to Electrical & fibre-optic cables and umbilicals)
cut and lift	The ‘cut and lift’ method of removing trenched and buried pipelines would involve excavating the pipelines from within the seabed and thereafter cutting the pipeline in to recoverable and transportable lengths. The method is usually only viable for short pipelines.
CWC	Concrete Weight Coated (thickness varies between 60mm and 80mm), applies to PL1965 only.
DESNZ	Department for Energy Security and Net Zero
DOB	Depth of Burial. Depth from mean seabed to top of pipeline (or umbilical or cable)
DP1	Drilling Platform 1
DP3, DP4	Drilling Platform 3 and Drilling Platform 4, connected to South Morecambe Hub. Both topsides were removed in 2021; the jackets are also to be removed.
DP6, DP8	Drilling Platform 6 and Drilling Platform 8, connected to South Morecambe Hub
DPPA	(North Morecambe) Drilling and Production Platform Alpha
EIS	East Irish Sea
electrical cable	Electrical cable and fibre-optic cable
FishSAFE	The FishSAFE database contains a host of oil & gas structures, pipelines, and potential fishing hazards. This includes information and changes as the data are reported for pipelines and cables, suspended wellheads pipeline spans, surface & subsurface structures, safety zones& pipeline gates (www.fishsafe.eu) FishSAFE is a PC-based safety device that provides the skipper of a fishing vessel with detailed information about subsea obstruction and provides a timely warning of any nearby oil and gas related infrastructure that may pose a snagging hazard and potentially result in the damage or loss of the fishing gear or even the vessel.
freespans	Refer “span”
HAT	Highest Astronomical Tide
HAZID	Hazard Identification
HSEQ	Health, Safety, Environment and Quality
ID	Identifier. Usually a number provided by the North Sea Transition Authority for pipelines, umbilicals and electrical cables. Where not available (e.g. electrical cables),

Table of Abbreviations	
Abbreviation	Description
	an ID will need to be applied for using the Pipeline Works Authorisation (PWA) application process.
infrastructure	Includes Calder and Millom West platforms, all WHPS and all pipelines, umbilicals and electrical cables associated with the Calder, Dalton and Millom fields.
IOM Interconnector Cable	Isle of Man Interconnector Cable runs beneath the seabed between Douglas on the Isle of Man, and Bispham on the Lancashire coast and spans a distance of 104km (56 nautical miles), linking the Isle of Man to the UK National Grid.
JNCC	Joint Nature Conservation Committee
KP	Kilometre Point, usually measured from point of origin, the start of the pipeline at the pipeline flange. A negative KP means that the features (e.g. tie-in spools) lie between the riser flange and the start of the pipeline.
kV	Unit of 1000 volts, measured in Kilovolts
LAT	Lowest Astronomical Tide
Lanis-1	Fibre-optic telecommunications cable installed by Mercury Communications but now owned by Vodafone that is 113km long and routed between Blackpool and Port Grenaugh, Isle of Man, installed in 1992. http://globalnetworkmap.vodafone.com/#/submarine-cable/lanis-1
m	metre, 1000mm
MADJ	Mean Adjacent Seabed (refer burial profiles)
MFE	Mass Flow Excavator provides a method of clearing sediment material from buried objects.
MLWM	Mean Low Water Mark (PL1965, KP42.424)
mm	millimetre
MM	Millions (Table F.3.1)
MW	Megawatts (windfarms)
NPT	Non Productive Time
NSTA	North Sea Transition Authority
NWIFCA	North-Western Inshore Fisheries and Conservation Authority
OOR	Out of range. This means that the product (pipeline, umbilical, cable) was not detected by the pipetracker, and usually means that the product was out of range. Referred to in the burial profiles.
OPRED	Offshore Petroleum Regulator for Environment and Decommissioning
piggybacked	Clamped or connected to another pipeline along part or all of its length
pipeline	Pipeline, umbilical or electrical & fibre-optic cable
PL, PLU	Pipeline or Umbilical Identification number as given by NSTA using the PWA application process
platform	Installation, typically comprising topsides and substructure such as a jacket or legs supported by suction piles - as is the case for a SIP.
PLEM	Pipeline End Manifold
post trenching	Post-trenching involves cutting, ploughing, or jetting a trench underneath the pipeline, such that it is lowered into the seabed. Often referred to as re-trenching.
PWA	Pipeline Works Authorisation
Q1, Q2, Q3	Millom Well Q1, Q2, and Q3 respectively
R1, R2	Dalton Well R1 and R2 respectively

Table of Abbreviations	
Abbreviation	**Description**
reportable span	A reportable span is a significant span which meets set criteria (FishSAFE criteria) of height above the seabed and span length (10m long x 0.8m high)
risk	Defined by the Institution of Civil Engineers as being either an 'opportunity' or 'threat'. in this report the word "risk" is used to describe a "threat".
Rivers (Gas) Terminal	It is named as "Rivers" because its fields (Calder, Dalton, and Millom) are all named after Lancashire rivers. This is one of three gas terminals (North Morecambe, South Morecambe, and Rivers) located near Barrow-in-Furness. The South Morecambe terminal has been decommissioned.
ROV	Remotely Operated Vehicle
SAC	Special Area of Conservation
SIP	Self-Installing Platform, sometimes referred to as a Multi-Purpose Platform. Self-Installing Platform comprising a topsides and four legs anchored to the seabed using suction piles.
SPA	Special Protection Area
span	Sometimes referred to as a 'freespan'. Similar to an exposure except that the whole of the section of pipeline is visible above the seabed rather than just part of it. Once the height and length dimensions meet or exceed certain criteria the span becomes a reportable span.
South Morecambe Hub	This comprises three platforms, AP1, CPP1, and DP1, all bridge linked together with a Flare Platform.
SSSI	Special Site of Scientific Interest
suction piles	Also referred to as suction caissons, suction anchors, or suction buckets. These are large open-bottomed tubes that are installed into the seabed sediment by using self-weight and pumping water out of the top of the tube until it has reached the penetration required.
trunklines	Pipelines that extend from out in the field to shore. E.g. Calder pipelines PL1965 & PL1966.
UKCS	United Kingdom Continental Shelf
umbilical	Flexible pipeline manufactured of various materials including steel and plastics typically used to send electrical power, communication signals, chemicals and hydraulic fluid to a manifold or wellhead. An umbilical pipeline will include cables and tubes that are covered with an outer sheath to protect them from damage.
WF	Windfarm or Wind Farm
WFC	Windfarm Cable. Referred to in the pipeline burial profiles
x	Number, e.g. 9x = 9 off or number

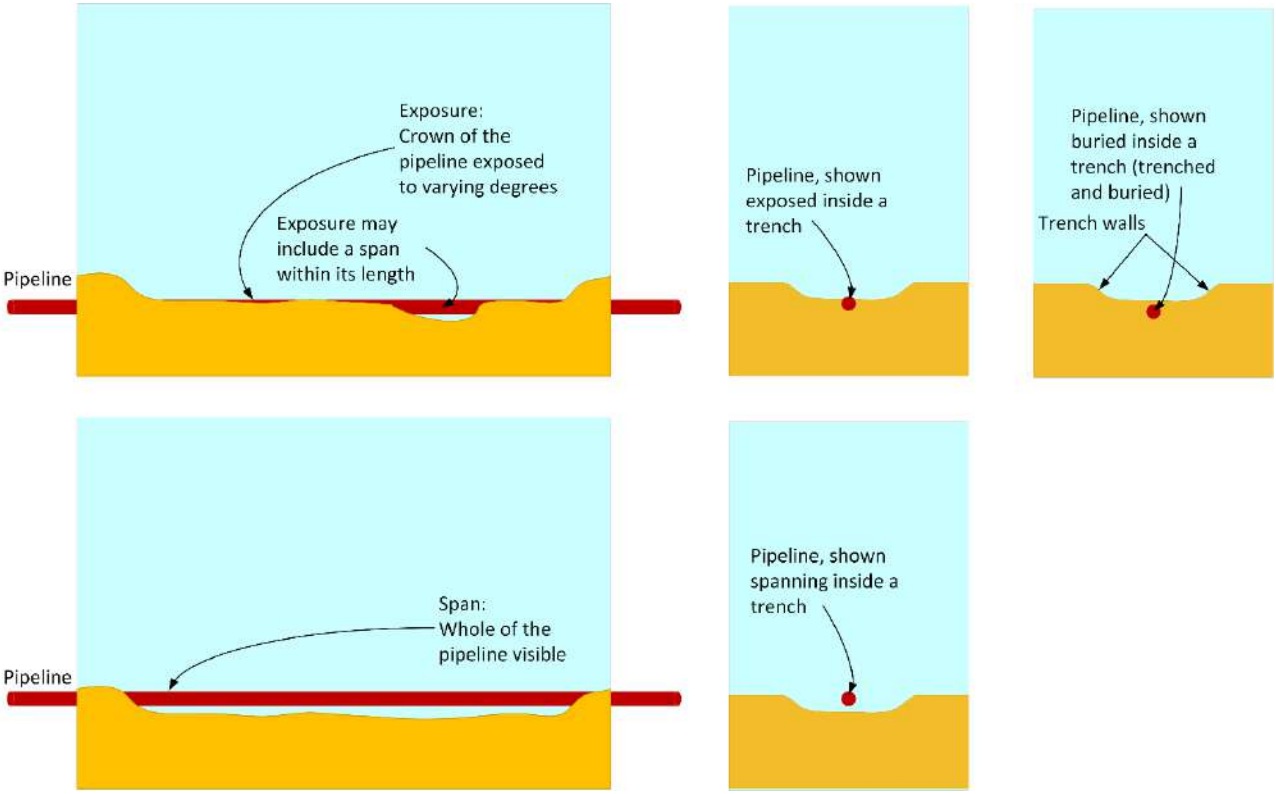


Figure 1.1.1: The difference between pipeline burial, exposures, and spans[1]

[1] Trench walls may or may not be prominent

Comparative Assessment colour scheme

Comparative Assessment colour scheme	
Assessment[2]	Description
Broadly Acceptable / Low & least preferred	Risks broadly acceptable but controls shall be subject to continuous improvement through the implementation of the HSEQ Management System and considering changes such as technology improvements; performance in other 'broadly acceptable' options marginally worse.
Broadly Acceptable / Low & in-between least & most preferred	As above, but performance of this option is marginally better or marginally worse than others. The colour is only used where there are three decommissioning options; for this comparative assessment this colour is only used for PL1965 & PL1966.
Broadly Acceptable / Low & most preferred	As above but performance in other 'broadly acceptable' options is marginally better.
Tolerable / Medium Non-preferred	Risks are tolerable and managed to ALARP. Controls and measures to reduce risks to ALARP require identification, documentation, and approval by responsible leader.
Intolerable / High Not acceptable	Impacts are intolerable. Controls and measures to reduce impact to ALARP (at least to Medium) and require identification, documentation, implementation, and approval.

Table 1.1.1: Comparative Assessment colour scheme

[2] The options are compared in absolute terms. For a preferred option the "Broadly Acceptable / Low & most preferred" shade of green is used. If both / all options are deemed acceptable, a choice of one of the two shades of green are used to provide further differentiation.

1 Executive Summary

1.1 Overview

A comparative assessment of the pipelines, umbilicals and cables is a key consideration within the Calder, Dalton and Millom Decommissioning Programmes submitted to the Offshore Petroleum Regulator for Environment and Decommissioning (OPRED).

The Calder, Dalton and Millom fields are situated in the East Irish Sea, generally 40km to the west of Blackpool and south-west of Barrow-in Furness. The Calder and Dalton fields are in Blocks 110/7a and 110/2b respectively of the United Kingdom Continental Shelf. Millom is in Blocks 110/2c, 113/26 and 113/27a.

The Calder platform is provided with power using PL6340 from the South Morecambe Central Processing Platform (CPP1) while the trunklines extend from the Calder platform to the Rivers gas terminal near Barrow. The Dalton and Millom infrastructure is supported by and connected to the North Morecambe Drilling and Processing Platform Alpha (DPPA). Both CPP1 and DPPA are operated by Spirit Energy.

The water depths at Calder, Dalton and Millom are 28m, 37.5m and 41.8m respectively. The water depths at CPP1 and DPPA are 31.7m and 29m.

The infrastructure in the short distance between Dalton Well R1 and Dalton Pipeline End Manifold (PLEM) is surface laid. The infrastructure in the short distances between Millom Well Q1, Q2 and Q3 and the Millom PLEM is also surface laid. All pipelines, umbilicals and electrical cables longer than 300m were buried in the seabed to depth of at least 1m below seabed. All surface laid pipelines, umbilical and cables are protected and stabilised with concrete mattresses, including the pipeline ends as they emerge from burial in the trenches.

Short lengths of the Calder trunklines pass through the Liverpool Bay / Bae Lerpwl (~7km and ~2km long) and the Morecambe Bay and Duddon Estuary (~5km) Special Protection Areas (SPAs). None of the Dalton and Millom infrastructure passes through either of the SPAs. The SPAs cover an area 2,528km^2 [10] and 669km^2 [2] respectively.

Although there are several windfarms in the area, only the Calder trunklines are affected, and this is because the windfarm power cables cross over the top of the pipelines in a few locations.

The pipelines are summarised below:

Calder pipelines

PL6340 62mmm electrical cable CPP1 to Calder, buried, ~7.6km long; and,

PL1965 24in gas pipeline piggybacked by PL1966, 3in Methanol pipeline, Calder to MLWM, buried, ~42.6km.

Dalton pipelines

PL1668 12in gas pipeline, Dalton PLEM to DPPA, buried, ~7.2km.

PL1669 8in gas pipeline, Dalton R2 to Dalton PLEM, buried, ~1.0km.

PL1670 8in gas pipeline, Dalton R1 to Dalton PLEM, surface laid, ~83m long.

PL1671 113mm umbilical, DPPA to Dalton PLEM, buried, ~7.2km.

PL1672 100mm umbilical, Dalton PLEM to Dalton R2, buried, ~1.0km; and,

PL1673 100mm umbilical, Dalton PLEM to Dalton R1, surface laid, ~78m long.

Millom pipelines

PL6352 58mm electrical cable, DPPA to Millom West, buried, ~15.3km.

PL1674 12in gas pipeline, Millom PLEM to DPPA, buried, ~8.8km.

PL1675 12in gas pipeline, Millom West to Millom PLEM, buried, ~6.3km.

PL1676 2.5in MeOH pipeline, Millom PLEM to Millom West, buried, ~6.3km.

PL1677 8in gas pipeline, Millom Q1 to Millom PLEM, surface laid, ~0.1km.

PL1678 113mm CI & controls umbilical, DPPA to Millom PLEM, buried, ~8.8km.

PL1679 100mm CI & controls umbilical, Millom PLEM to Millom Q1, surface laid, ~74m.

PL1873 8in gas pipeline, Millom Q2 to Millom PLEM, surface laid, ~142m.

PLU1874 100mm CI & controls umbilical, Millom PLEM to Millom Q2, surface laid, ~164m.

PL1980 6in flexible flowline, Millom Q3 to Millom PLEM, surface laid, ~248m; and,

PLU1678JQ3 111mm CI & controls umbilical, Millom PLEM to Millom Q3, surface laid, ~247m.

1.2 Pipelines, umbilicals & electrical cables

1.2.1 Decommissioning options

For the purposes of the comparative assessment there is an implicit assumption that options for re-use of the pipelines have been exhausted before facilities and infrastructure move into the decommissioning phase and comparative assessment. Therefore, the re-use option has been excluded from this assessment. With the exception of the Calder trunklines (PL1965 & PL1966) none of the infrastructure has been found to be exposed along the buried sections meaning that the decommissioning options are as follows:

- **Complete removal** – This would involve the complete removal of the pipelines by whatever means most practicable and acceptable from a technical perspective.
- **Partial removal or remediation** – This would involve removing exposed or potentially unstable sections of pipelines or carrying out remedial work to make the remaining pipeline safe for leaving *in situ.* This option is relevant for those pipelines that have known exposures or spans. This option only applies to the Calder trunklines PL1965 and PL1966 near KP16 (the Isle of Man Interconnector crossing) and between ~KP31.0 and the end of the pipeline at Mean Low Water Mark (MLWM) at KP42.424. The burial status would need to be confirmed via future surveys.
- **Leave *in situ*** – This would involve leaving the pipeline(s) *in situ* with no remedial works but possibly verifying their burial status via future surveys.

1.2.2 Method

The assessment considered five criteria for both the short-term decommissioning activities and the longer-term for ‘legacy’ related activities. The criteria were: technical feasibility, safety related risks with three sub-criteria, environmental with five sub-criteria, societal effects with three sub-criteria and cost.

The surface laid pipelines are not included in the assessment. As the decommissioning of the surface laid ends at of the pipelines on the final approaches is the same irrespective of which option is pursued, the surface laid ends are also not included in the assessment. Please note, however, the leave *in situ* component of the cost assessment takes account of the pipeline ends and associated protection and stabilisation features being removed as part of the decommissioning works.

1.2.3 Conclusion

Once the pipelines had been excavated, ‘cut and lift’ could be considered feasible for the removal of the two sets of piggybacked pipelines (PL1965 & PL1966) and (PL1975 & PL1976). For the partial removal of the trunklines (PL1965 & PL1966), excavation followed by the ‘cut and ‘lift’ method would also be technically feasible. Usually the 'cut and 'lift' approach would only be used for relatively short lengths of pipeline, but the repeatability of the method means that it would be technically feasible.

Once the pipelines had been excavated, reverse reel could be considered technically feasible for the smaller individual pipelines, flowlines, umbilicals and cables with 'cut and lift' being a contingency requirement.

From a safety perspective once the pipeline ends have been removed and, in the case of PL1965 & PL1966, the exposures had been dealt with, there would be no difference between the complete removal and leave *in situ* options from a marine safety perspective. The pipelines are believed to be sufficiently buried that it is unlikely that exposures will appear, and surveys will be carried out in future to confirm this. Several exposures have been found over the years totalling ~1.2km in a relatively short section (~12km out of 42.4km) of PL1965 & PL1966, but with the right corrective action that is risk assessed, it should be possible to remediate these so that the pipeline ends do not re-appear in future.

Energy and emissions, the discharges to sea, noise in water from cutting and lifting, and the associated impacts would all be greater for the complete removal and partial removal (Calder trunklines) options than for leave *in situ*.

The complete removal option would theoretically result in no materials being left in the seabed although it is possible small quantities of concrete may spall during the recovery of PL1965, and despite best intentions, some of this material could be left on the seabed. However, the effect of this is not likely to be significant.

If it can be assumed that the removal of all the buried pipelines would affect a 10m wide corridor along each pipeline, the overall area affected - including the combined area of the Liverpool Bay / Bae Lerpwl and the Morecambe Bay & Duddon Estuary SPAs can be considered very small, as would be the area of seabed affected by material left *in situ*.

The partial removal decommissioning option for the Calder trunklines (PL1965 & PL1966) would result in a short length of the pipelines in the seabed being temporarily affected as the exposed sections are removed. Should an alternative to partial removal be adopted, such as the deposition of rock over the exposed sections, that part of the seabed that is currently used by the bottom feeding fish, the birds and fauna would be permanently lost. Albeit very small (maximum ~1.5km x ~10m wide = 0.015km^2), this would be an addition to the area of sandy seabed already permanently lost due to the deposition of rock on other infrastructure such as windfarm cables.

The leave *in situ* options would result in materials being left to degrade naturally. The deposition of the concrete, steel and composite materials into the marine environment would likely occur very gradually over hundreds of years, and so would be at little detriment to the local marine environment.

The main commercial activity in the area is demersal fishing but over the past few years, the fishing effort has reduced, using relatively small vessels (<10m). In the short-term there should be no real disruption to commercial fishing activities, and if there is, it would be relatively short-lived. Over the longer-term should the partial removal of the Calder pipelines be replaced by the deposition of rock, the feeding grounds of bottom feeding fish would be reduced but as already explained the area of seabed lost and the knock on-effect on fishing activity would be very small.

The collective recovery of all the pipelines in the Calder, Dalton and Millom areas could result in creation of new jobs, although they might only be short-term. The significance of the positive impact can be assessed as low.

For material that is brought to shore, the port and the disposal site would likely be existing sites which are used for oil and gas activities and hold the required permits for waste management. The effect on communities is not considered a significant differentiator between options.

If there is nothing to choose between the options from a technical, safety, environmental and societal perspective, then cost is used as the final differentiator. The cost assessment concludes that it would cost more to completely remove the pipelines (or partially removed in the case of the Calder pipelines) than it would be to remove the ends and leave the buried sections *in situ*. The difference in cost typically increases due to two factors: the method of removal and the length of pipelines.

The cost for the removal of the Calder pipelines and of the Calder and Millom West electrical cables would each be an order of magnitude greater than either the partial removal (PL1965 & PL1966 only) or leave *in situ* options. For the remainder of the pipelines the difference in cost is much less marked but still significant.

1.2.4 Recommendations

As a result of this comparative assessment the following recommendations arise:

- Completely remove surface laid pipelines, and remove the pipeline ends down to burial depth. Completely remove the associated protection and stabilisation features.
- Leave the buried sections of the pipelines *in situ*.
- Leave the Isle of Man (IOM) Interconnector crossing protection and stabilisation features *in situ* as it is not protected by a 500m safety zone; this would be no different to the current situation. Confirm that no snagging hazards remain to the satisfaction of all stakeholders.
- Meantime check the status of PL1965 & PL1966 near the IOM Interconnector crossing. Unsupported section of the pipelines - all be they covered with mattresses - was observed in 2014 (25m long), 2017 (7.2m long) and 2022 (18m long) and this is thought to be attributed to local scour. The pipelines may be sufficiently protected by mattresses with no further action. Carry out remediation work as per company Inspection, Repair and Maintenance procedures for the pipeline(s) until they are decommissioned.
- Remediate the exposed sections of Calder trunklines PL1965 & PL1966. The preference would be for the exposed sections to be removed, minimising the number of remaining cut ends as they could re-appear as exposures. The option to bury the exposed sections under rock especially near the cable crossings remains a valid approach but given the sensitivity of the area consideration should be given to the loss of native habitat, however small. It may be appropriate to bury the exposures near the cable crossings under deposited rock (e.g. sporadically between KP35.5 and KP36.4, total length ~250m c.f. 206m) while removal of the exposed sections of pipelines between KP36.4 and KP41.02 (minimum length ~1,023m) would result in all the exposures documented in 2017 as being remediated. Total length remediated ~1.3km. The 2017 survey data present a slightly worst case than the combined 2022 and 2023 survey data.

The decommissioning options are summarised in Table 7.2.1, Table 7.2.2 and Table 7.2.3 below:

Calder pipeline, umbilical and cable decommissioning summary				
Description	Route	Burial	Length (km)	Removal option
PL6340 62mm electrical cable	CPP1 to Calder	Buried	~7.6	Leave *in situ*
PL1965 24in pipeline	Calder to MLWM	Buried	~42.7	Leave most of pipelines *in situ*, remediate exposures
PL1966 3in pipeline	MLWM to Calder	Buried	~42.6	

Table 1.2.1: Calder pipeline, umbilical and cable decommissioning summary

Dalton pipeline, umbilical and cable decommissioning summary				
Description	Route	Burial	Length (km)	Removal option
PL1668 12in pipeline	Dalton PLEM to DPPA	Buried	~7.3	Leave *in situ*
PL1669 8in pipeline	Dalton R2 to Dalton PLEM	Buried	~1.0	Leave *in situ*
PL1670 8in pipeline	Dalton R1 to Dalton PLEM	Surface laid	~0.1	Complete removal
PL1671 113mm umbilical	DPPA to Dalton PLEM	Buried	~7.2	Leave *in situ*
PL1672 100mm umbilical	Dalton PLEM to Dalton R2	Buried	~1.0	Leave *in situ*
PL1673 100mm umbilical	Dalton PLEM to Dalton R1	Surface laid	~0.1	Complete removal

Table 1.2.2: Dalton pipeline, umbilical and cable decommissioning summary

Millom pipeline, umbilical and cable decommissioning summary				
Description	Route	Burial	Length (km)	Removal option
58mm electrical cable	DPPA to Millom West	Buried	~15.3	Leave *in situ*
PL1674 12in pipeline	Millom PLEM to DPPA	Buried	~8.9	Leave *in situ*
PL1675 12in pipeline	Millom West to Millom PLEM	Buried	~6.2	Leave *in situ*
PL1676 2.5in pipeline	Millom PLEM to Millom West	Buried	~6.3	Leave *in situ*
PL1677 8in pipeline	Millom Q1 to Millom PLEM	Surface laid	~0.1	Complete removal
PL1678 113mm umbilical	DPPA to Millom PLEM	Buried	~8.8	Leave *in situ*
PLU1678JQ3 111mm umbilical	Millom PLEM to Millom Q3	Surface laid	~0.3	Complete removal
PL1679 100mm umbilical	Millom PLEM to Millom Q1	Surface laid	~0.1	Complete removal
PL1873 8in pipeline	Millom Q2 to Millom PLEM	Surface laid	~0.1	Complete removal
PLU1874 100mm umbilical	Millom PLEM to Millom Q2	Surface laid	~0.2	Complete removal
PL1980 6in flexible flowline	Millom Q3 to Millom PLEM	Surface laid	~0.3	Complete removal

Table 1.2.3: Millom pipeline, umbilical and cable decommissioning summary

2 Introduction

2.1 Overview

The Calder, Dalton and Millom fields are situated in the East Irish Sea generally 40km to the west of Blackpool and south-west of Barrow-in-Furness. The Calder and Dalton fields are in Blocks 110/7a and 110/2b respectively of the United Kingdom Continental Shelf. Millom is in Blocks 110/2c, 113/26 and 113/27a of the UKCS. All three assets are connected in some way or another to the either DPPA or CPP1.

The various platforms, Wellhead Protection Structures (WHPS) and Pipeline End Manifolds (PLEMs) were installed on the following dates:

Installation dates	
Asset	Installation date
Calder platform	November 2002
Dalton PLEM	1999
Dalton R1 WHPS	
Dalton R2 WHPS	
Millom PLEM	1999
Millom Q1 WHPS	
Millom Q2 WHPS	
Millom Q3 WHPS	October 2006
Millom West platform	1999

Table 2.1.1 Installation dates for Calder, Dalton, and Millom infrastructure

The Calder infrastructure comprises a Self-Installing Platform (SIP), a 24in pipeline (PL1965) piggybacked by a 3in pipeline (PL1966) routed to and from the Rivers Gas Terminal near Barrow-in-Furness. Both pipelines are approximately 42.7km long. There is also an 11kV electrical cable (PL6340) routed from Morecambe Central Processing Platform (CPP1) to Calder and this is ~7.6km long. Refer Figure 2.2.1 and Figure 2.2.2.

The Dalton infrastructure comprises two subsea wells R1 and R2 that are tied back to the Dalton Pipeline End Manifold (PLEM). The Dalton PLEM is tied back to the North Morecambe platform via a 12in pipeline (PL1668) ~7.3km long. Dalton R1 and R2 are tied back to the PLEM via 8in pipelines, each ~86m (PL1670) and ~1.0km (PL1669) long respectively. A chemical injection umbilical (PL1671) ~7.2km long is routed from North Morecambe to Dalton PLEM, and this is extended to wells R1 and R2 using umbilicals ~78m (PL1673) and ~1.0km (PL1672) long respectively. Refer Figure 2.2.1 and Figure 2.2.3.

The Millom infrastructure comprises three subsea wells that are tied back to the Millom East PLEM and the Millom West platform which is a SIP.

Wells Q1, Q2 and Q3 respectively are tied back to the Millom PLEM via individual pipelines that are PL1677 (~110m long), PL1873 (~142m long) and PL1980 (6in flexible flowline, ~257m long). Millom West is also tied back to the Millom PLEM via a 12in pipeline PL1675 (6.3km long). The Millom PLEM itself is tied back to North Morecambe platform via 12in pipeline PL1674 (~8.9km long).

North Morecambe provides Millom West with electrical power via an 11kV electric cable (PL6352, 15.3km long) and provides Millom PLEM with chemical injection capability via umbilical PL1678 (~257m long). Millom PLEM provides chemical injection to wells Q1 (PL1679, ~74m long), Q2 (PLU1874, ~174m long) and Q3 (PLU1678JQ3, ~257m long) and to Millom West via 2.5in pipeline PL1676, (~6.3km long).

2.2 East Irish Sea (EIS) Area layout

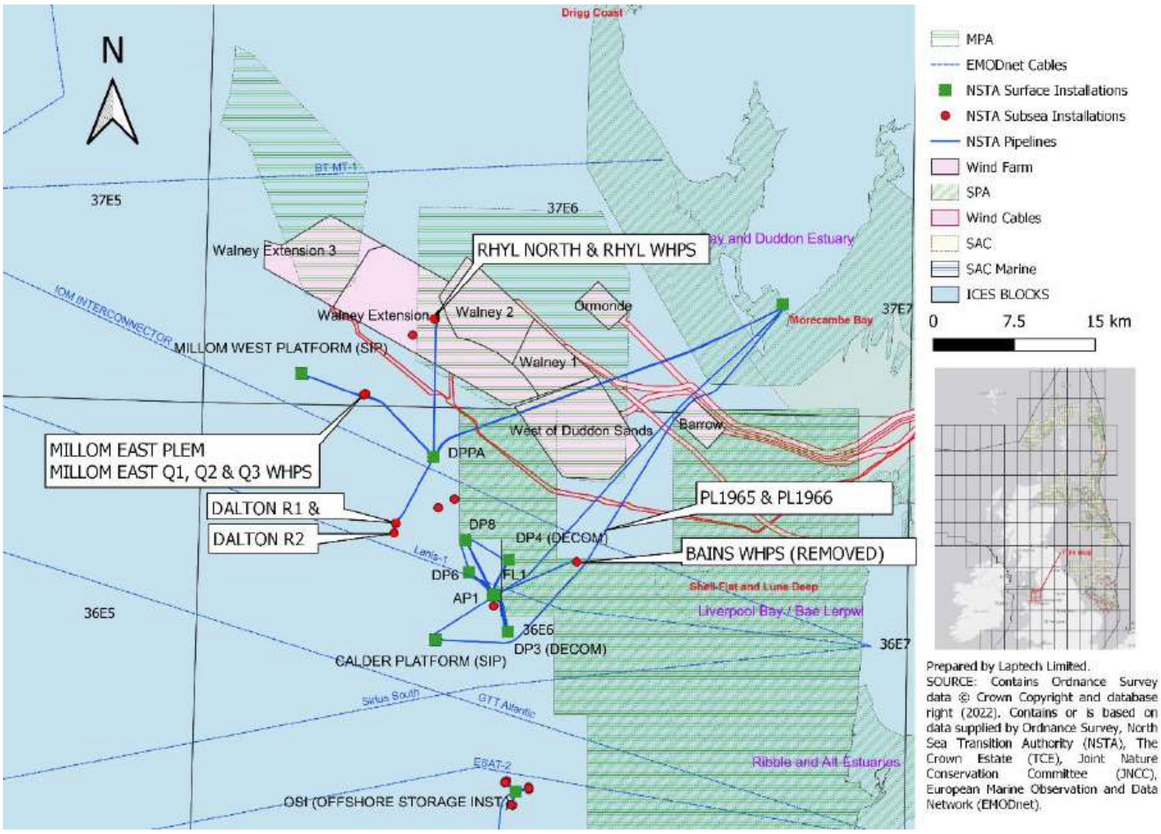


Figure 2.2.1: Overview of Calder, Dalton & Millom Assets[3]

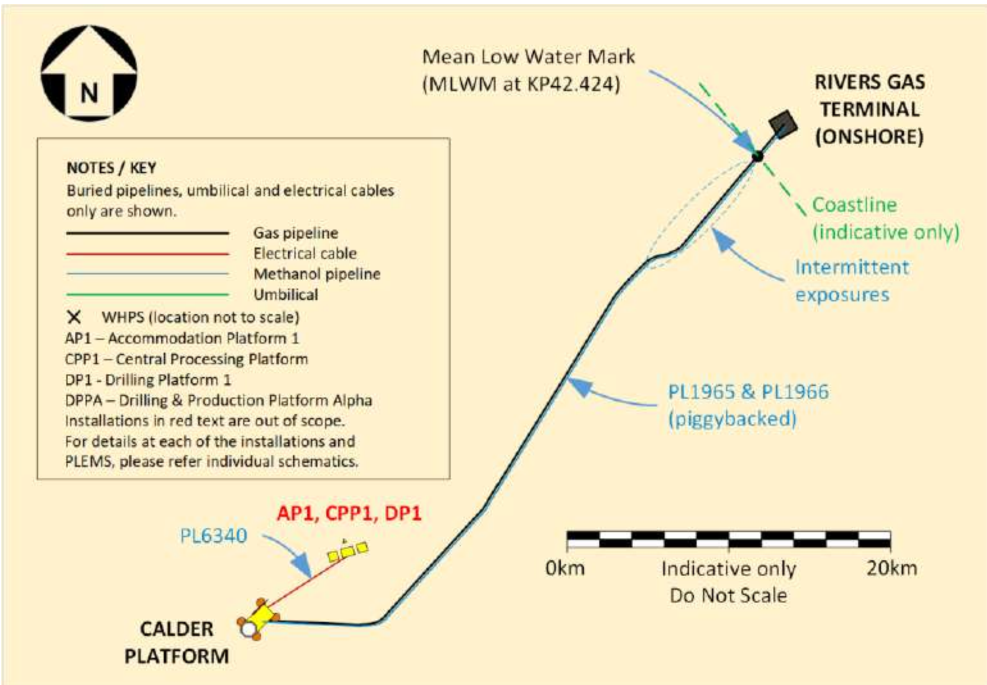


Figure 2.2.2: Layout of Calder (AP1, CPP1 & DP1 out of scope)

[3] The routes of BT-MT1 and Lanis-1 shown here do not agree with that shown on the Admiralty Chart.

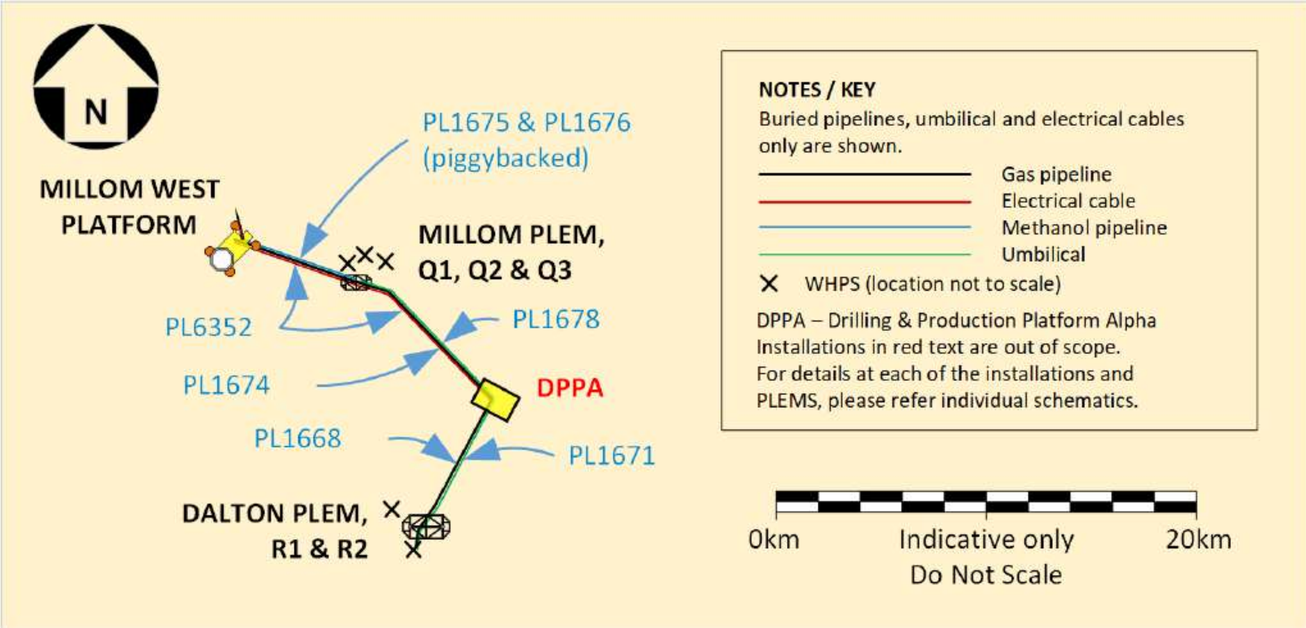


Figure 2.2.3: Layout of Dalton & Millom in relation to each other

2.3 Purpose

The purpose of this document is to present a comparative assessment in support of the Calder, Dalton, and Millom Decommissioning Programmes [7] as per the OPRED guidance notes [17]. The comparative assessment describes the options considered for decommissioning the pipelines and the protection and stabilisation features such as concrete mattresses, fronded mattresses or deposited rock that would be affected by decommissioning of the pipelines. The findings have been determined using a qualitative approach similar to that adopted for other comparative assessments prepared in support of decommissioning programmes for several pipelines in the East Irish Sea and the North Sea.

2.4 Environmental setting

2.4.1 Overview

In general terms the water depths measured to LAT along the pipeline routes vary between 28m and 41.8m. The water depths at Calder, Dalton and Millom are 28m, 37.5m and 41.8m respectively. The water depths at CPP1 and DPPA are 31.7m and 29m respectively.

Many of the pipeline routes lie within areas of flat and featureless seabed. Post-installation surveys show the pipelines to be generally buried to more than 0.6m depth, which is greater than the surficial mobility (0.3m) in the area. Historically, until 2022, with the exception of spot checks along the two Calder pipelines, pipeline surveys had not included depth of burial. Bathymetric surveys[4] have indicated slight surficial variations (mobile mega-ripples) along the length of the pipelines, but overall the seabed level is little changed since the infrastructures were originally installed.

Except for where they are exposed, it is therefore reasonable to assume that the pipelines are sufficiently well buried, and this is supported by there being no pipeline or cable exposures, or spans reported over the trenched lengths. Where available, the 'as-built' pipeline burial profiles are illustrated in section 3.

Other offshore activities and infrastructure in the EIS are associated with oil and gas, offshore wind, marine aggregate extraction, submarine power and communication cables, and military exercise areas.

In accordance with the Petroleum Act [19] the trunklines terminate as shown in Figure 2.4.1. This means that the onshore section(s) are out of scope of this comparative assessment.

[4] Various (acoustic) survey reports along the pipeline routes from ~2007 through ~2017.

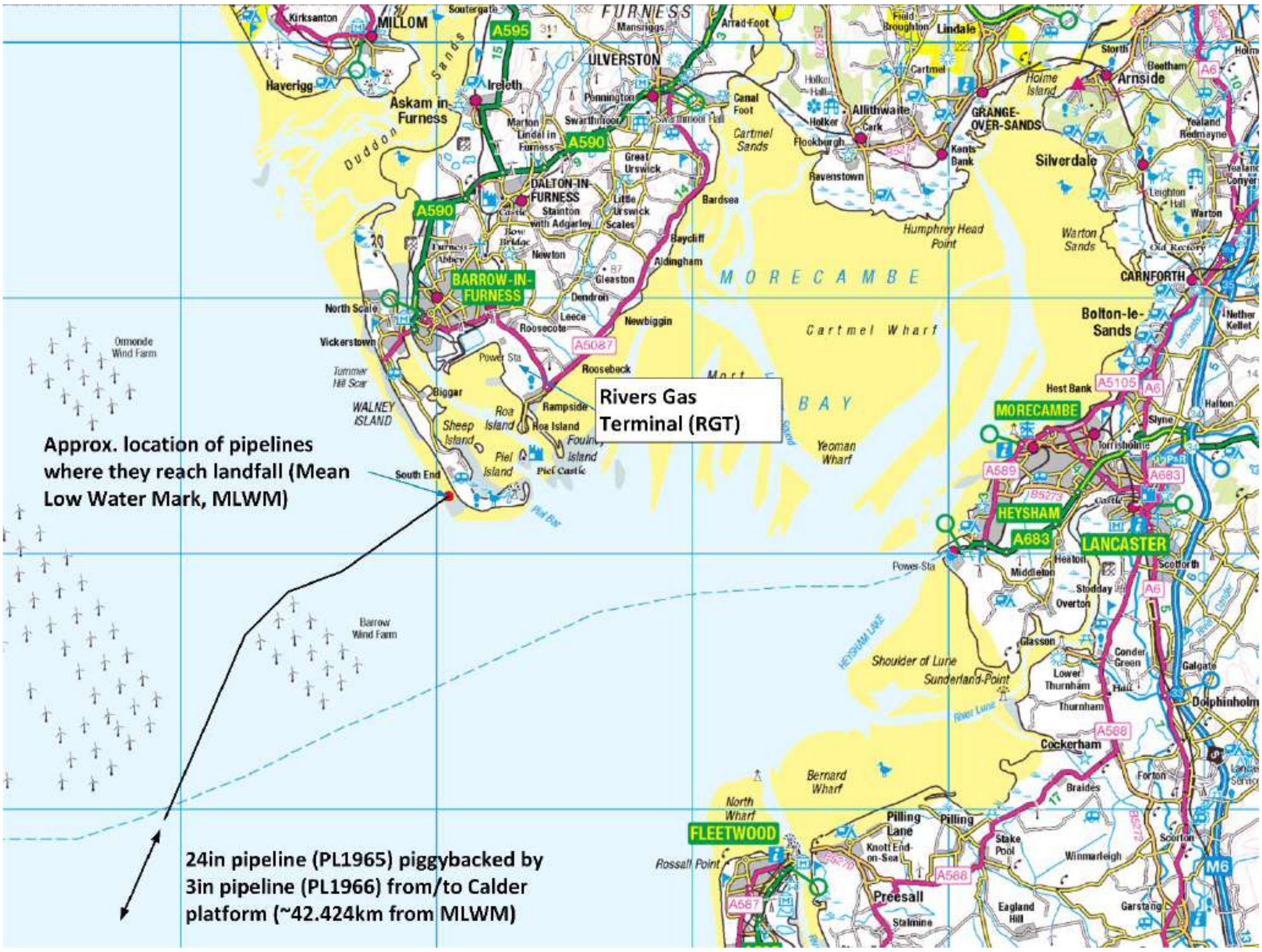


Figure 2.4.1: Approx. location of Calder trunklines (PL1965 & PL1966) at landfall

2.4.2 Protected areas

Several areas designated for the protection of coastal and marine habitats and species are present in the region. Coastal protected areas fringe the EIS, and marine protected areas have been designated to protect offshore habitats. Please refer Figure 2.2.1 above and Figure C.1.1 and Figure C.2.1 in Appendix C. The SPAs are designated for intertidal sand and mud flats and their associated bird populations. To the north and east of the EIS region there are offshore marine protected areas protecting seabed habitats including a Marine Nature Reserve. Details of these are presented in the Environmental Appraisal [8].

Liverpool Bay/Bae Lerpwl SPA

Liverpool Bay / Bae Lerpwl SPA borders the coastlines of north-west England and north Wales, running as a broad arc from Morecambe Bay to the east coast of Anglesey (Figure C.1.1).

The seabed of the SPA consists of a wide range of mobile sediments. Large areas of muddy sand stretch from Rossall Point to the Ribble Estuary, and sand predominates in the remaining areas, with a concentrated area of gravelly sand off the Mersey Estuary and a number of prominent sandbanks off the English and Welsh coasts. The tidal currents throughout the SPA are generally weak, which combined with a relatively large tidal range facilitates the deposition of sediments. The site is used regularly and is classified as a SPA for the protection of red-throated diver (*Gavia stellata*), common scoter (*Melanitta nigra*), and little gull (*Hydrocoloeus minutus*) in the non-breeding season; common tern (Sterna hirundo) and little tern (*Sterna albifrons*) in the breeding season, and an internationally important waterbird assemblage. It covers an area 2,528km^2 [10].

Morecambe Bay and Duddon Estuary SPA

This SPA extends between Rossall Point in Lancashire and Drigg Dunes in Cumbria. The site includes the former Morecambe Bay SPA and Duddon Estuary SPA, as well as an extension to include the Ravenglass Estuary, the intervening coast, and the shallow offshore area off south-west Cumbria coast [5].

The site supports non-breeding whooper swan (*Cygnus Cygnus*), little egret (*Egretta garzetta*), European golden plover (*Pluvialis apricaria*), bar-tailed godwit (*Limosa lapponica*), ruff (*Calidris pugnax*), Mediterranean gull (*Larus melancephalus*) pink-footed goose (*Anser brachyrhynchus*), common shelduck (*Tadorna tadorna*), northern pintail (*Anas acuta*), Eurasian oystercatcher (*Haematopus ostralegus*), grey plover (*Pluvialis squatarola*), common ringed plover (*Charadrius hiaticula*), Eurasian curlew (*Numenius arquata*), black-tailed godwit (*Limosa limosa*), ruddy turnstone (*Arenaria interpres*), red knot (*Calidris canutus*), Sanderling (*Calidris alba*), dunlin (Calidris alpina alpine), common redshank (*Tringa tetanus*), and lesser black-backed gull (*Larus fuscus*). The site also supports breeding little tern (*Sternula albifrons*), sandwich tern (*Sterna sandvicensis*) common tern (*Sterna hirundo*), lesser black-backed gull (Larus fuscus), and European herring gull (*Larus argentatus argenteus*), as well as supporting an internationally important waterbird and seabird assemblages. It covers an area 669km^2 [2].

Conservation objectives of the SPAs

The conservation objectives for both the Liverpool Bay / Bae Lerpwl SPA and the Morecambe Bay and Duddon estuary SPA are described as follows [10][11]:

Ensure that the integrity of the site(s) is maintained or restored as appropriate, and ensure that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring:

- The extent and distribution of the habitats of the qualifying features.
- The structure and function of the habitats of the qualifying features.
- The supporting processes on which the habitats of the qualifying features rely.
- The population of each of the qualifying features, and,
- The distribution of the qualifying features within the site.

2.4.3 Fishing

The eastern Irish Sea ports have supported a commercial fishing industry since the early 1800s and although the industry has been in decline for several years there is still commercial fishing activity in the area. The location is an important fishing ground for queen scallops, small prawns, and a variety of white fish, all of which historically has involved the use of bottom trawl fishing gear. The only fish landings records of note concern shellfish and to a lesser degree demersal fish, with nothing significant recorded on the ICES database for pelagic fish in the region for the last few years up to 2021 [11].

The Dalton assets are in ICES Rectangle 36E6 while the Millom assets are situated in 37E6.

An analysis of the fishing activity between 2015 and 2021 would suggest that the area has contributed relatively little to the overall UK fishing effort [11], This is indicated in Figure 2.4.2 and Figure 2.4.3, and can be measured as a fraction of one percentage point in each of the two ICES Rectangles.

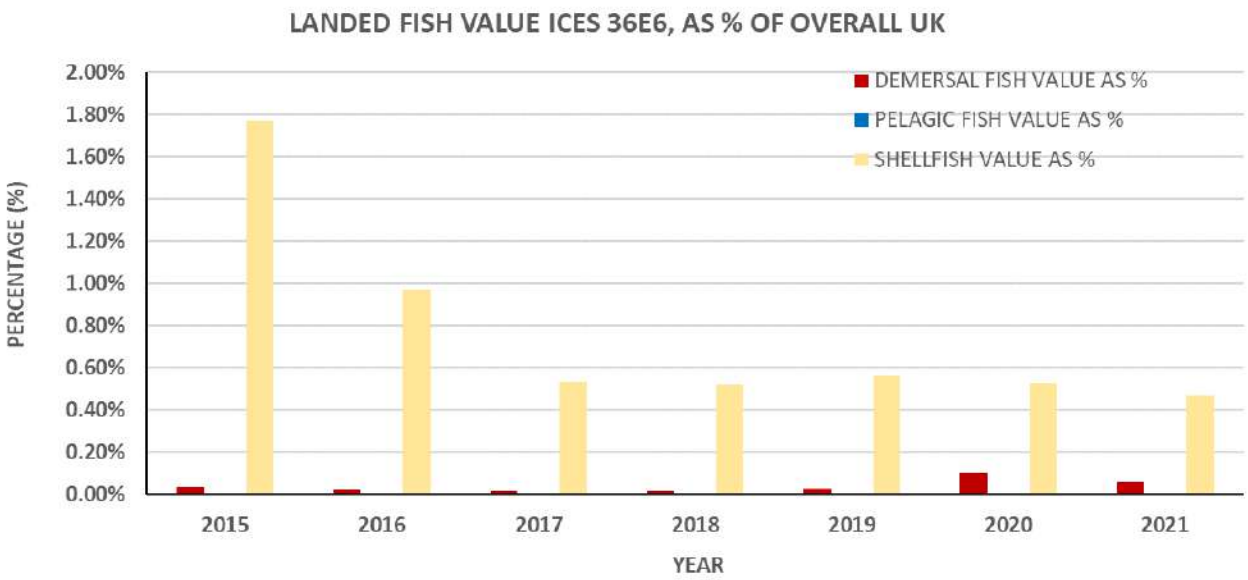


Figure 2.4.2: Value of fish landings as a percentage of UK fishing effort (36E6)

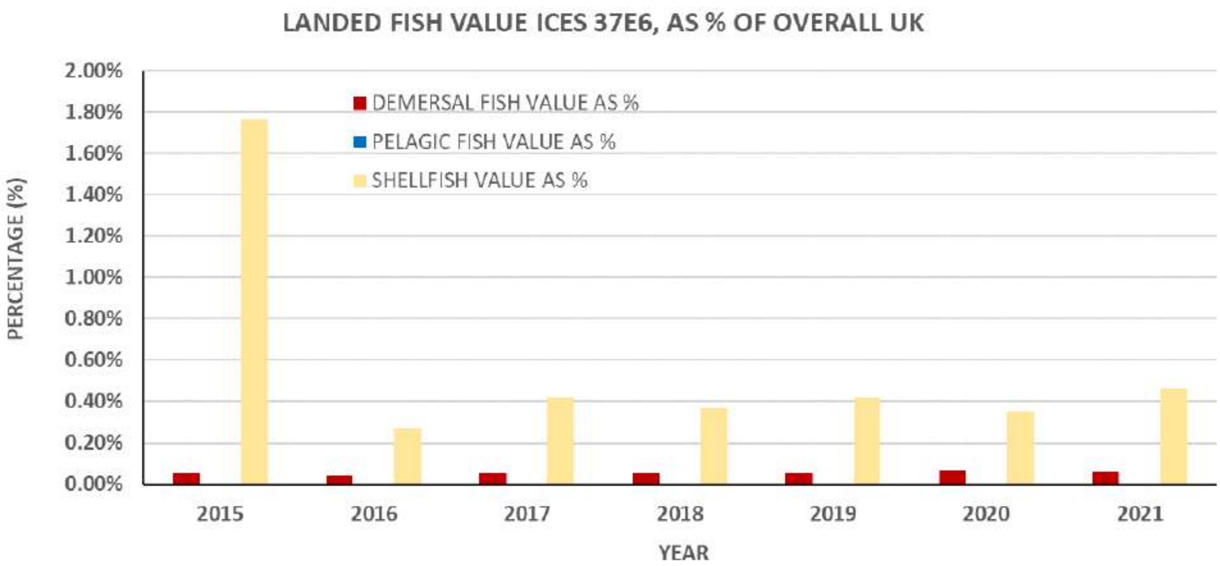


Figure 2.4.3: Value of fish landings as a percentage of UK fishing effort (37E6)

Landed fish value and average landed fish value per km^2 are presented in Figure 2.4.4 and Figure 2.4.6. Using pots and traps landed fish value and average landed fish value per km^2 within ICES rectangle 36E6 can be seen in Figure 2.4.5 and Figure 2.4.7 respectively. Between 2015 and 2021 the percentage of catch using pots and traps versus the overall landed shellfish values in ICES rectangle 36E6 has varied between 12.3% (2016) and 53.3% (2019). In 2021 this percentage was 36%.

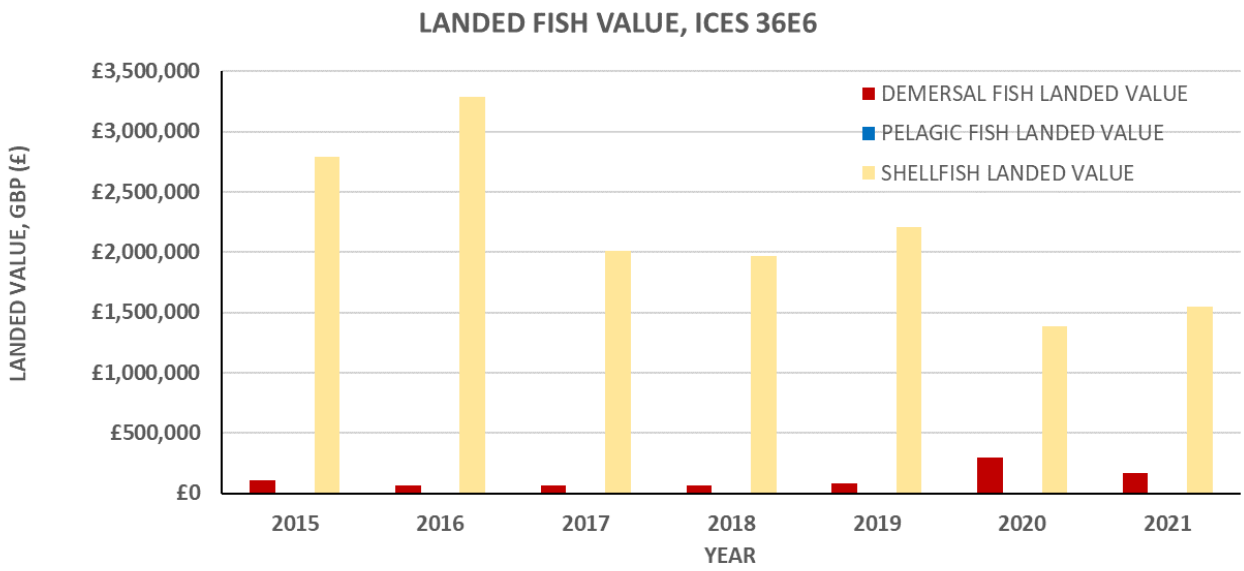


Figure 2.4.4: Landed fish value for ICES 36E6

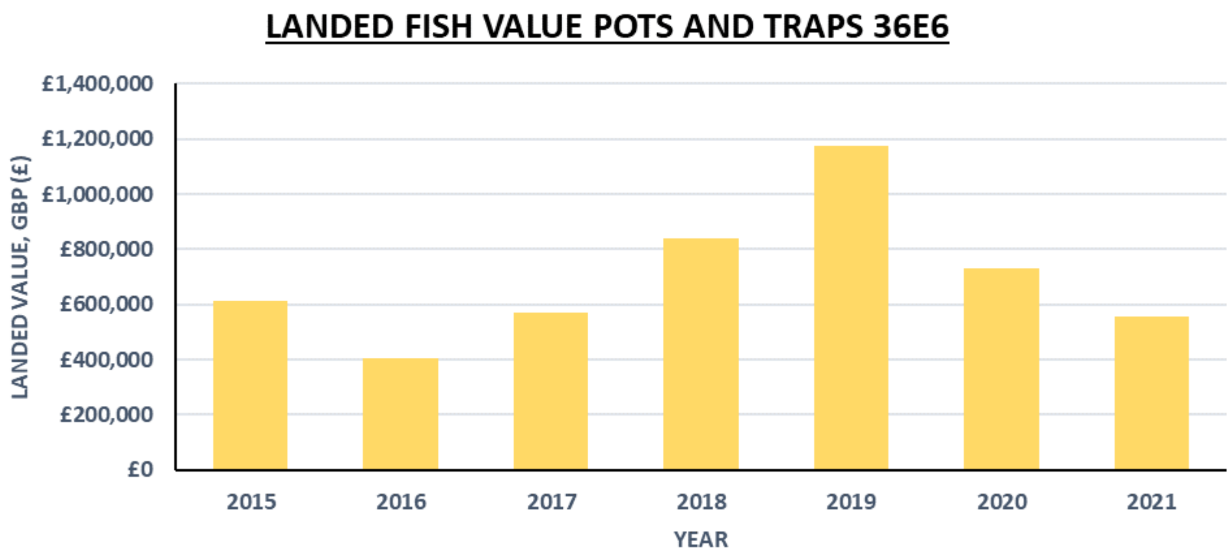


Figure 2.4.5: Landed fish value for ICES using pots and traps in ICES 36E6

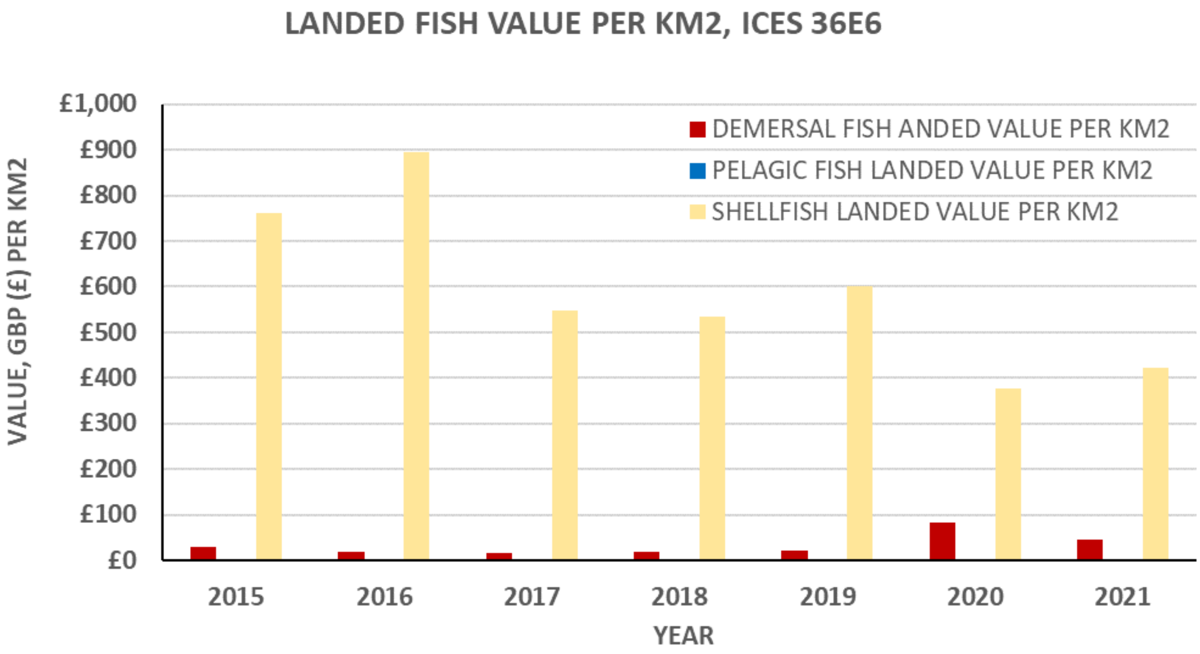


Figure 2.4.6: Value per km² for fish landed from ICES 36E6

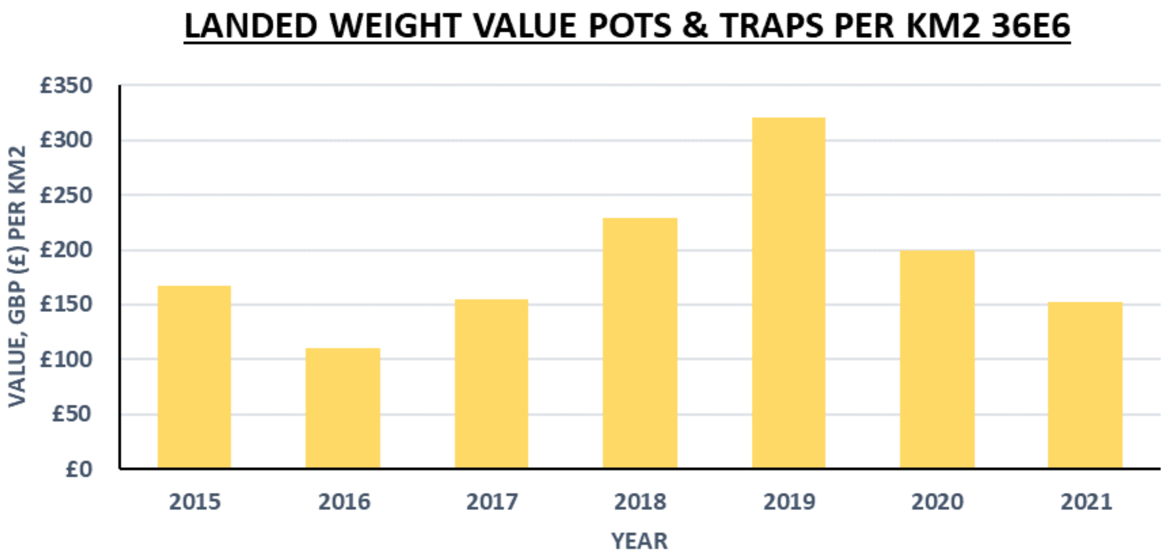


Figure 2.4.7: Value per km² for fish landed using pots and traps in ICES 36E6

Landed fish value and average landed fish value per km² within ICES rectangle 37E6 can be seen in Figure 2.4.8 and Figure 2.4.10 respectively. Landed fish value and average landed fish value per km² using pots and traps within ICES rectangle 37E6 can be seen in Figure 2.4.9 and Figure 2.4.11 respectively. Between 2015 and 2020 the percentage of catch using pots and traps versus the overall landed shellfish values in ICES rectangle 37E6 has varied between 28.5% (2015) and 56.5% (2020). In 2021 this percentage was 31%.

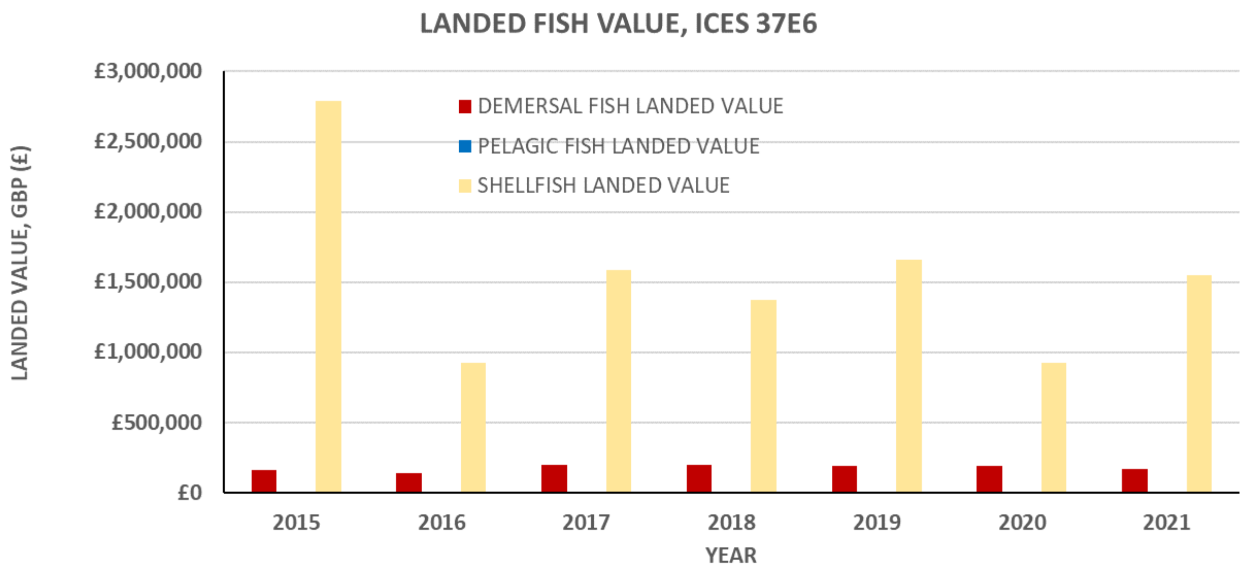


Figure 2.4.8: Landed fish value for ICES 37E6

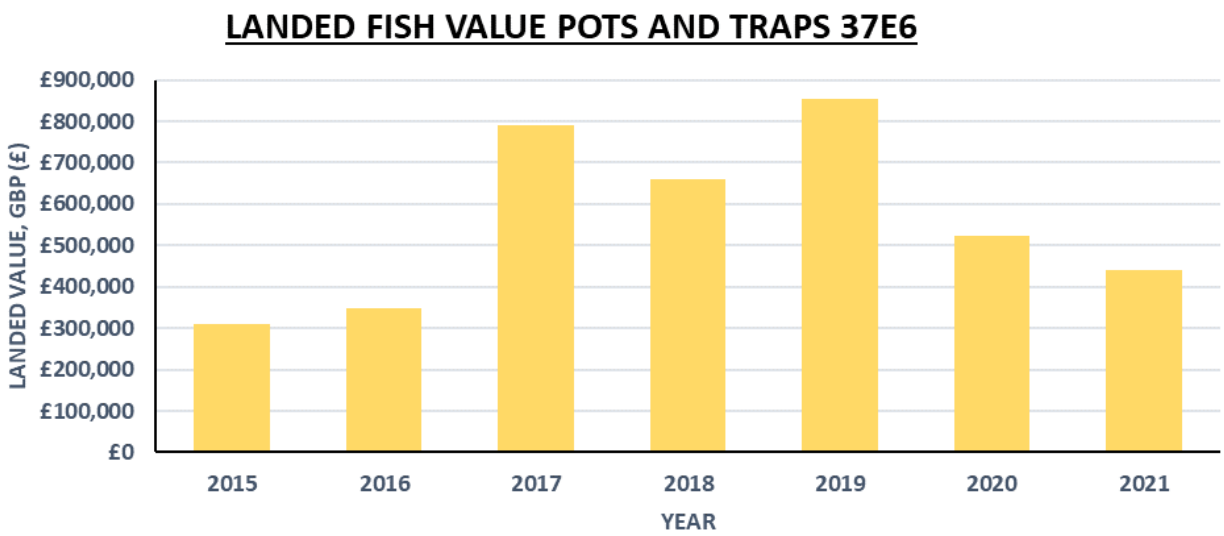


Figure 2.4.9: Landed fish value using pots and traps for ICES 37E6

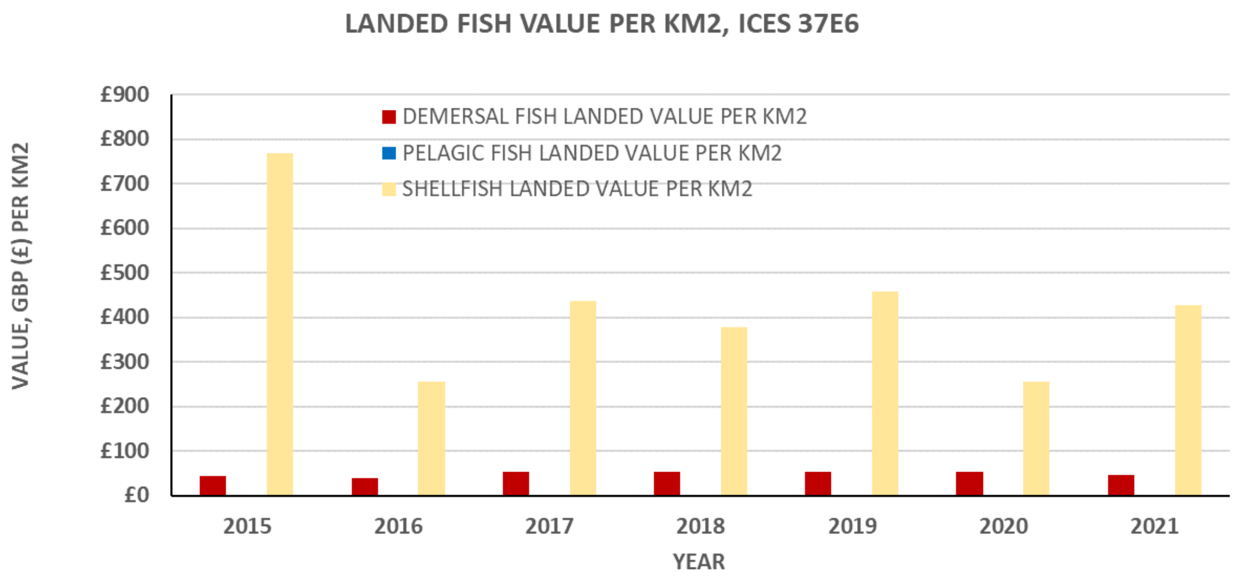


Figure 2.4.10: Value per km² for fish landed from ICES 37E6

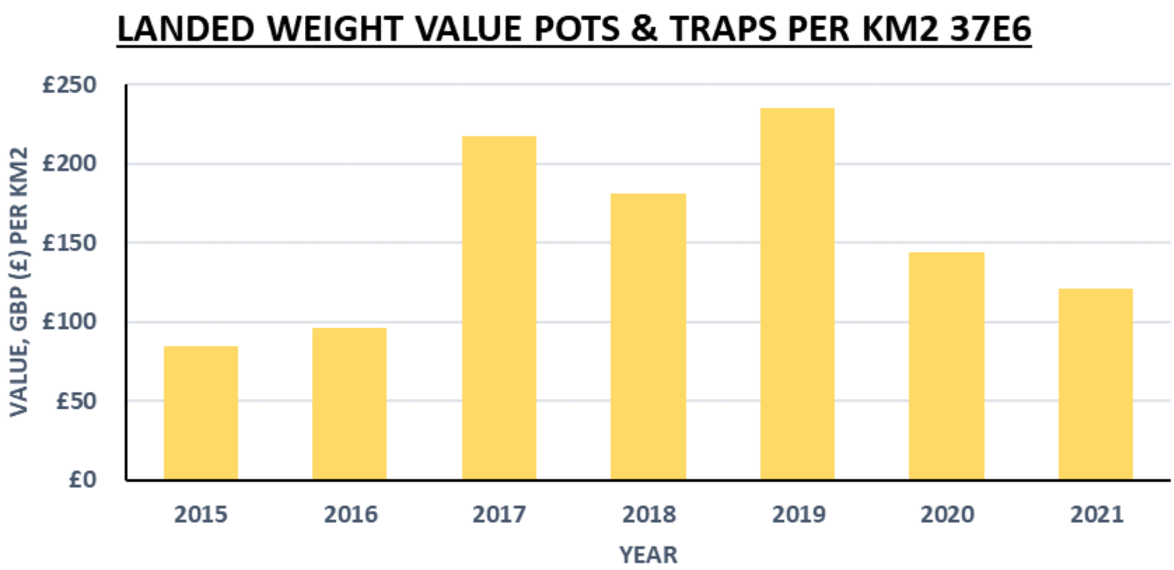


Figure 2.4.11: Value per km² for fish landed using pots and traps from ICES 37E6

For ICES Rectangle 36E6, in 2021, the average value of demersal and shellfish landed per km² was £45.79 and £422.33. This is calculated by dividing the commercial value of fish landed by the area of ICES Rectangle 36E6 (3,671km²). This is a slight decrease on 2020 values for demersal fish and an increase for shellfish.

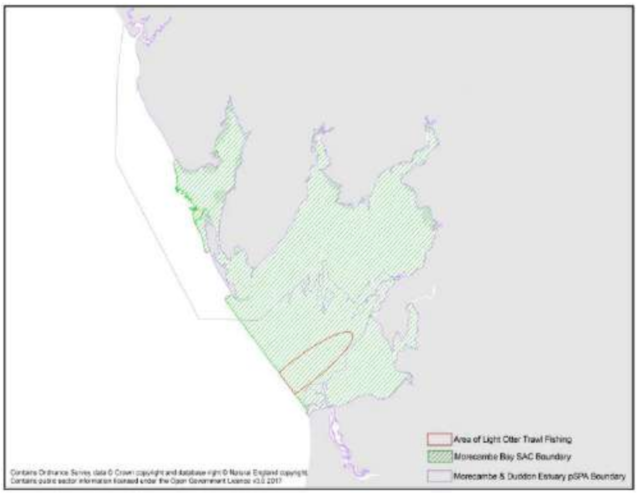
For ICES Rectangle 37E6, in 2021, the average value of demersal and shellfish landed per km² was £46.34 and £427.34. This is calculated by dividing the commercial value of fish landed by the area of ICES Rectangle 37E6 (3,628km²). This is a slight decrease on 2020 values for demersal fish and an increase for shellfish.

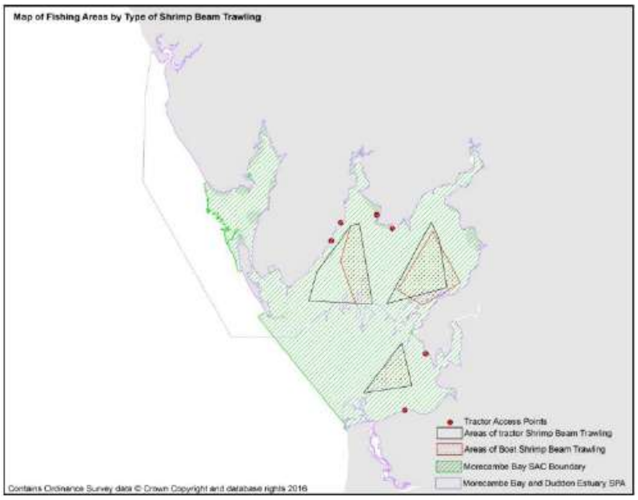
This indicates that at least up until 2020 fishing in the area has been in decline before seeing a slight increase in landed values for shellfish in 2021. Any decommissioning activities that could interfere with the deployment of static fishing gear such as pots and traps will need to be managed carefully with early engagement with stakeholders recommended.

Fishing within the protected areas

Fishing activities in the Liverpool Bay/Bae Lerpwl SPA and the Morecambe Bay and Duddon Estuary SPA are much reduced, with many trawling techniques and dredging activities – whether from a vessel or tractor, no longer being used [13], [14], [15] & [16].

Most of the fishing activities within the Morecambe Bay and Duddon Estuary SPA itself are carried out within the inshore Morecambe Bay area exception for the fixed netting along the shoreline to the north-west Morecambe Bay area as indicated in the bottom left map in Figure 2.4.12.



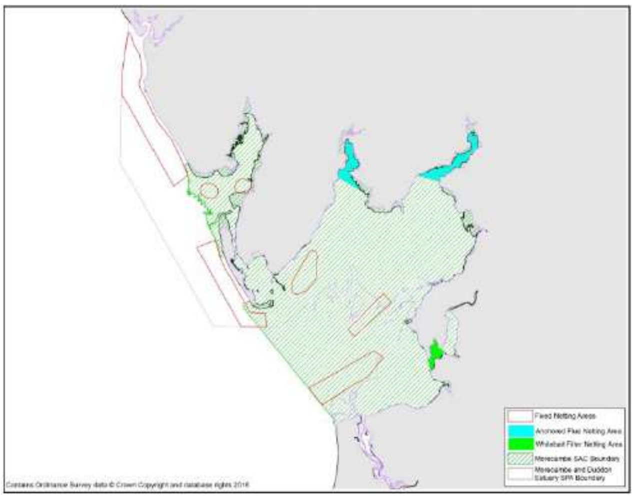


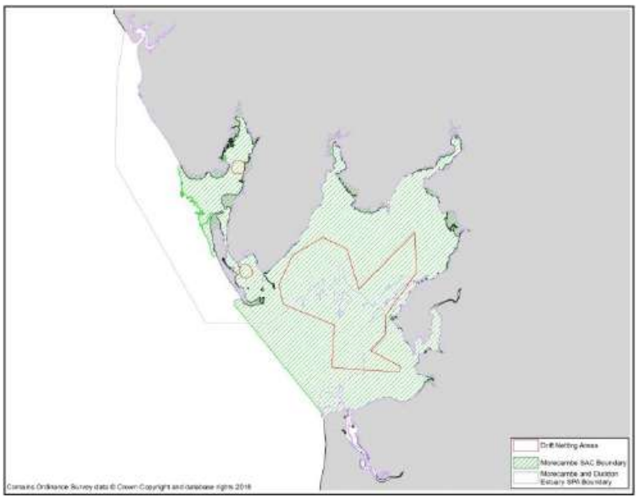
Key:

- Area of Light Otter Trawl Fishing
- Morecambe Bay SAC Boundary
- Morecambe and Duddon Estuary SPA Boundary

Key:

- Tractor Access Point
- Areas of tractor Shrimp Beam Trawling
- Areas of Boat Shrimp Trawling
- Morecambe Bay SAC Boundary
- Morecambe and Duddon Estuary SPA Boundary





Key:

Fixed Netting Areas

Anchored Flue Netting Area

Whitebait Filter Netting Area

Morecambe Bay SAC Boundary

Morecambe and Duddon Estuary SPA Boundary

Key:

Drift Netting Area

Morecambe Bay SAC Boundary

Morecambe and Duddon Estuary SPA Boundary

Figure 2.4.12: Fishing Activity in Morecambe Bay & Duddon Estuary SPA

2.4.4 Wind farms

Barrow wind farm

Barrow Offshore Wind Farm is located in the eastern Irish Sea near Barrow-in-Furness. The transmission cable runs into Morecambe Bay where it is connected to the National Grid transformer station in Heysham. The construction of Barrow Offshore Wind Farm took place between March 2005 and July 2006. The wind farm became operational in July 2006 [1]. This wind farm and the associated power cable was installed later than the two Rivers pipelines PL1965 and PL1966, but the power cable does not cross them.

Figure 2.4.13: Location of Barrow Offshore Windfarm [1]

Ormonde wind farm

The Ormonde Offshore Wind Farm is located in the East Irish Sea, approximately 9km from Walney Island near Barrow-in-Furness, Cumbria, UK. The wind farm covers an area of 8.7km^2. It has a total capacity of 150MW and is expected to produce around 500 GWh of electricity per year. Construction started in 2010 and the windfarm has been operational since 2011 [20]. This wind farm and the associated power cable was installed later than the two Rivers pipelines PL1965 and PL1966 and crosses over them.

Figure 2.4.14: Location of Ormonde (2011) Offshore Windfarm[6]

Walney Wind Farm

Walney Offshore Wind Farm originally consisted of two stages: Walney 1 and Walney 2 which cover a combined area of 73km^2. Each stage comprises of 51 turbines and the total combined capacity of the wind farm is 367MW. The Walney 1 and Walney 2 Windfarms are supplemented by the Walney Extension Offshore Wind Farm that uses 87 turbines with a total capacity of 659MW. The Walney Extension covers an area 145km^2 and is located approximately 19km west of Barrow-in-Furness in Cumbria off the North-West coast of England [18].

Walney 1 became operational in 2011 and Walney 2 became operational in 2012. The Walney Extension Offshore Wind Farm became operational in September 2018. The locations of these wind farms are shown in Figure 2.4.15 and Figure 2.4.16 below. These wind farms and the associated power cables were installed later than the two Rivers pipelines PL1965 and PL1966 and the power cable crosses over them.

Figure 2.4.15: Walney 1 (2011) & Walney 2 (2012) Offshore Windfarm Locations

Figure 2.4.16: Walney Extension (2018) Offshore Windfarm Location

West of Duddon Sands Offshore Wind Farm

The West of Duddon Sands Wind Farm covers an area 67km^2 and has been fully operational since 2014 and comprises 108 turbines and the total combined capacity of the wind farm is 389 MW [18]. This wind farm and the associated power cable was installed after the two Rivers pipelines PL1965 and PL1966 and the power cable crosses over them.

Figure 2.4.17: West of Duddon Sands (2014) Offshore Windfarm Location

2.4.5 Grout bags

The number of grout bags noted in the Decommissioning Programmes [7] has been estimated using available data such as as-built drawings and design sketches, although as no quantities are quoted on the documentation engineering judgment is used. Apart from around the subsea installations and pipeline structures, few grout bags were used for the pipelines apart possibly from right next to the subsea installations and PLEM protection structures. Several fronded grout bags were installed around the Millom PLEM.

In this instance the intention would be to fully remove all grout bags when decommissioning the surface laid pipelines, umbilicals and cables. Any other grout bags that are buried and would remain undisturbed during decommissioning operations would be left *in situ*. Although several different methods could theoretically be used to remove the grout bags, from a practical perspective it is not known whether the bag material has remained intact since the original installation.

2.4.6 Mattresses

When a pipeline or structure is installed, it is often provided with protection and stabilisation features, and usually this takes the form of a concrete mattress. Most of the mattresses used for the Calder, Dalton and Millom pipeline infrastructure are concrete. When a pipeline or structure is placed into an area with a loose sedimentary material, under certain conditions the flow of water can cause erosion of the seabed, and this is called scour. Scour around a structure or pipeline will undermine its stability, and so is undesirable. Fronded mattresses are put in place to provide protection against scour, and when they do their job the fronds act like natural seaweed, and the silt and sediment that is carried in the water column builds up within the fronds. Eventually they become buried. Given the right conditions they can be very effective.

Fronded mattresses, concrete bases

Few fronded mattresses have been used to protect and stabilise the infrastructure within the Calder, Dalton, and Millom area. According to the documentation just 2x fronded mattresses are to be found protecting and stabilising PLU1678JQ3 and PL1980 next to the Millom PLEM; no other fronded mattresses were installed. All the mattresses are 6m x 3m x 0.15m as indicated in Figure 2.4.18 below.

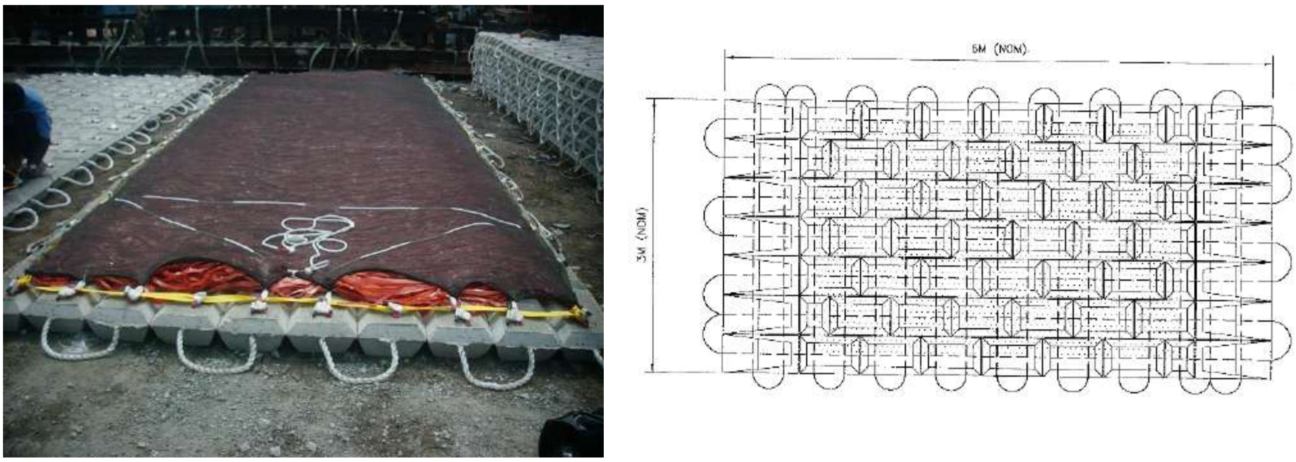


Figure 2.4.18: Typical concrete and concrete fronded mattresses (6m x 3m x 0.15m)

2.4.7 Deposited rock

An examination of the Calder, Dalton and Millom related documentation suggests that deposited rock was only installed around the Calder and Millom West installations, and this was to mitigate scour.

Methods that could be used to remove the rock include:

- dredging the rock and disposing of the material at an approved offshore location.
- dredging the rock and transporting the material to shore to be disposed of in an approved manner.
- lifting the rock using a grab vessel, depositing in a hopper barge, and transporting it to shore for appropriate disposal.

All these proposed methods would impact on the seabed and associated communities, create sediment plumes, and require additional vessel use with the associated environmental impacts, safety risks, impacts on other users of the sea and additional costs.

While it is considered physically possible to remove deposited rock, the decommissioning philosophy in this document is consistent with the guidance notes [17], with all deposited rock being left *in situ*.

Material left in place will preserve the marine habitat that will have established over the time it has been on the seabed, and in this case its presence will not have a negative impact on the environment, nor impact on the safety of other users of the sea.

2.5 Assumptions, limitations, and gaps in knowledge

The most significant assumptions, limitations and knowledge gaps relating to the comparative assessment are listed below. In addition, it should be noted that the presentation of the different categories of risks for comparison has required a degree of engineering judgement, which includes the following technical assumptions:

- A purely qualitative approach has been taken. This has necessarily required a degree of judgement, but since most impacts are related to area of seabed impacted, duration of works and vessel time, this is deemed appropriate.
- Theoretically, it would be technically feasible to displace the overlying sediment in a trench and unbury and remove all pipelines irrespective of the method used. The method used would primarily affect comparisons in the cost assessment.
- Technically, removal of the concrete weight coated (CWC) and piggybacked pipeline could be achieved using the 'cut and lift' method assuming that the overlying seabed sediment or rock could be excavated or displaced to allow access.
- Complete removal of the electrical cables and umbilicals by reverse reel would be achievable should the overlying sediment be displaced to allow the cables and umbilicals to be pulled from the trench.
- It is possible that the smaller individual pipelines less than 16in diameter could be removed using reverse reel assuming that their integrity could be assured, and that the overlying sediment could be displaced to allow the pipeline(s) to be pulled from the trench.
- Harbour Energy is not aware of any fishing gear snagging reports. None of the pipelines[5] that were originally trenched and buried have been found to be exposed apart from on the final approaches to the installations or PLEMs. To the companies' knowledge no exposures have been of such a magnitude or location such that they have warranted being recorded as a snagging hazard via Kingfisher Information Services on FishSAFE (www.fishsafe.eu).

The following legacy assumptions have also been made:

- Minimising the number of cut pipeline ends is to be preferred from a legacy perspective (e.g. snagging of fishing nets) and from an environmental perspective if pipelines ends are to be buried using deposited rock.
- An environmental survey would be required on completion of decommissioning activities.
- Any pipeline being left *in situ* would be subject to at least three legacy burial surveys, although given the depth of burial it is possible that this requirement could be re-assessed following the post-decommissioning surveys.
- The seabed sediment type is such that any spoil heaps created during any decommissioning operations would not present significant snagging hazards.
- In the long term, assuming the size and profile or the resulting rock berm is suitable, deposited rock remaining *in situ* would not present snagging hazards.
- The impact of the procurement of any new materials such as fabricated items or mining of new rock is ignored.
- Impact on commercial activities (fishing in particular, and to a much lesser extent windfarm related activities) is proportional to the duration of vessel activity.

[5] Apart from the Calder trunklines PL1965 & PL1966 on the final few kilometres as they approach the shoreline

- Societal benefits and vessel associated environmental impacts and risks are assumed to be proportional to vessel duration.
- Only a high-level comparison of what differentiates the costs is used.
- The procurement and deposition of additional rock on pipeline ends is ignored in the cost assessment.

Please also refer Appendix F.2 for assumptions that are specific to the cost assessment.

3 The Pipelines, Umbilicals and Cables

3.1 Overview

Except for the Calder trunklines that were (mostly) trenched to ~0.6m below seabed, all pipelines, umbilicals and electrical cables longer than 300m were designed to be buried in the seabed to depth of at least 1m below seabed. On the approaches, the pipelines are protected and stabilised with concrete mattresses as they emerge from burial in the trenches.

The pipelines and umbilical jumpers for Dalton R1, and Millom Q1, Q2 and Q3 to and from the Dalton and Millom PLEMS were all surface laid and provided with protection and stabilisation features in the form of concrete mattresses. Deposited rock has not been used apart from to mitigate the effects of scour around Calder and Millom West platforms. Some of this rock may be found on the pipelines and umbilicals at the two platforms but rock was not used for the purpose of protecting and stabilising the pipelines, umbilicals, etc.

At the time of installation the infrastructure crossed over few third-party pipelines and infrastructure. These crossings were limited to the two Calder trunklines crossing over the Isle of Man Interconnector. However, since their original installation in 2002 several windfarms have been installed, and this has resulted in the Calder trunklines being crossed by several power cables that service these wind farms. A brief description of these crossings was presented earlier in section 2.4.4.

The results of acoustic monitoring surveys conducted on several occasions since 2007, and a pipeline survey in 2022 have shown that none of the pipelines have been found to be exposed along their length except for the two Calder trunklines PL1965 and PL1966 where they cross the IOM Interconnector cable, and where they themselves are crossed by the various wind farm cables.

The Calder, Dalton, and Millom pipelines and the intended burial status when originally installed are summarised in Table 3.1.1, Table 3.1.2 and Table 3.1.3 below:

Calder pipeline, umbilical and cable summary			
Description	Route	Burial	Length (km)
PL6340 62mm electrical cable	CPP1 to Calder	Buried	~7.6
PL1965 24in pipeline (trunkline)	Calder to MLWM	Buried	~42.7
PL1966 3in pipeline (trunkline)	MLWM to Calder	Buried	~42.6
NOTE: 1. Calder PL1965 is piggybacked by PL1966 and the overall length including the onshore section to the Rivers gas terminal is ~47.8km.			

Table 3.1.1: Calder pipeline, umbilical and cable summary

PL1965 is considered by the Department for Energy Security and Net Zero (DESNZ) as a candidate for re-use for Carbon, Capture, Use, and Storage CCUS [3][4]. The potential re-use of PL1965 for CCUS and timescales will be monitored, discussed, and agreed with NSTA.

Dalton pipeline, umbilical and cable summary			
Description	Route	Burial	Length (km)
PL1668 12in pipeline	Dalton PLEM to DPPA	Buried	~7.2
PL1669 8in pipeline	Dalton R2 to Dalton PLEM	Buried	~1.0
PL1670 8in pipeline	Dalton R1 to Dalton PLEM	Surface laid	~0.1
PL1671 113mm CI & controls umbilical	DPPA to Dalton PLEM	Buried	~7.2
PL1672 100mm CI & controls umbilical	Dalton PLEM to Dalton R2	Buried	~1.0
PL1673 100mm CI & controls umbilical	Dalton PLEM to Dalton R1	Surface laid	~0.1
NOTE: 1. All pipelines, umbilicals and electrical cables appear to be laid separately, and where applicable in their own trenches. 2. Decommissioning of the riser section of PL1668 is out of scope as it will be included in the DPPA decommissioning programmes that will be submitted separately.			

Table 3.1.2: Dalton pipeline, umbilical and cable summary

Millom pipeline, umbilical and cable summary			
Description	Route	Burial	Length (km)
PL6352 58mm electrical cable	DPPA to Millom West	Buried	~15.3
PL1674 12in pipeline	Millom PLEM to DPPA	Buried	~8.8
PL1675 12in pipeline	Millom West to Millom PLEM	Buried	~6.3
PL1676 2.5in pipeline	Millom PLEM to Millom West	Buried	~6.3
PL1677 8in pipeline	Millom Q1 to Millom PLEM	Surface laid	~0.1
PL1678 113mm CI & controls umbilical	DPPA to Millom PLEM	Buried	~8.8
PLU1678JQ3 111mm CI & controls umbilical	Millom PLEM to Millom Q3	Surface laid	~0.3
PL1679 100mm CI & controls umbilical	Millom PLEM to Millom Q1	Surface laid	~0.1
PL1873 8in pipeline	Millom Q2 to Millom PLEM	Surface laid	~0.1
PLU1874 100mm CI & controls umbilical	Millom PLEM to Millom Q2	Surface laid	~0.2
PL1980 6in flexible flowline	Millom Q3 to Millom PLEM	Surface laid	~0.3
NOTE: 1. Millom PL1675 is piggybacked by PL1676. 2. Decommissioning of the riser section of PL1674 is out of scope as it will be included in the DPPA decommissioning programmes that will be submitted separately. 3. All other pipelines, umbilicals and electrical cables appear to be laid separately, and where applicable in their own trenches.			

Table 3.1.3: Millom pipeline, umbilical and cable summary

3.2 Pipeline exposures & spans

It is useful to explain the difference between exposures and spans as illustrated in Figure 3.2.1. An exposure or span does not necessarily introduce a snagging hazard and is often preferable to the removal of the exposed section and leaving two cut ends, even though the cut ends would be remediated to prevent their being exposed some time again in future.

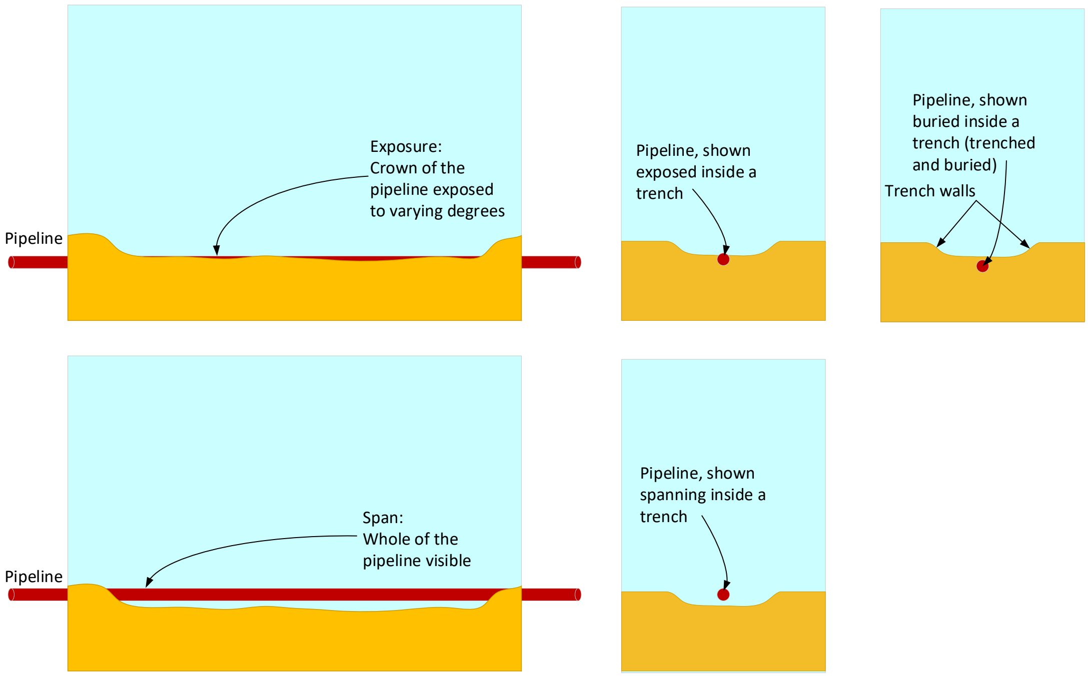


Figure 3.2.1: The difference between pipeline exposures and spans[6]

3.3 Pipeline crossings

Some of the pipelines and umbilicals considered in this comparative assessment cross over other pipelines and umbilicals, as indicated in the figures in Figure 3.4.12, Figure B.4.1 and Figure B.6.1. For oil and gas related infrastructure, this can usually be determined by the pipeline number. The higher pipeline number will usually cross over the top of a pipeline with a lower identification number, so for example, PL2969 or PL2970 would cross over PL940. This is illustrated in Figure 3.3.1.

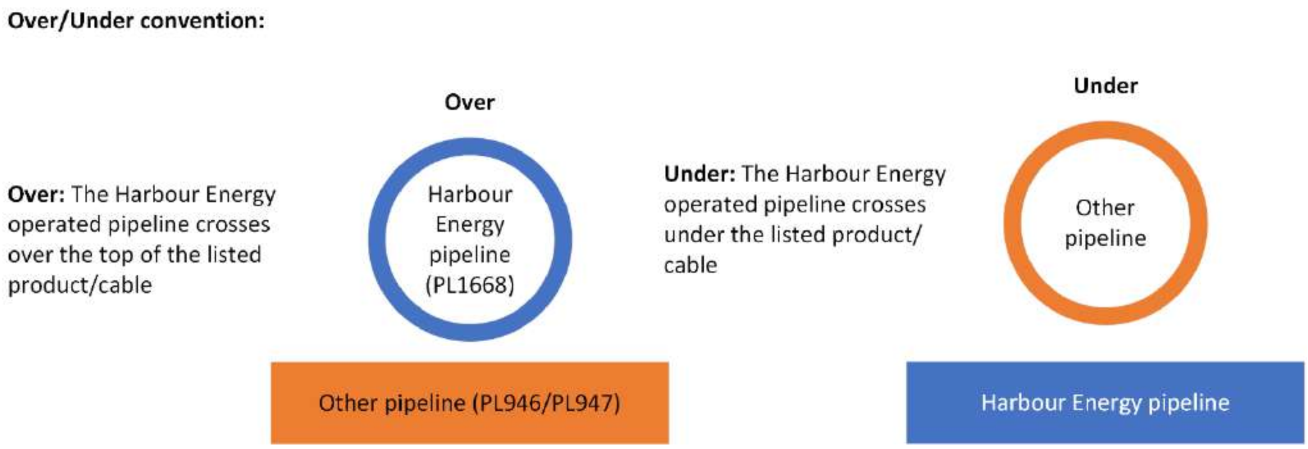


Figure 3.3.1: Over/under convention for pipeline crossings

A summary of the pipeline crossings for the Calder, Dalton and Millom pipeline infrastructure is presented in section 3.7.

[6] Trench walls may or may not be prominent.

3.4 Calder pipelines and cables

3.4.1 PL1965 & PL1966 trunklines to and from Calder to Rivers Terminal

PL1965 is a 24in carbon steel pipeline that is coated with a 6mm thick asphalt enamel coating, on top of which lies a 40mm thick concrete weight coating (CWC) throughout its length except for the riser at Calder. It is ~42.7km long measured to MLWM. The concrete coating is used intermittently on the pipeline tie-in spools at Calder. PL1966 is a 3in pipeline constructed using carbon steel that is coated with 3-Layer Polypropylene (3LPP). PL1966 is ~42.6km long measured from MLWM. The pipelines pass through the Liverpool Bay / Bae Liverpool and the Morecambe Bay & Duddon Estuary SPAs. Please refer Figure C.1.1 and Figure C.2.1 and Appendix C for more information of the pipelines routed through these areas.

The original design intent was that the pipelines were to be trenched to least 0.6m below seabed to the top of the upper most pipeline (PL1966) and allowed to backfill naturally for most of their length, although the minimum depth of trenching increased to 2m for the last km or so as the pipelines approach landfall. Apart from around the Calder platform no rock was deposited as part of the installation operations or because of any subsequent remedial works. A profile of the water depth relative to LAT along the pipelines is presented in Figure 3.4.1 below. The water depth reduces quite sharply after ~KP34.5.

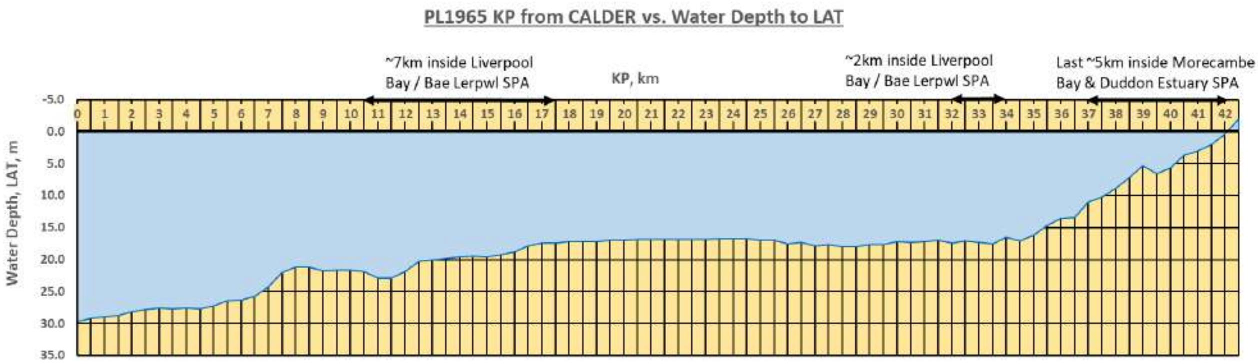


Figure 3.4.1: LAT Depth to Seabed along PL1965 (& PL1966) from Calder to shore

In the absence of 'as-built' trenching and burial listings, the design intent for the burial profile is presented in Figure 3.4.2 below. A review of the 'as-built' alignment sheets reveals that the trenching depth below mean seabed achieved the design requirements, but the original burial listings do not cover the full length of the pipelines and are somewhat sporadic. According to the original installation records the lengths between KP0.036 (start of trench at Calder) through to KP35.58 were acceptable with regards to position and depth of lowering before trenching difficulties were encountered between KP35.6 and KP38.4.

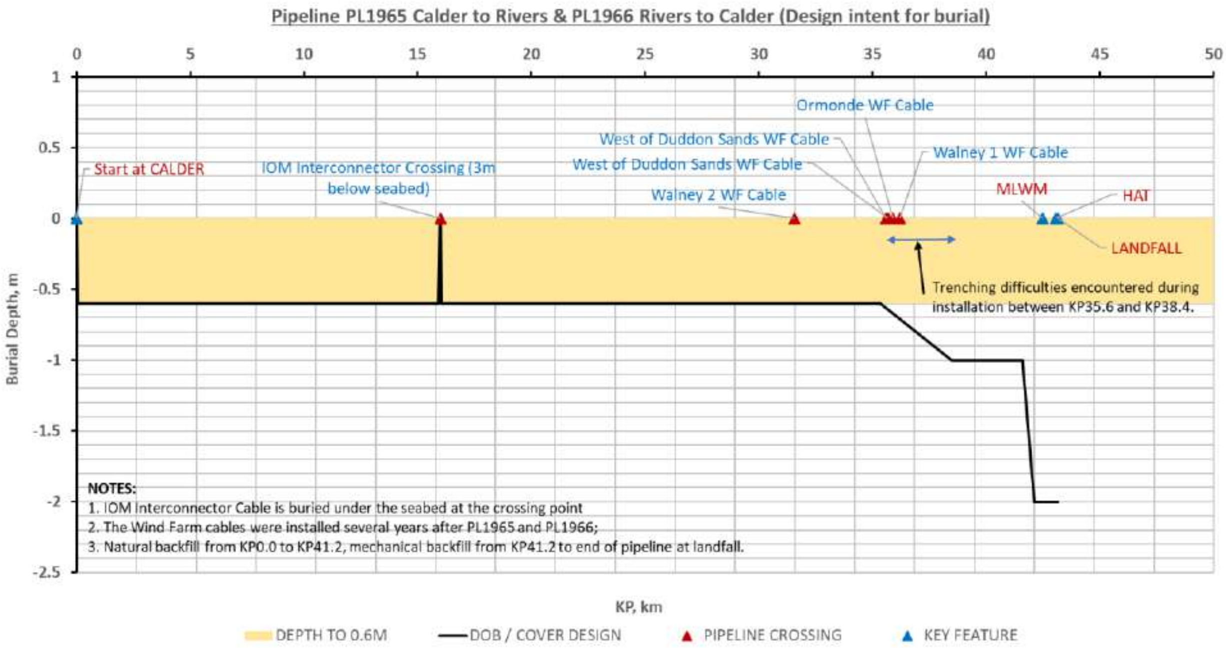


Figure 3.4.2: PL1965 & PL1966 original intended burial profile

Several acoustic monitoring surveys (2007, 2008, 2011, 2014 and 2017) and the results of these are summarised in Figure 3.4.3. Along with the acoustic surveys, spot depth of burial checks were conducted in 2017 (Figure 3.4.4) and a depth of burial survey was conducted up to KP36.3 in 2022 (Figure 3.4.7). An acoustic monitoring survey examines whether the pipelines are exposed, the extent of any exposures and whether any freespans are present but does not examine the depth of burial. The lines between the spot locations present the theoretical profile of the pipeline(s) but were not measured during the survey(s). The 2022 survey data shown in Figure 3.4.6, Figure 3.4.7, Figure 3.4.8 and Figure 3.4.9 include the exposed sections of pipeline near the IOM Interconnector crossing and the windfarm cables between KP35.6 and KP36.2.

Since the Rivers pipelines were installed, several wind farm power cables have been installed over the top of these pipelines and buried under rock. No pattern is evident regarding the number, and length of exposures and spans from year to year, but according to the original installation data trenching of the seabed between KP35.6 and KP38.4 appeared to be ‘very difficult’ in places, leading to a concession request to reduce the trenching depth to 0.3m to top of pipe. It is also possible that the deposition of rock in the area has led to an increase in local scouring and to the Rivers pipelines being exposed in the area. Figure 3.4.5 shows the location of exposures vs. rock between KP35.584 and KP36.369 near where the windfarm cables are located. The exposures that have been observed over the years would appear to be occurring because of the pipelines being installed at a shallower depth to top of pipe in these areas.

At the IOM Interconnector crossing. an unsupported section of the pipeline(s) covered with mattresses was observed in 2014 (25m long) and 2017 (7.2m long) and 2022 (18m long) and is thought to be attributed to local scour. Several short exposures between the mattresses were also observed in 2022 (Figure 3.4.8). Several exposures were found near the various windfarm crossings (Figure 3.4.9).

Over the years several exposures have been found near the windfarm power cable crossings as well as in the areas that was difficult to trench. The lengths of exposure have been found to vary over the years with the figures for 2017 shown in Figure 3.4.3. A breakdown of exposures surveyed per year and within a specific KP range is shown in Table 3.4.2. The KP ranges are relevant because the exposures between KP31.5 and KP31.6 and between KP35.6 and KP36.4 are in proximity of the deposited rock used for the wind farm cables.

SURVEY	EXPOSURES			SPANS			
YEAR	NO	TOTAL LENGTH	MAX LENGTH	NO	TOTAL LENGTH	MAX LENGTH	REPORTABLE
2007	25	1,417m	135m	1	14m	14m	None
2008	18	965m	216m	None	None	None	None
2011	18	619m	120m	None	None	None	None
2014	22	922m	130m	1	2m	2m	None
2017	22	1,229m	141m	10	80m	20m	None
2022	6	15m	5m	6	62m	18m	None
2023	18	984m	145m	The existence of spans or otherwise is not noted in 2023 pipeline survey report.			

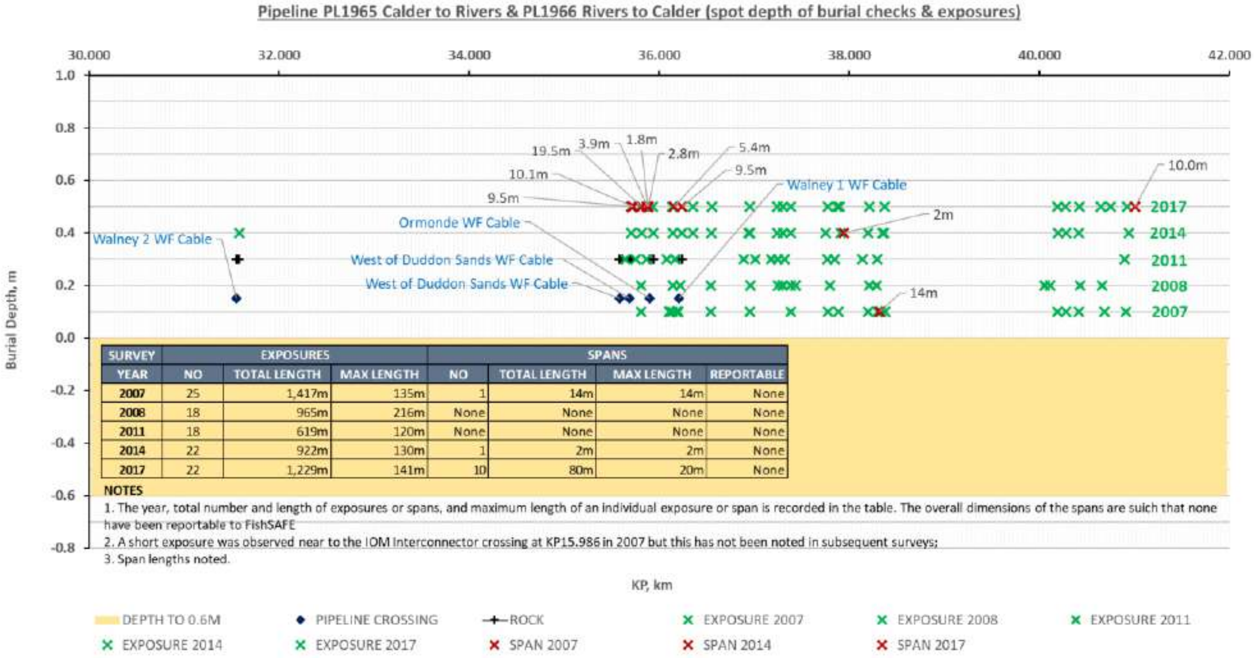
Table 3.4.1: PL1965 & PL1966 cumulative number and length of exposures / spans noted in survey

LOCATION OF HISTORICAL EXPOSURES BY KP						
YEAR	DESCRIPTION	<KP31.5	KP31.5 to KP31.6	KP35.6 to KP36.4	>KP36.4	TOTAL
2007	NO.	3	0	7	15	25
	∑ LENGTH	208m	0m	218m	991m	1,417m
2008	NO.	0	0	3	15	18
	∑ LENGTH	0m	0m	156m	809m	965m
2011	NO.	3	0	5	10	18
	∑ LENGTH	20m	0m	133m	466m	619m
2014	NO.	0	1	6	15	22
	∑ LENGTH	0m	7m	187m	728m	922m
YEAR	KP RANGE (2017)	<KP31.5	n/a	KP35.6 to KP36.4	KP36.4 to KP41.02	n/a
2017	NO.	0	0	6	16	22
	∑ LENGTH	0m	0m	206m	1,023m	1,229m
2022	NO.	2	0	4	n/a	6
	∑ LENGTH	23m	0m	39m	n/a	62m
2023	NO.	n/a	n/a	3	15	18
	∑ LENGTH	n/a	n/a	60m	924m	984m

NOTE

1. An unsupported pipeline span (~25m long in 2014, ~7.2m in 2017, ~18m in 2022) at KP15.986 occurs near the IOM interconnector crossing and may need to be remediated.
2. The KP RANGE (2017) shows the start and finish KP of the first and last exposure within the range. It should be noted that in some instances there are gaps of several hundred metres between exposures and this should be taken account in any remediation strategy.
3. In 2022 apart from at the Calder platform and near the IOM Interconnector crossing, several exposures and spans were found near the windfarm cable crossings between KP35.6 and KP36.4. Note that the 2022 survey data only extend as far as KP36.4. In 2023 the pipeline(s) were surveyed between KP35.6 and KP41.106.

Table 3.4.2: PL1965 & PL1966 location of historical exposures by general location



SURVEY	EXPOSURES			SPANS			
YEAR	NO	TOTAL LENGTH	MAX LENGTH	NO	TOTAL LENGTH	MAX LENGTH	REPORTABLE
2007	25	1,417m	135m	1	14m	14m	None
2008	18	965m	216m	None	None	None	None
2011	18	619m	120m	None	None	None	None
2014	22	922m	130m	1	2m	2m	None
2017	22	1,229m	141m	10	80m	20m	None

NOTES
1. The year, total number and length of exposures or spans, and maximum length of an individual exposure or span is recorded in the table. The overall dimensions of the spans are suich that none have been reportable to FishSAFE
2. A short exposure was observed near to the IOM Interconnector crossing at KP15.986 in 2007 but this has not been noted in subsequent surveys;
3. Span lengths noted.

Figure 3.4.3: PL1965 & PL1966 summary of exposures and spans KP30.0 onwards

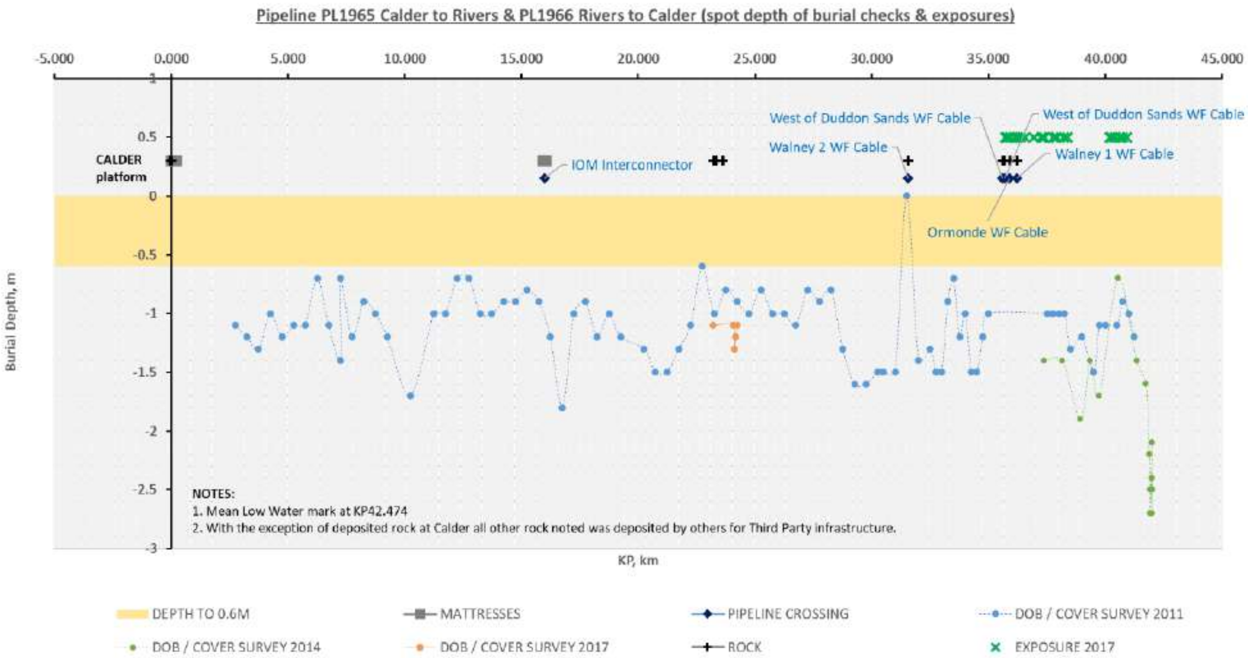


Figure 3.4.4: PL1965 & PL1966 spot depth of burial & exposures (2017)

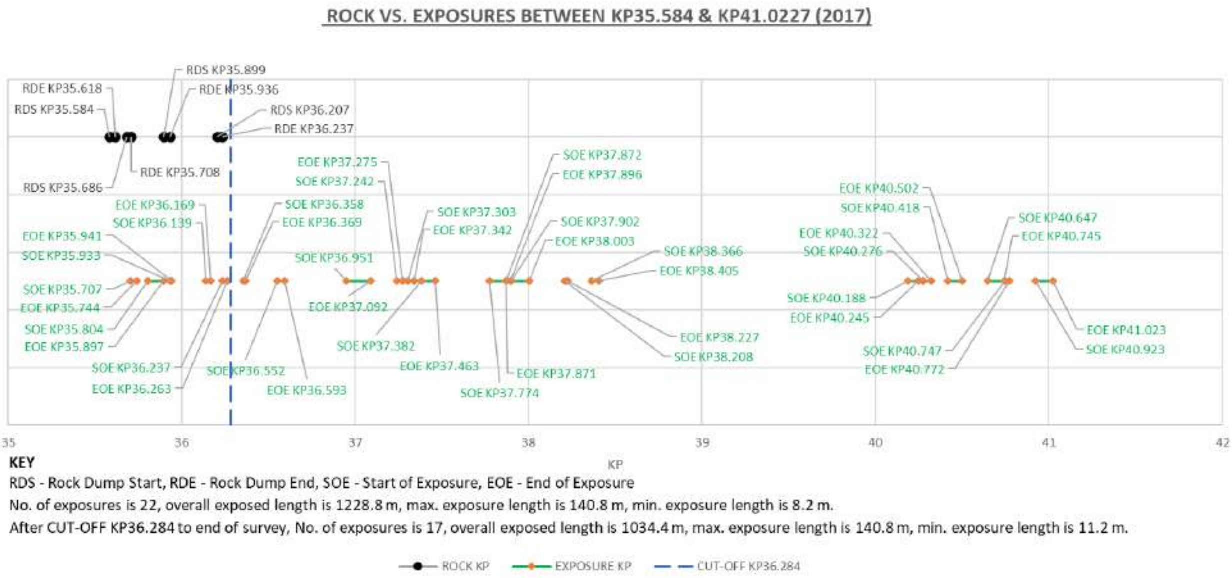


Figure 3.4.5: PL1965 & PL1966 rock vs. exposure detail (2017)[7]

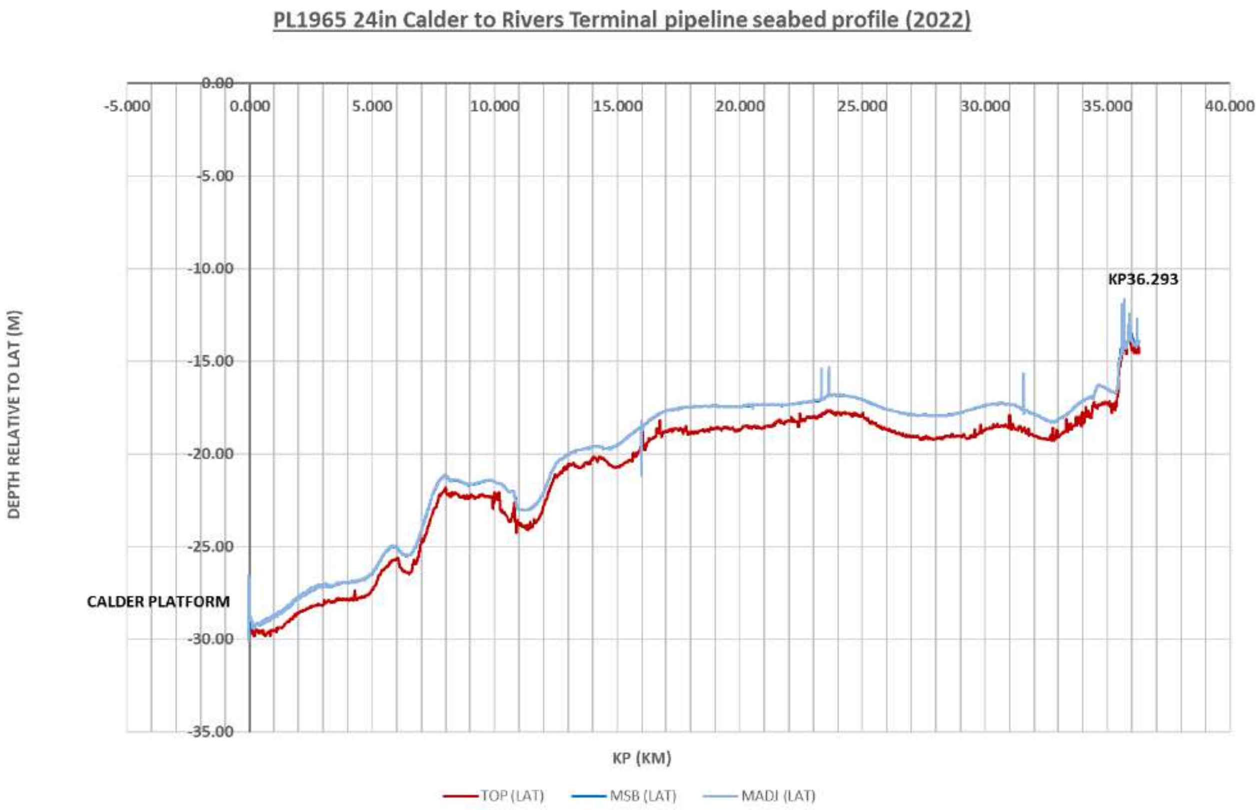


Figure 3.4.6: PL1965 & PL1966 seabed & burial profile (2022)

[7] "CUT-OFF KP36.284" is shown for ease of comparison with 2023 survey data shown in Figure 3.4.11.

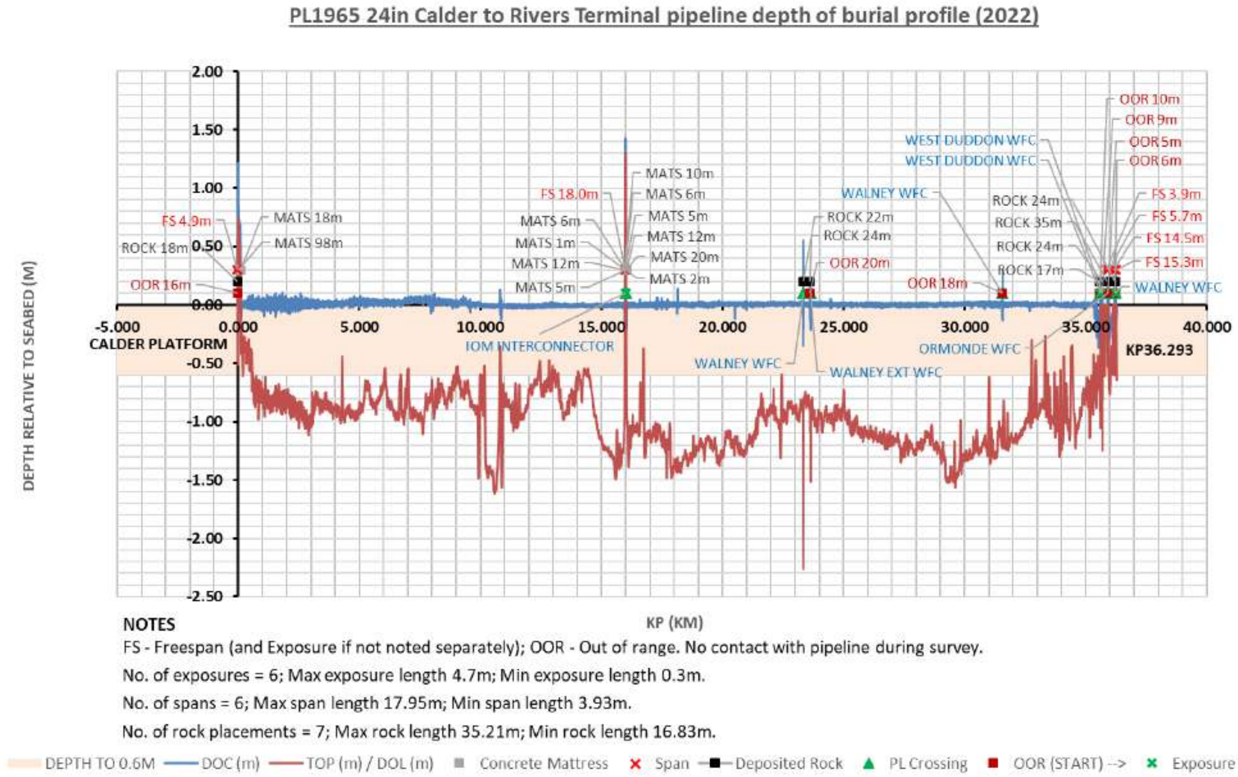


Figure 3.4.7: PL1965 & PL1966 burial profile (2022)

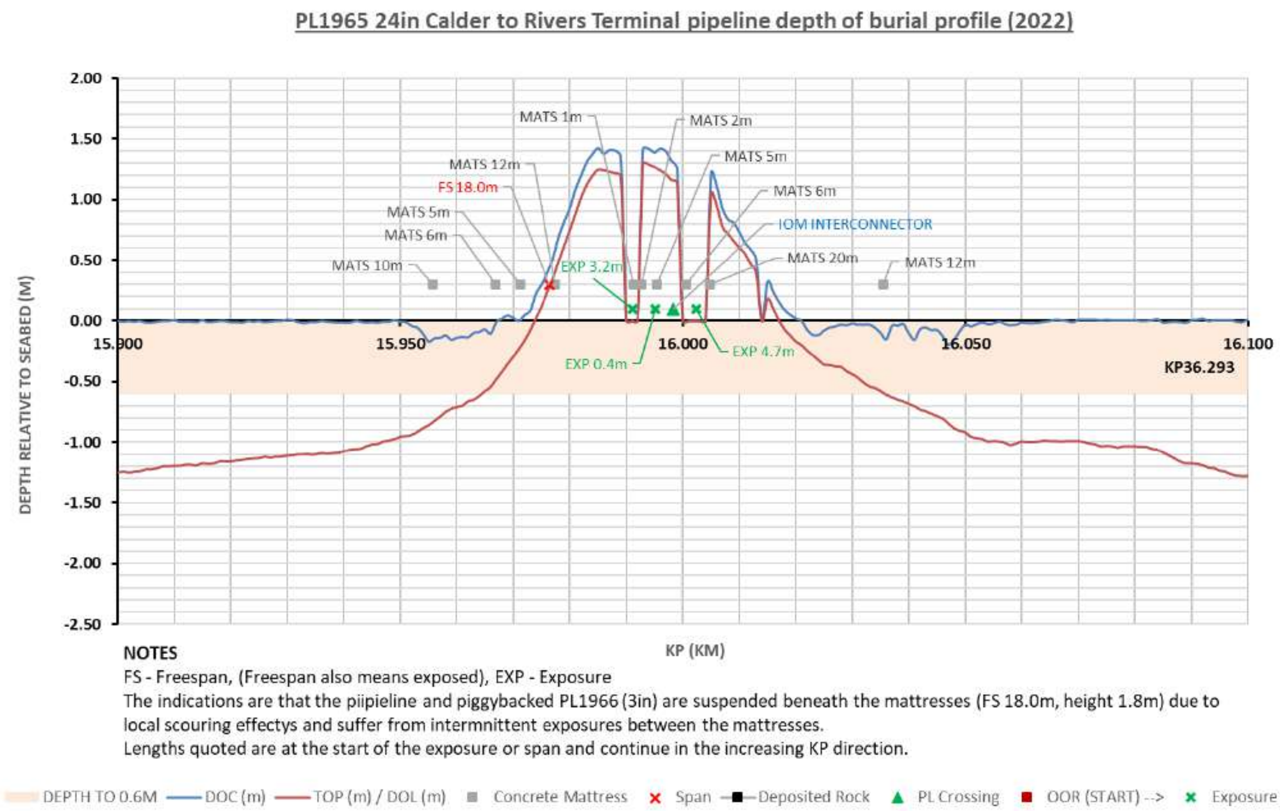


Figure 3.4.8: PL1965 & PL1966 burial profile between KP15.9-KP16.1 (2022)

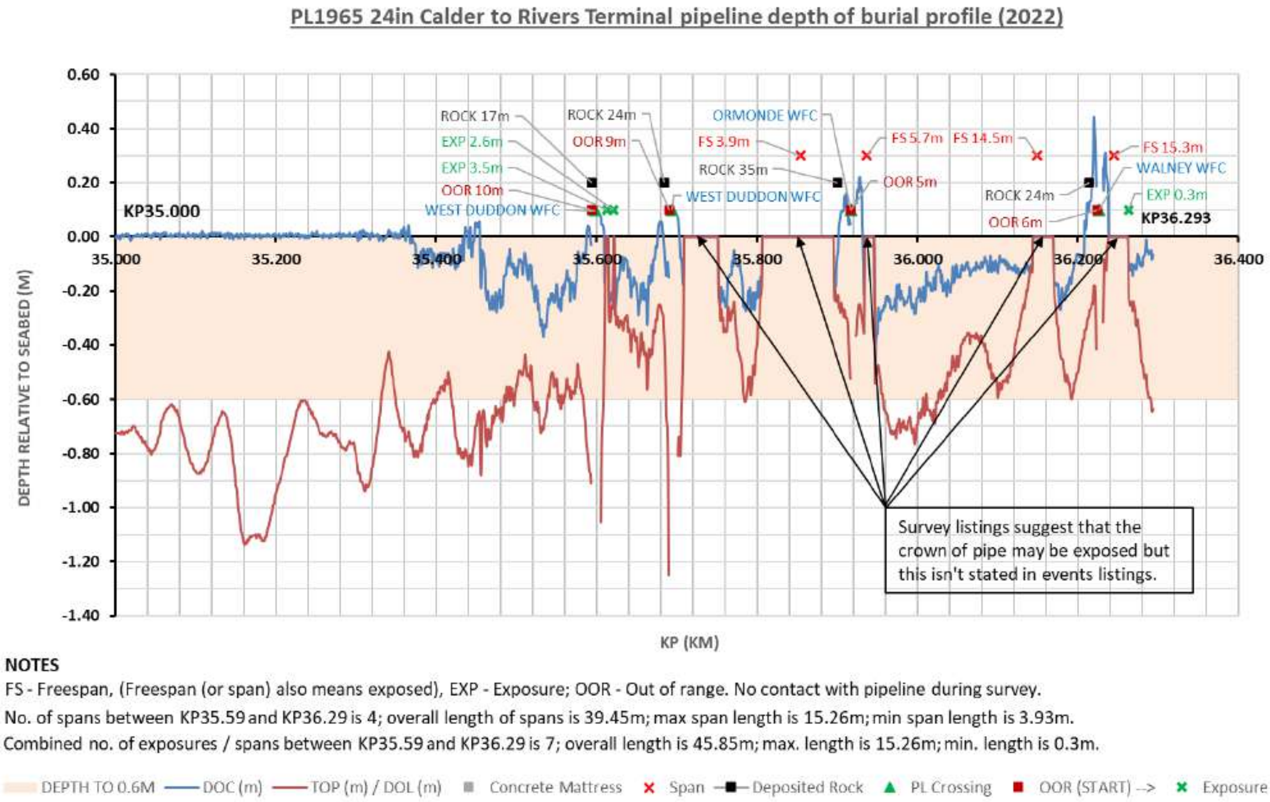


Figure 3.4.9: PL1965 & PL1966 burial profile between KP35.0 and KP36.4 (2022)

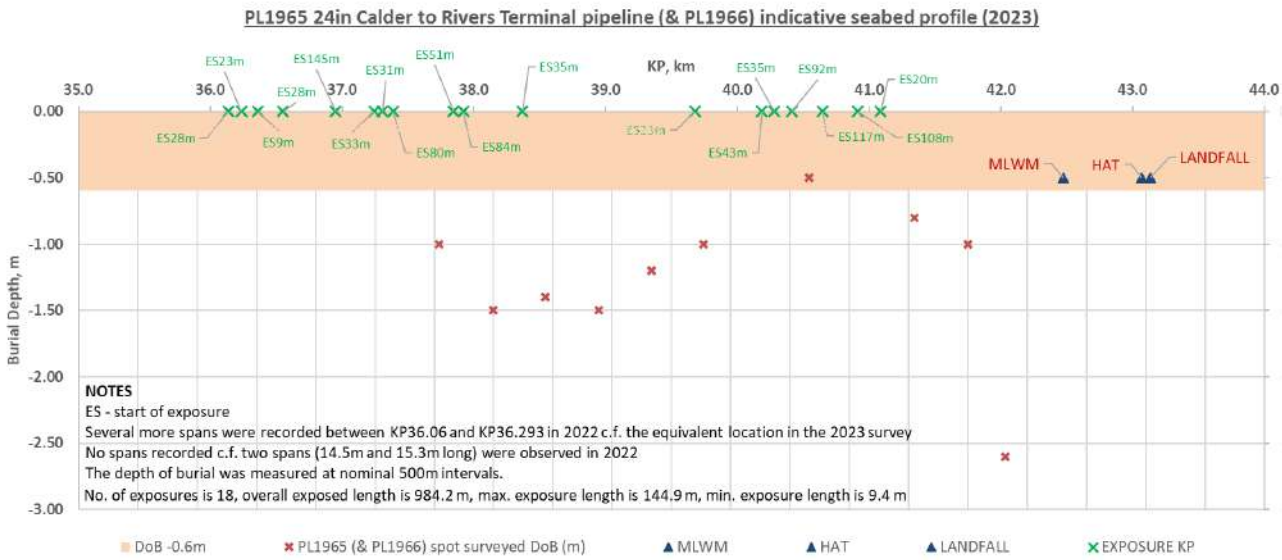


Figure 3.4.10: PL1965 & PL1966 burial profile between KP36.284 and KP42.035 (2023)[8]

[8] No spans were recorded in 2023 pipeline survey report.

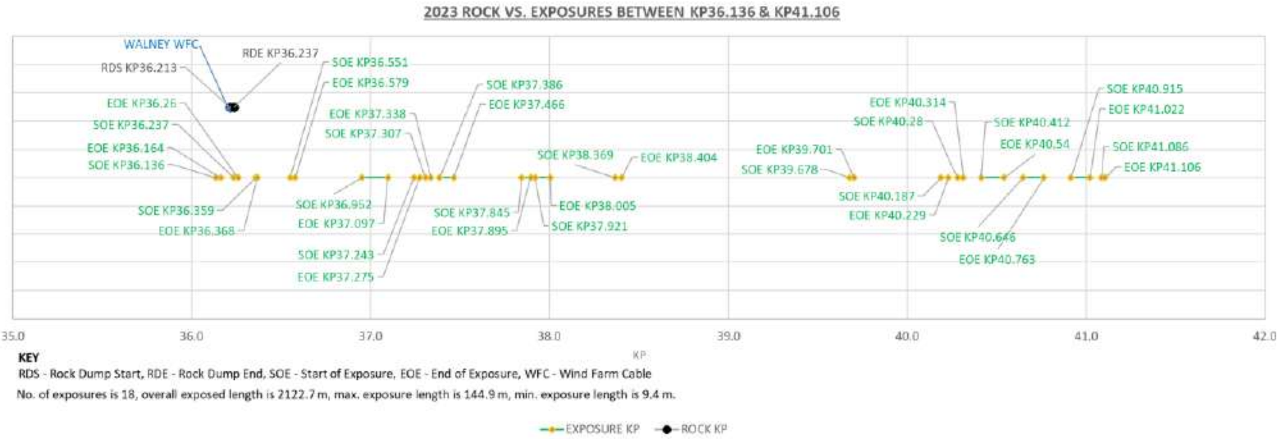


Figure 3.4.11: PL1965 & PL1966 rock vs. exposure detail (2023)

The pipelines cross over just one cable – the Isle of Man Interconnector at KP15.992 where the crossing is protected and stabilised by several concrete mattresses (Figure 3.4.12).

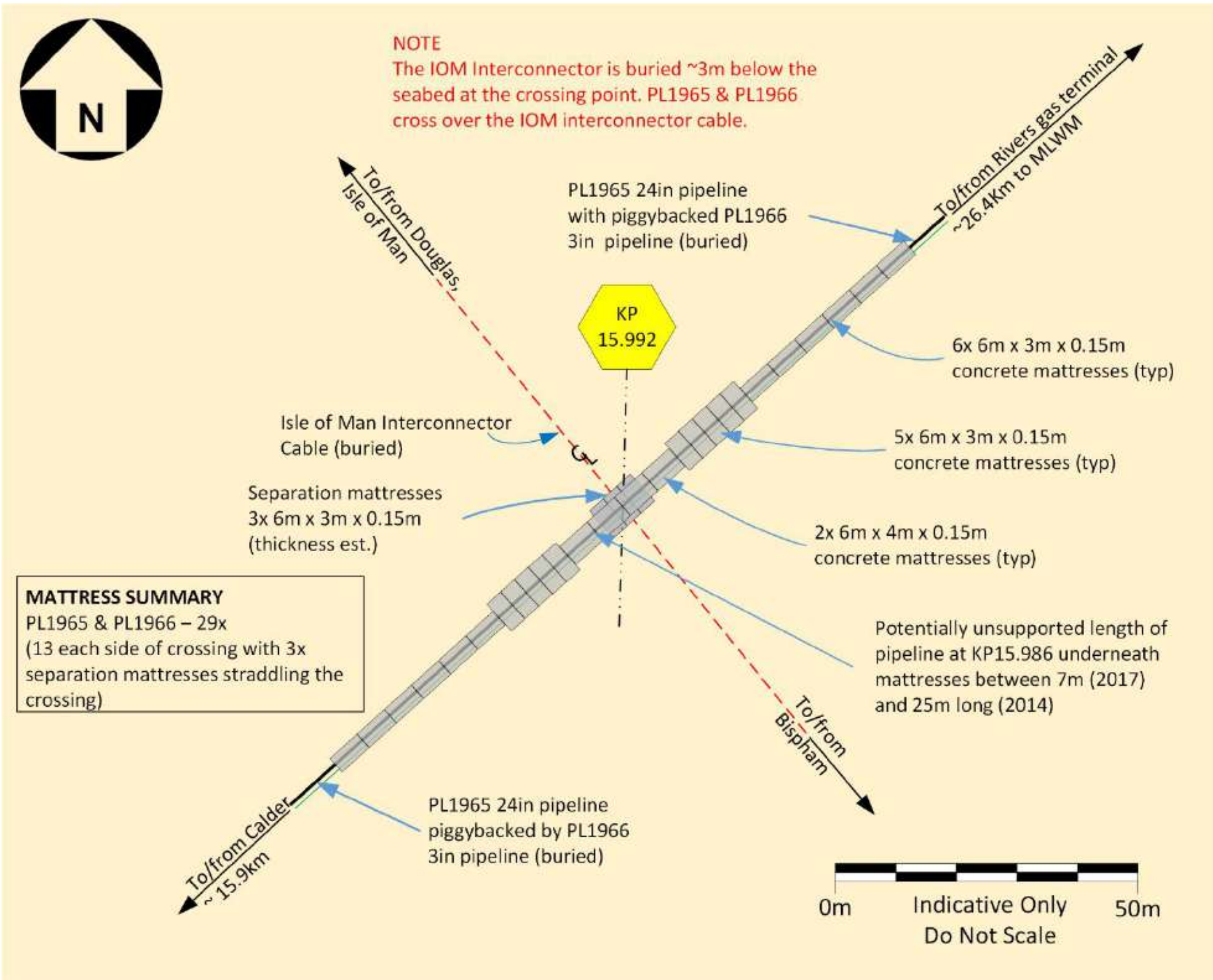


Figure 3.4.12: PL1965 & PL1966 IOM Interconnector cable crossing

3.4.2 PL6340 electrical cable from CPP1 to Calder platform

The electrical cable from CPP1 to Calder mostly comprises 3x 70m^2 copper power cores and a fibre-optic unit protected by a single layer of galvanised steel wire, all housed in a 62mm nominal diameter polyethylene outer sheath. For details of the cross-section refer Appendix A. The cable is ~7.6km long and buried except for the surface laid ends on the approaches which are protected and stabilised by concrete mattresses.

A profile of the water depth relative to LAT along the pipelines is presented in Figure 3.4.13 below. The water depth varies between ~27.2m and ~31.5m.

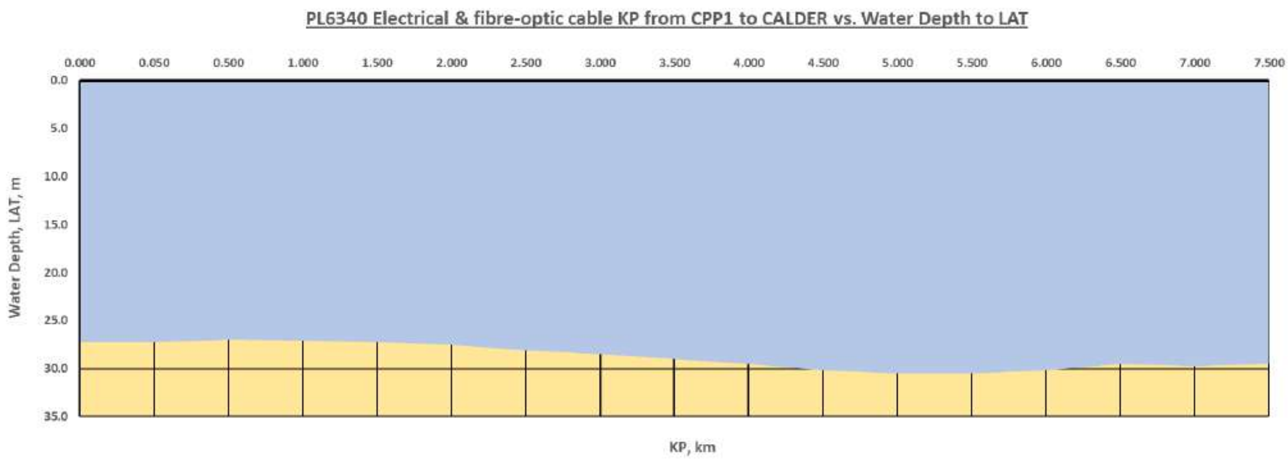


Figure 3.4.13: LAT Depth to seabed along electrical cable from CPP1 to Calder (PL6340)

In the absence of 'as-built' trenching and burial data, the design intent for the burial profile is presented in Figure 3.4.14 below. The electrical cable was to be trenched to at least 1m below mean seabed to top of cable. A depth of burial profile from the 2022 survey is presented in Figure 3.4.15 and Figure 3.4.16 below. The electrical cable can be seen to be out of range (OOR) for much of the survey.

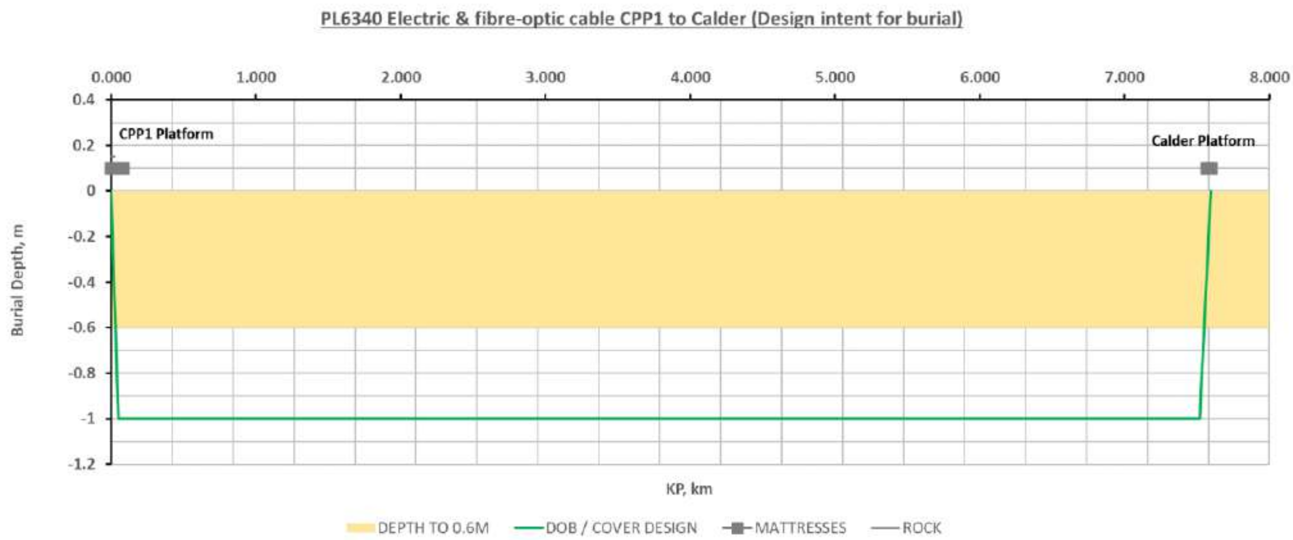


Figure 3.4.14: Intended burial profile for CPP1 to Calder electrical cable (PL6340)

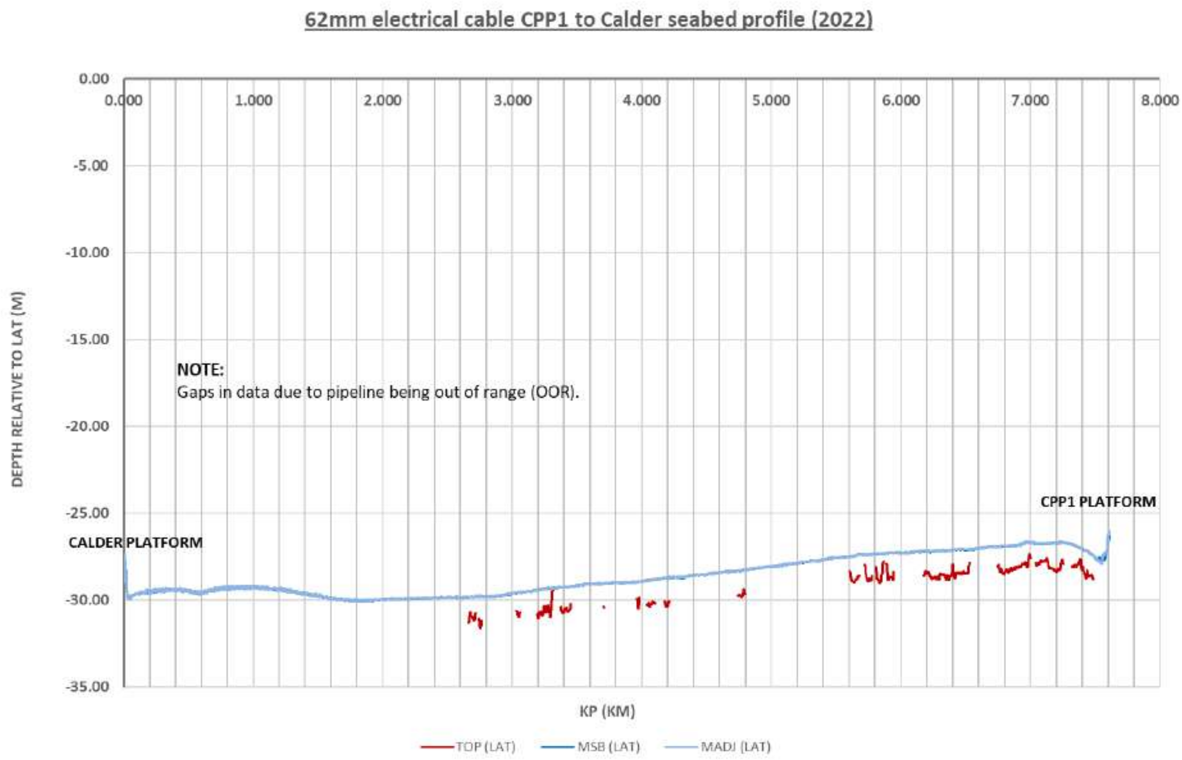


Figure 3.4.15: PL6340 electrical cable from CPP1 to Calder seabed & burial profile (2022)

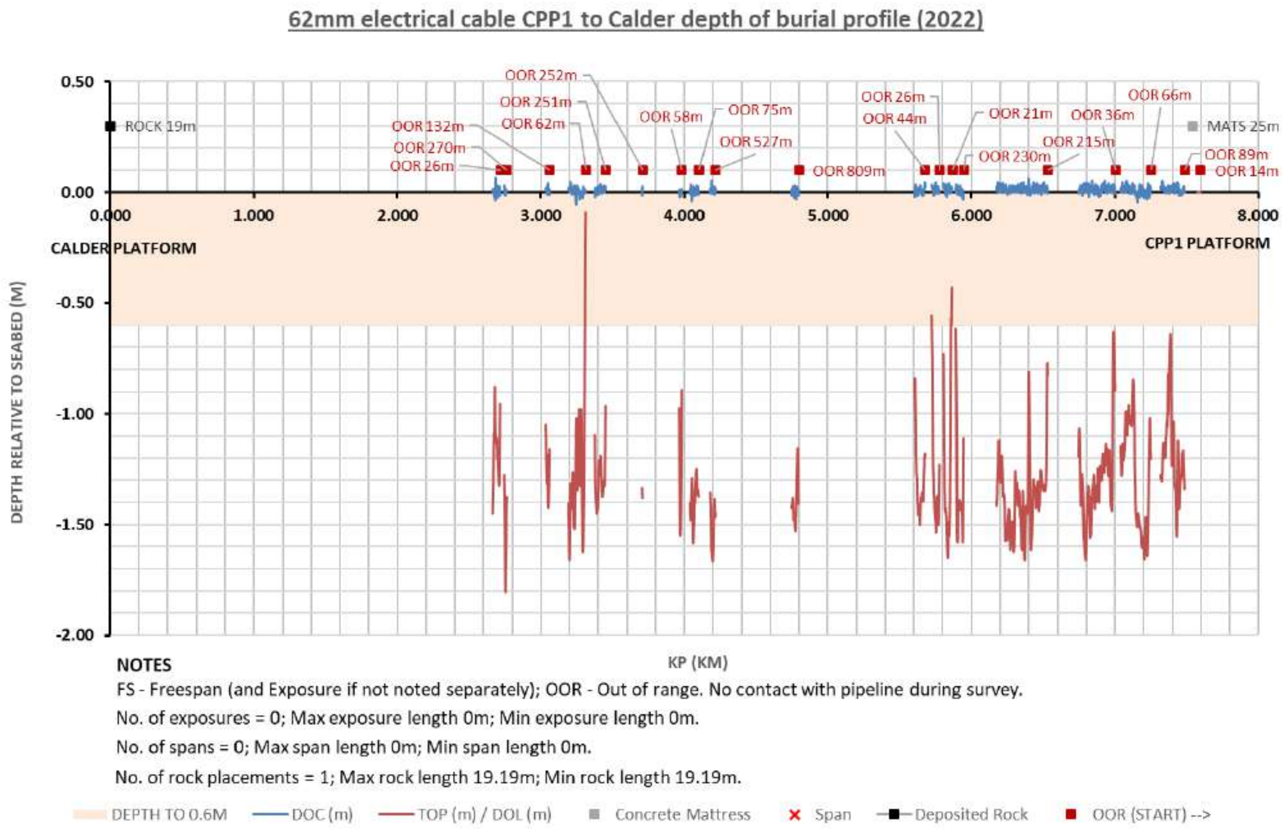


Figure 3.4.16: PL6340 electrical cable from CPP1 to Calder burial profile (2022)

No data have been found prior to 2011. However, acoustic monitoring survey data in 2011, 2014 and 2017 and depth of burial survey in 2022 (Figure 3.4.15 and Figure 3.4.16) noted no signs of the cable being exposed anywhere along its length.

Note that any exposures or spans shown in the any of the following 'as-built' profiles were obtained during acoustic pipelines surveys noted in the accompanying narrative.

3.5 Dalton pipelines and umbilicals

3.5.1 PL1668 12in pipeline Dalton PLEM to DPPA

PL1668 is a 12in carbon steel pipeline that is coated with 3LPP throughout its length, and it is ~7.2km long. It is trenched and buried throughout its length except for the surface laid ends on the approaches which are protected and stabilised by concrete mattresses. It's 'as-built' burial profile is shown in Figure 3.5.1 below. Although out of scope of the Calder, Dalton and Millom decommissioning programmes, note that the riser will be removed along with the DPPA jacket.

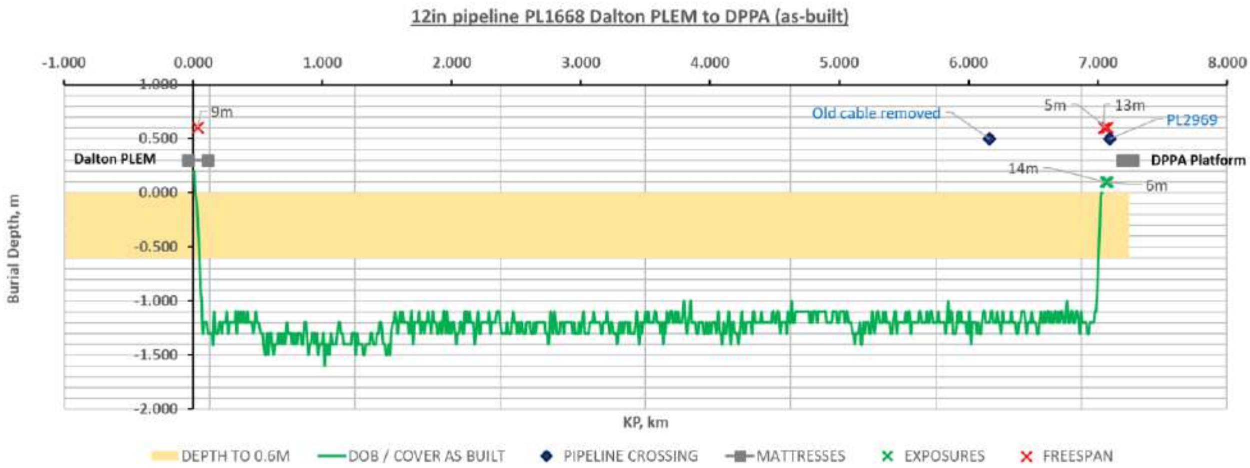


Figure 3.5.1: PL1668 pipeline 'as-built' burial profile

Following installation, full length acoustic monitoring surveys were conducted in 2014 and 2017 (Figure 3.5.1), and a depth of burial survey was conducted in 2022 (Figure 3.5.2 and Figure 3.5.3). Exposures or spans have only been observed at the pipeline ends and these will be removed during decommissioning operations.

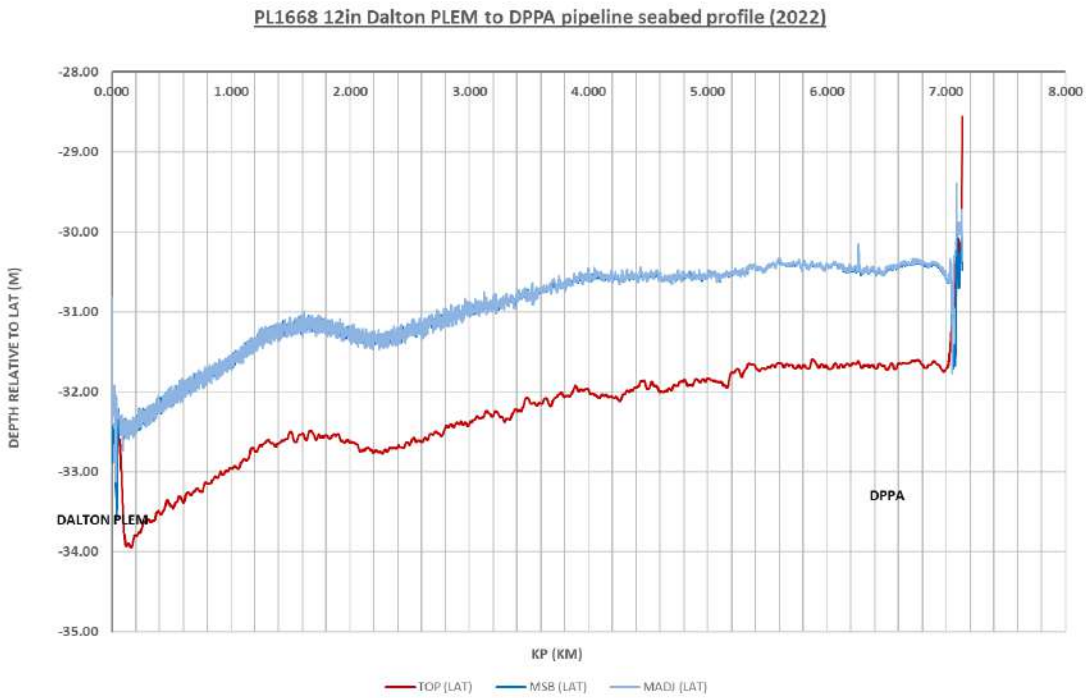


Figure 3.5.2: PL1668 pipeline seabed & burial profile (2022)

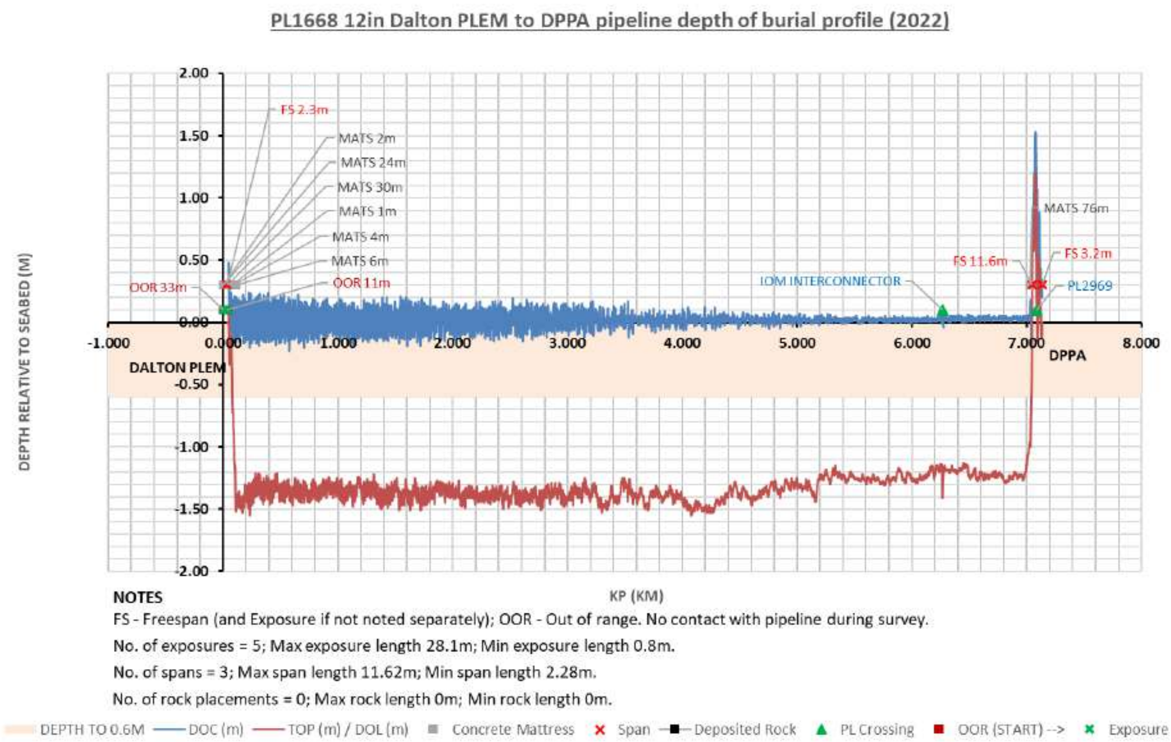


Figure 3.5.3: PL1668 pipeline burial profile (2022)

3.5.2 PL1669 8in pipeline Dalton R2 to Dalton PLEM

PL1669 is an 8in carbon steel pipeline that is coated with 3LPP throughout its length, and it is ~1.0km long. It is trenched and buried throughout its length except for the surface laid ends on the approaches which are protected and stabilised by concrete mattresses. Its 'as-built' burial profile is shown in Figure 3.5.4.

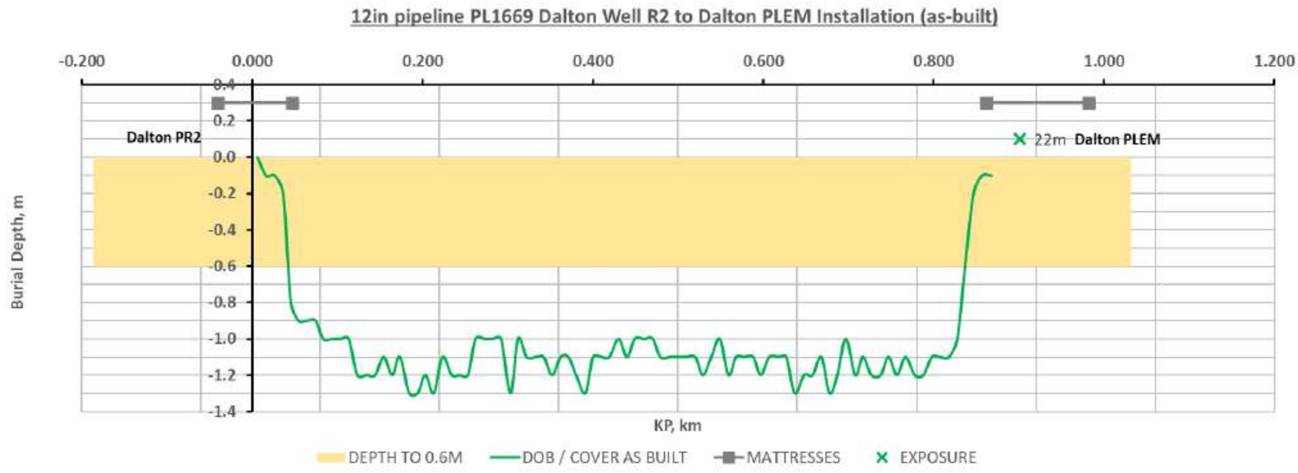


Figure 3.5.4: PL1669 pipeline 'as-built' burial profile

Following installation, full length acoustic monitoring surveys were conducted in 2014 and 2017 and a depth of burial survey was conducted in 2022 (Figure 3.5.5 and Figure 3.5.6). Exposures or spans have only been observed at the pipeline ends (Figure 3.5.4 and Figure 3.5.6) and these will be removed during decommissioning operations.

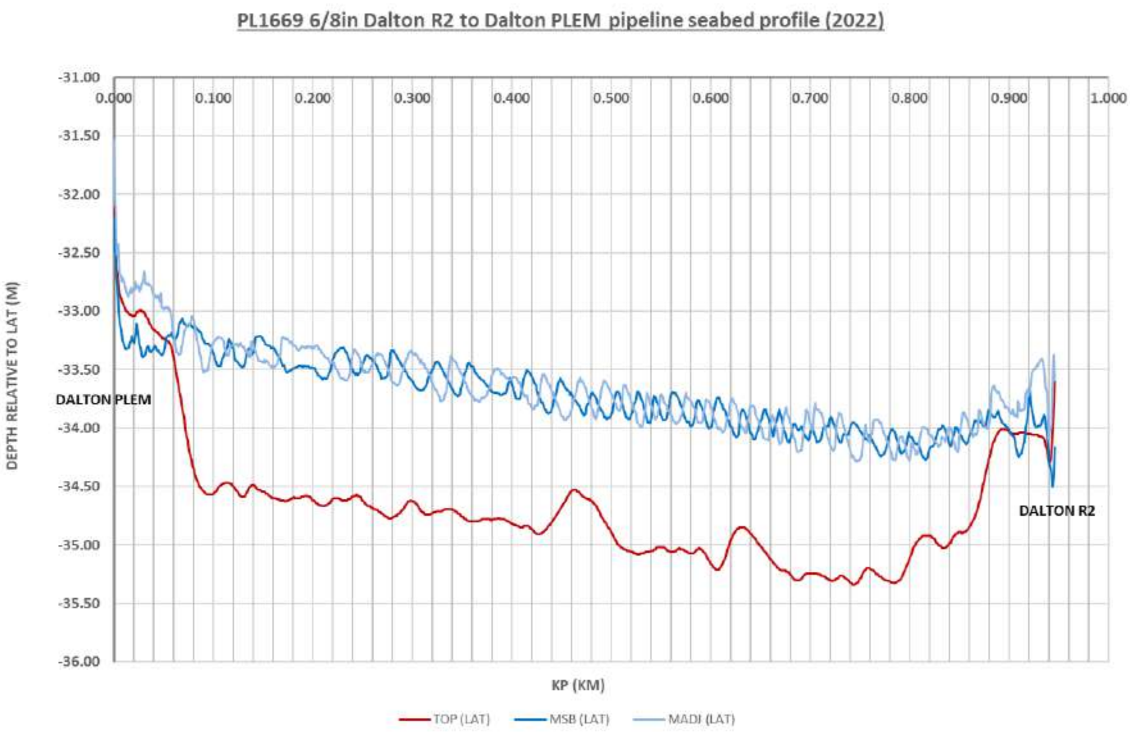


Figure 3.5.5: PL1669 pipeline seabed & burial profile (2022)

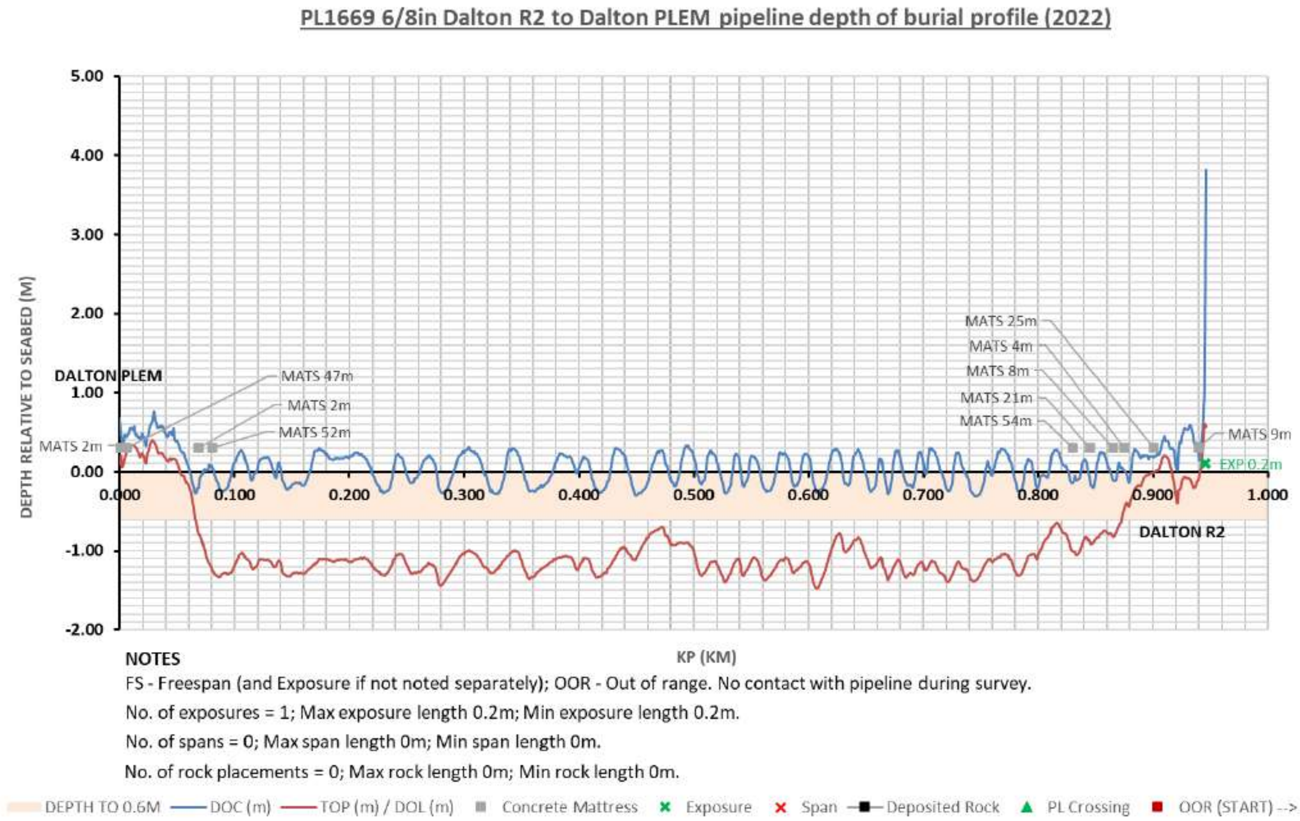


Figure 3.5.6: PL1669 pipeline burial profile (2022)

3.5.3 PL1670 8in pipeline Dalton R1 to Dalton PLEM

PL1670 is an 8in carbon steel pipeline that is coated with 3LPP throughout its length, and it is ~83m long. It is surface laid and protected and stabilised by concrete mattresses throughout.

For the purposes of the comparative assessment it is assumed that this pipeline will be completely removed.

3.5.4 PL1671.1 thru PL1671.5 chemical injection umbilical DPPA to Dalton PLEM

The chemical injection and controls umbilical PL1671 from DPPA to Dalton PLEM comprises hoses, copper wire and filler, all protected by a double layer of galvanised steel wire housed in a 113mm nominal diameter polyethylene outer sheath. For details of the cross-section refer Appendix A. The umbilical is ~7.2km long and buried except for the surface laid ends on the approaches which are protected and stabilised by concrete mattresses.

Following installation, full length acoustic monitoring surveys were conducted in 2014 and 2017. While no exposures or spans were noted in the 2014 survey a couple were noted in the 2017 survey and one freespan was noted in the 2022 survey (Figure 3.5.8 and Figure 3.5.9). These are shown in Figure 3.5.7 and Figure 3.5.9. Note that the exposures and spans only occurred at the pipeline ends and these will be removed during decommissioning operations.

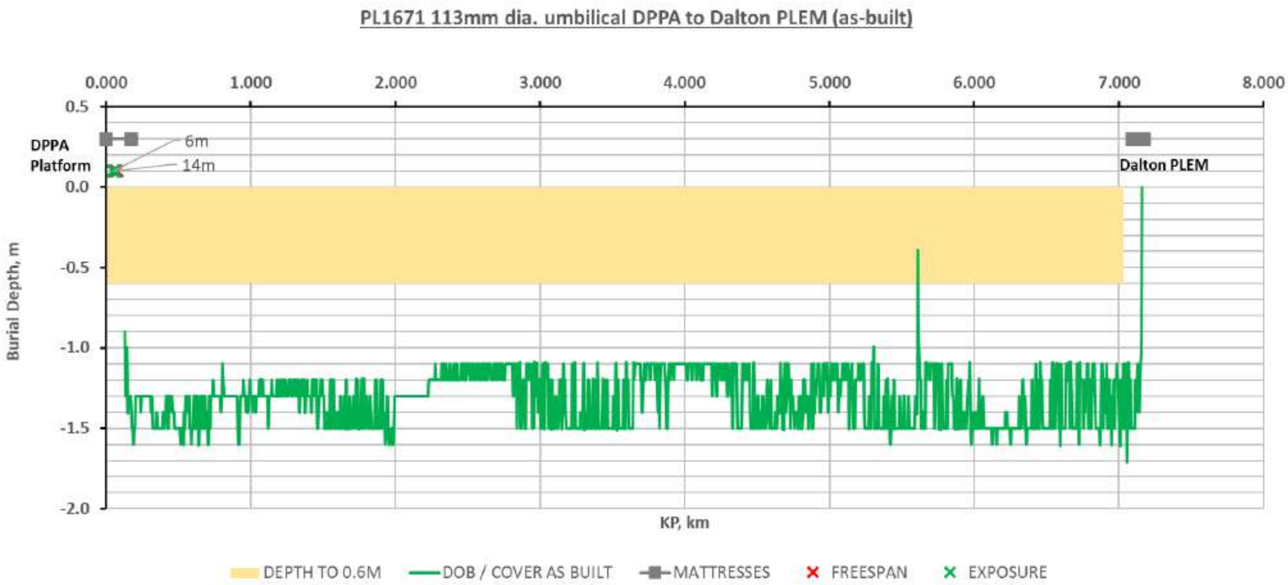


Figure 3.5.7: PL1671 umbilical 'as-built' burial profile

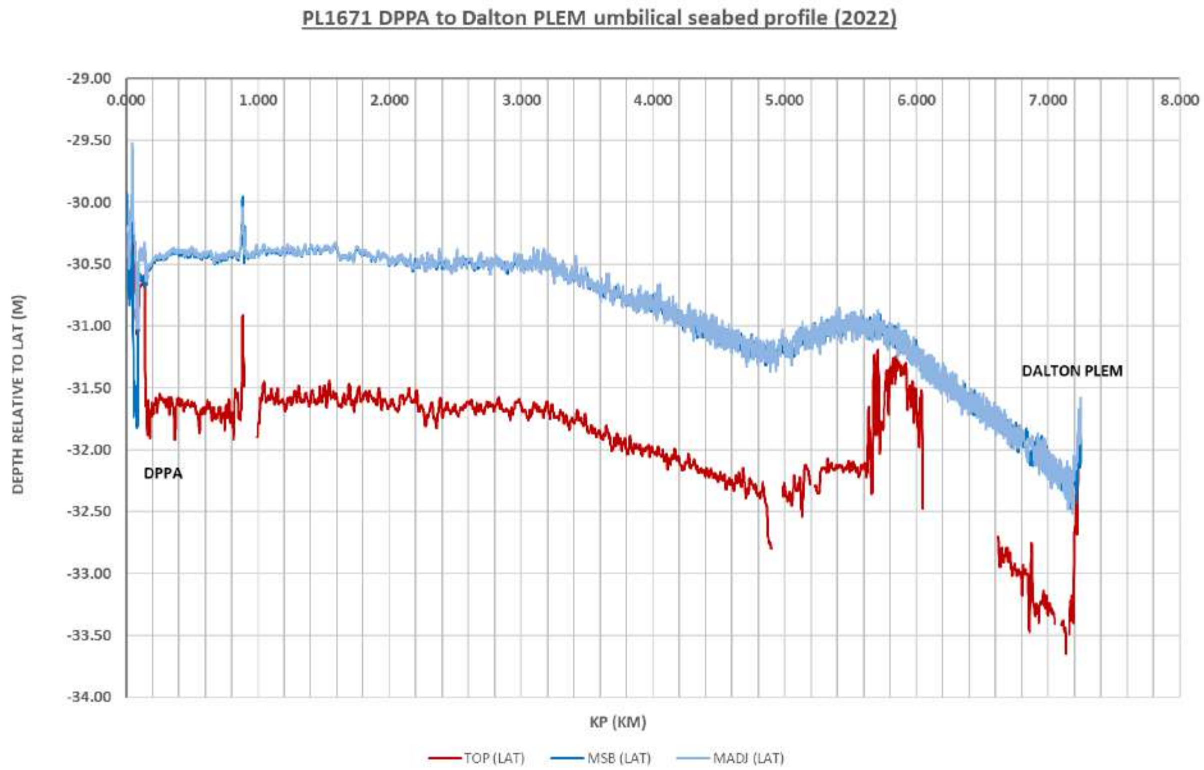


Figure 3.5.8: PL1671 umbilical seabed & burial profile (2022)

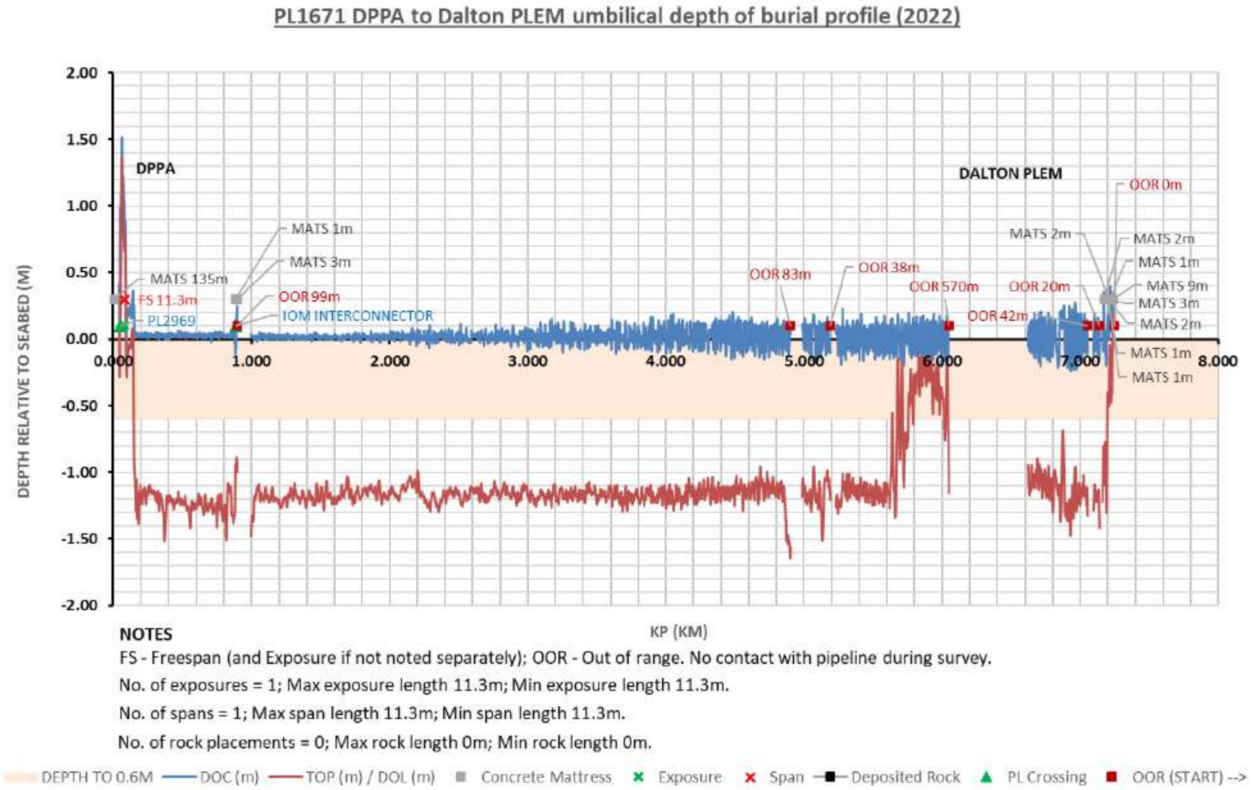


Figure 3.5.9: PL1671 umbilical burial profile (2022)

3.5.5 PL1672.1 thru PL1672.2 chemical injection umbilical Dalton PLEM to R2

The chemical injection and controls umbilical from Dalton PLEM to Dalton R2 comprises hoses, copper wire and filler all protected by a double layer of galvanised steel wire and housed in a 100mm nominal diameter polyethylene outer sheath. For details of the cross-section refer Appendix A. The umbilical is ~1.0km long and buried except for both the surface laid ends which are protected and stabilised by concrete mattresses. The route between Dalton PLEM and Dalton R2 is largely the same as that taken by PL1669. No exposures or spans have been found in any of the surveys (Figure 3.5.10, Figure 3.5.11 and Figure 3.5.12).

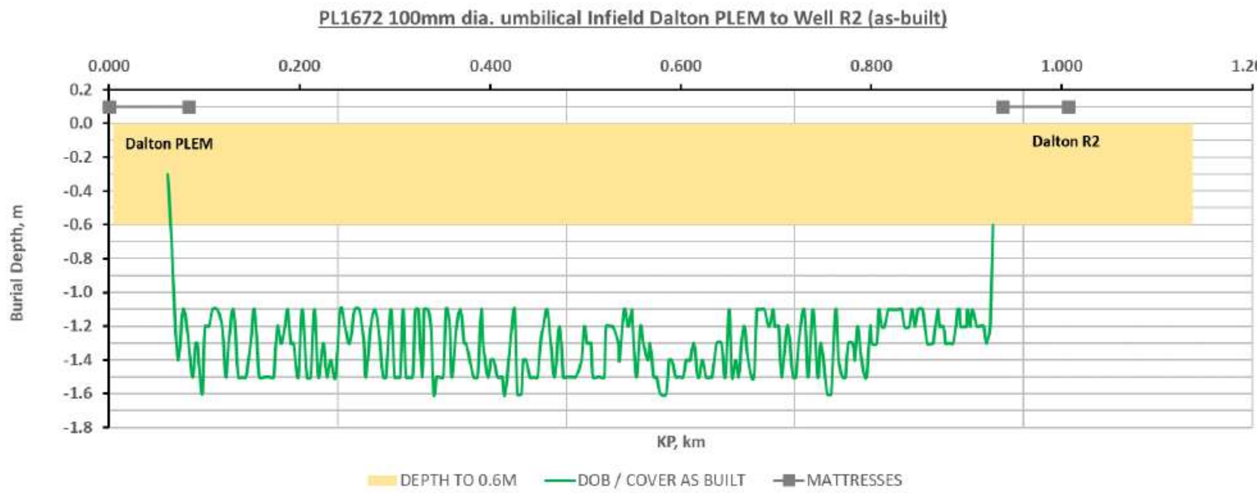


Figure 3.5.10: PL1672 umbilical 'as-built' burial profile

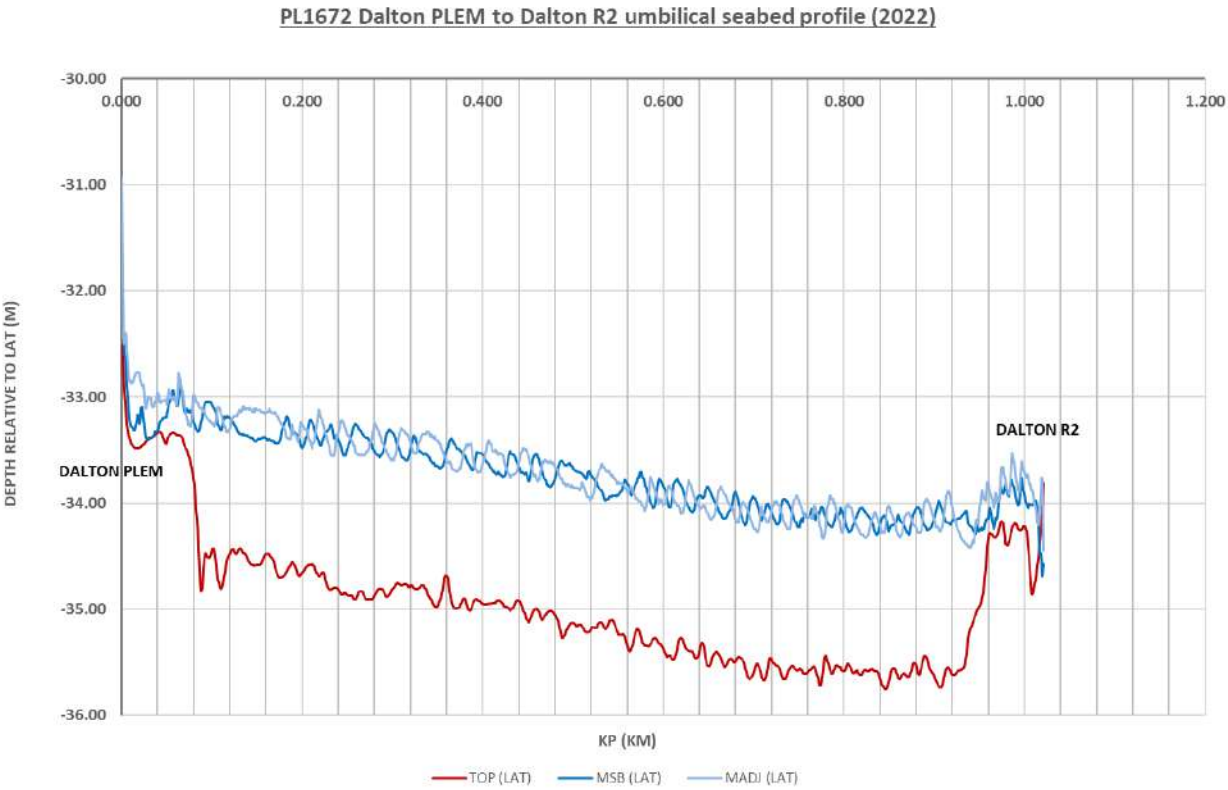


Figure 3.5.11: PL1672 umbilical seabed & burial profile (2022)

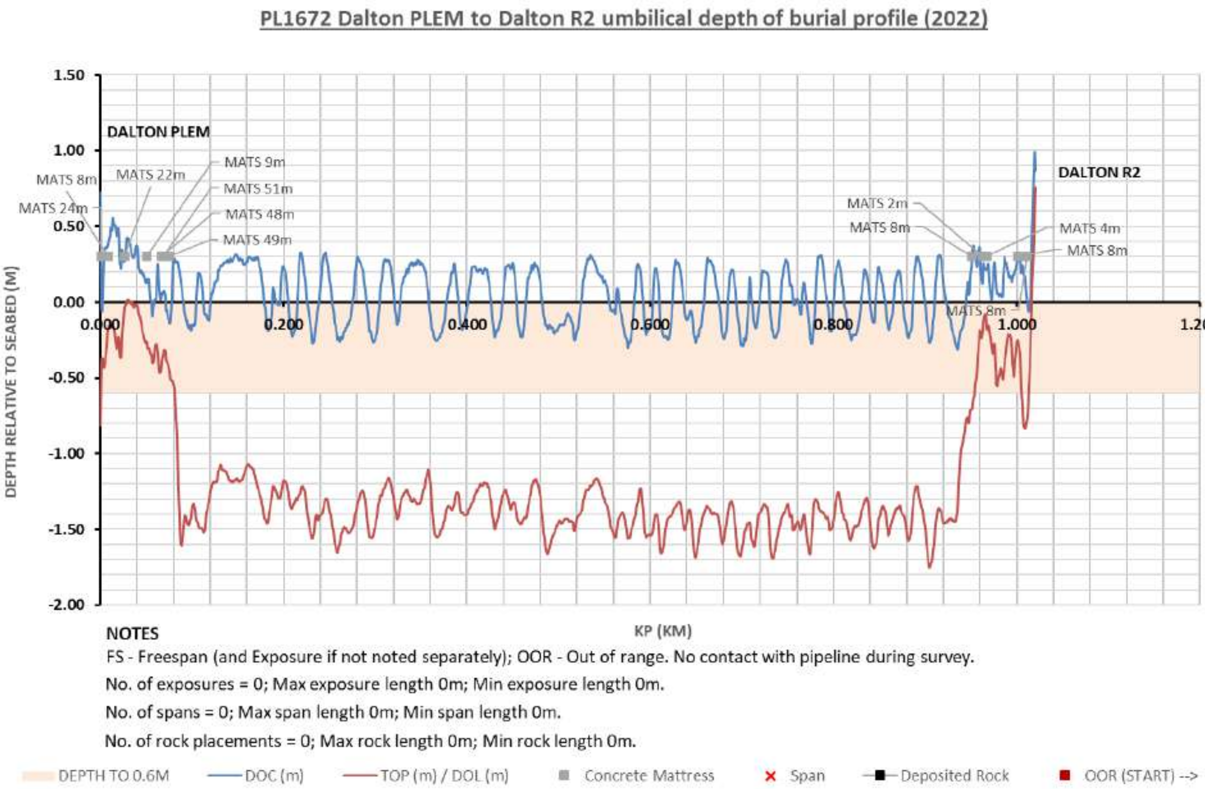


Figure 3.5.12: PL1672 umbilical burial profile (2022)

3.5.6 PL1673.1 thru PL1673.2 chemical injection umbilical Dalton PLEM to R1

The chemical injection and controls umbilical PL1673 from Dalton PLEM to Dalton R1 comprises hoses, copper wire and filler and protected by a double layer of galvanised steel wire, all housed in a 100mm nominal diameter polyethylene outer sheath. For details of the cross-section refer Appendix A. The umbilical is ~78m long and surface laid, protected and stabilised with concrete mattresses. The route between Dalton PLEM and Dalton R1 is largely the same as that taken by PL1670.

For the purposes of the comparative assessment it is assumed that this umbilical will be completely removed.

3.6 Millom East & Millom West pipelines, umbilicals and electrical cable

3.6.1 PL1674 12in pipeline Millom PLEM to DPPA

PL1674 is a 12in carbon steel pipeline that is coated with 3LPP throughout its length, and it is ~8.8km long. It is trenched and buried throughout its length except for the surface laid ends on the approaches which are protected and stabilised by concrete mattresses. Its 'as-built' burial profile is shown in Figure 3.6.1 below. Although out of scope of the Calder, Dalton and Millom decommissioning programmes, note that the riser will be removed along with the DPPA jacket.

Full length acoustic monitoring surveys were conducted in 2011, 2014 and 2017. Single exposures were noted in each of these surveys (Figure 3.6.1). A depth of burial survey was conducted in 2022, when two individual spans were recorded, one at each end of the pipeline (Figure 3.6.2 and Figure 3.6.3). The exposure and spans only occurred at the ends of the pipeline, and these will be removed during decommissioning operations.

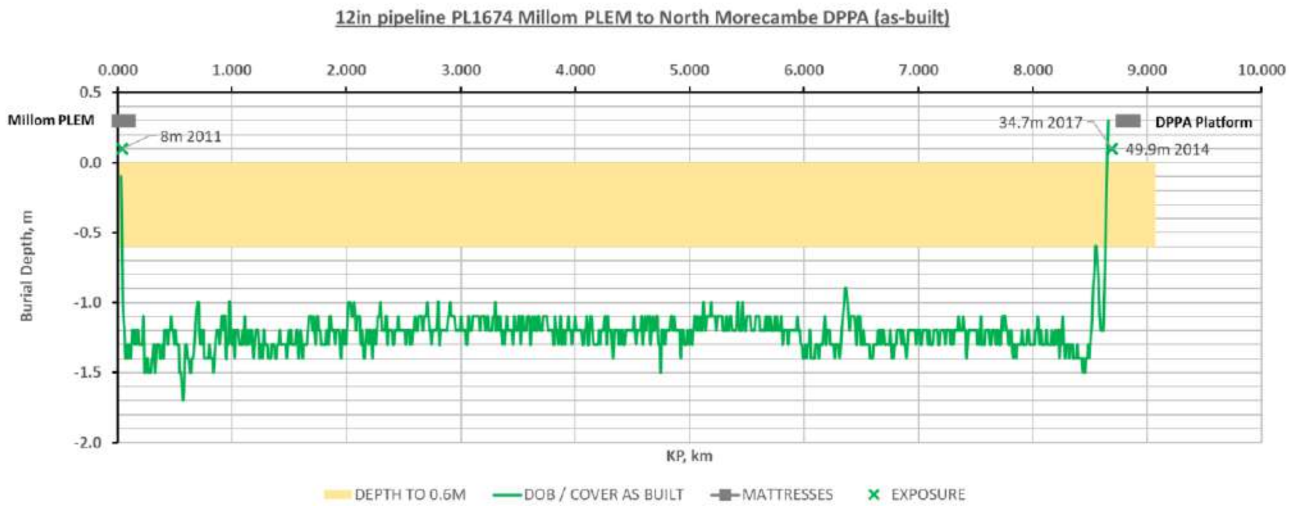


Figure 3.6.1: PL1674 pipeline 'as-built' burial profile

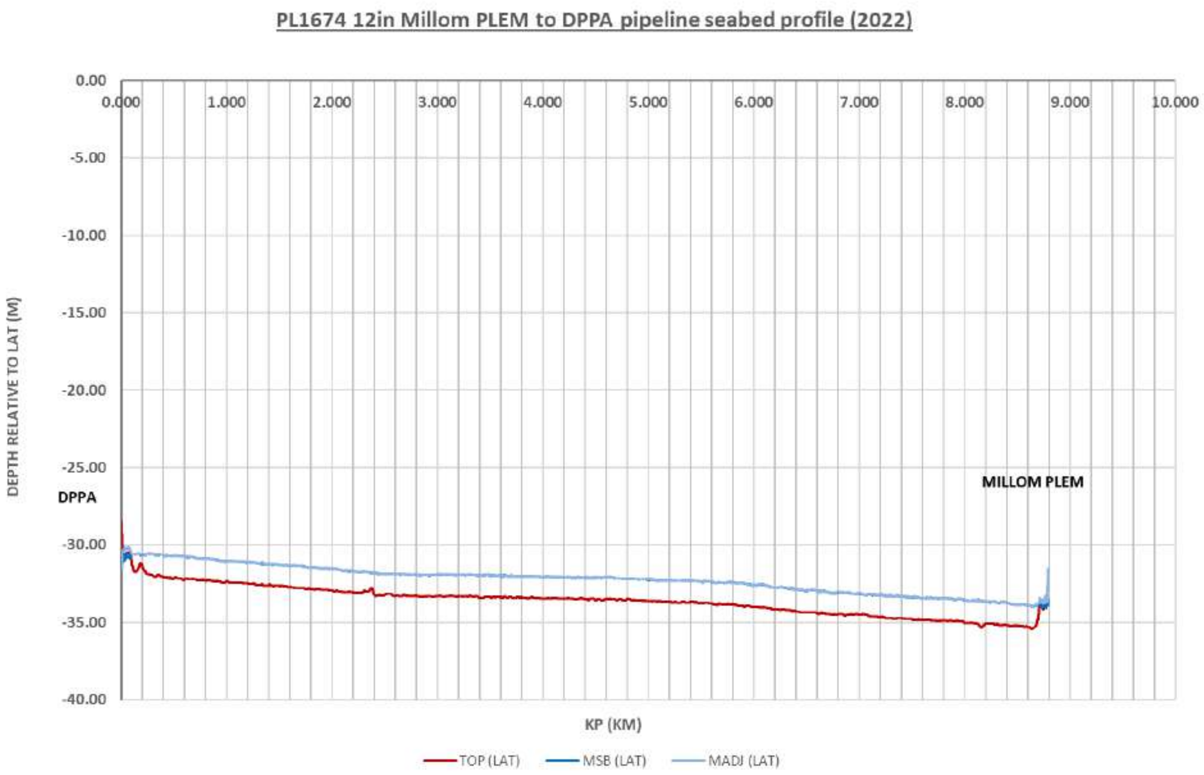


Figure 3.6.2: PL1674 pipeline seabed & burial profile (2022)

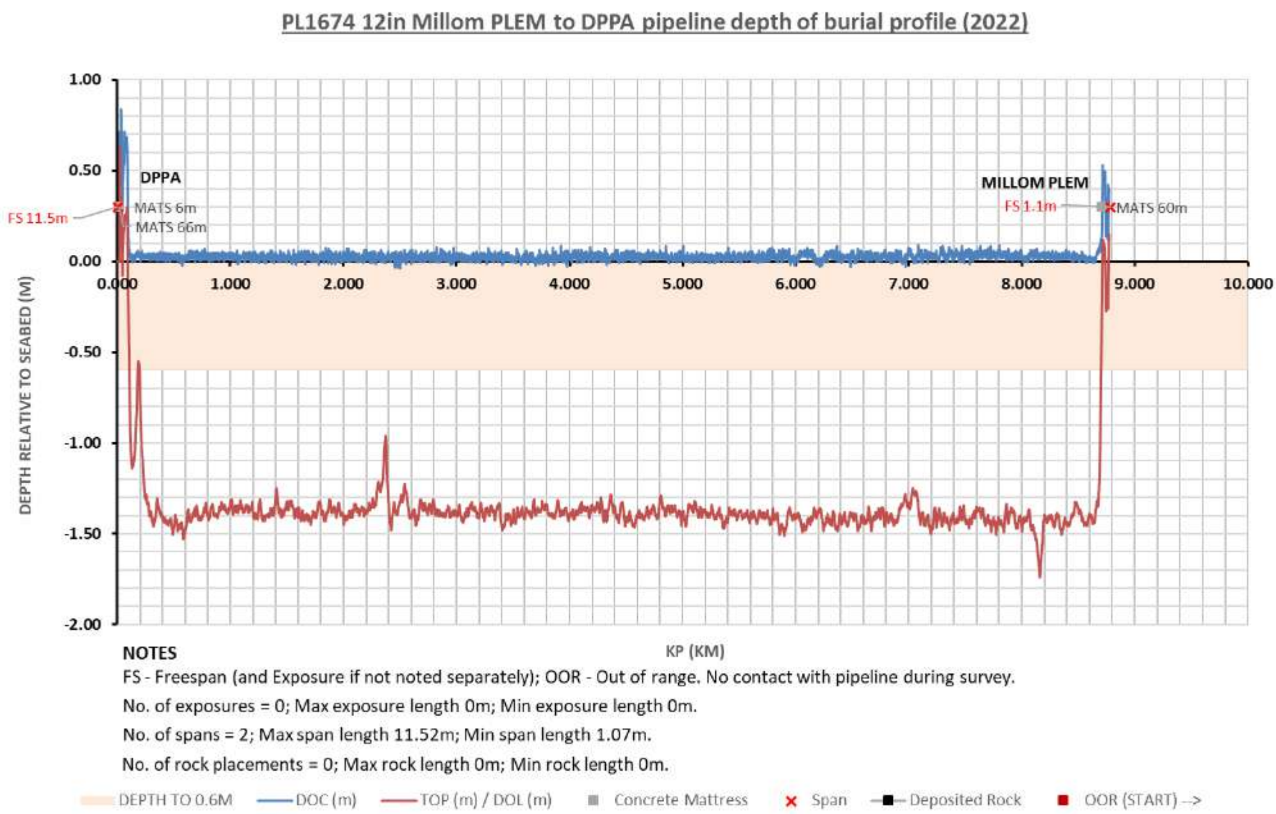


Figure 3.6.3: PL1674 pipeline burial profile (2022)

3.6.2 PL1675 12in pipeline Millom West to Millom PLEM piggybacked by PL1676 2.5in pipeline

PL1675 is a 12in carbon steel pipeline that is coated with 3LPP throughout its length, and it is ~6.3km long. It is piggybacked by PL1676 that is a 2.5in carbon steel pipeline that is also coated with 3LPP throughout its length. Both pipelines are trenched and buried throughout their lengths except for the surface laid ends on the approaches which are protected and stabilised by concrete mattresses. Its 'as-built' burial profile is shown in Figure 3.6.4 below.

Acoustic monitoring surveys were conducted in 2007, 2011, 2014 and 2017. These are shown in Figure 3.6.4. A burial survey was conducted in 2022 (Figure 3.6.5, Figure 3.6.6, Figure 3.6.7 and Figure 3.6.8). Exposures were noted in each of these surveys but only at the pipeline ends, and these will be removed during decommissioning operations.

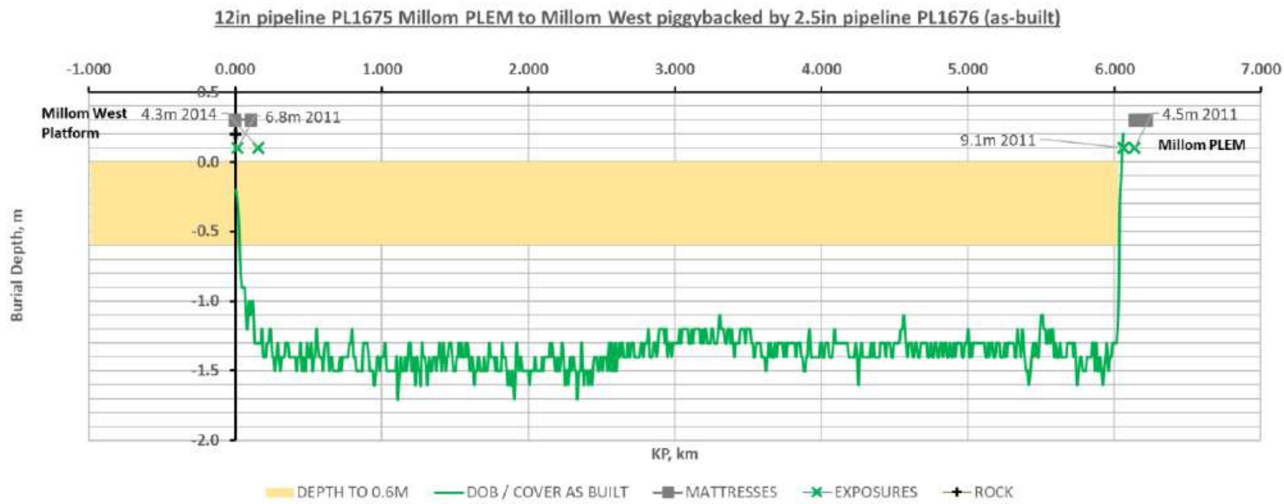


Figure 3.6.4: PL1675 & PL1676 pipeline 'as-built' burial profile

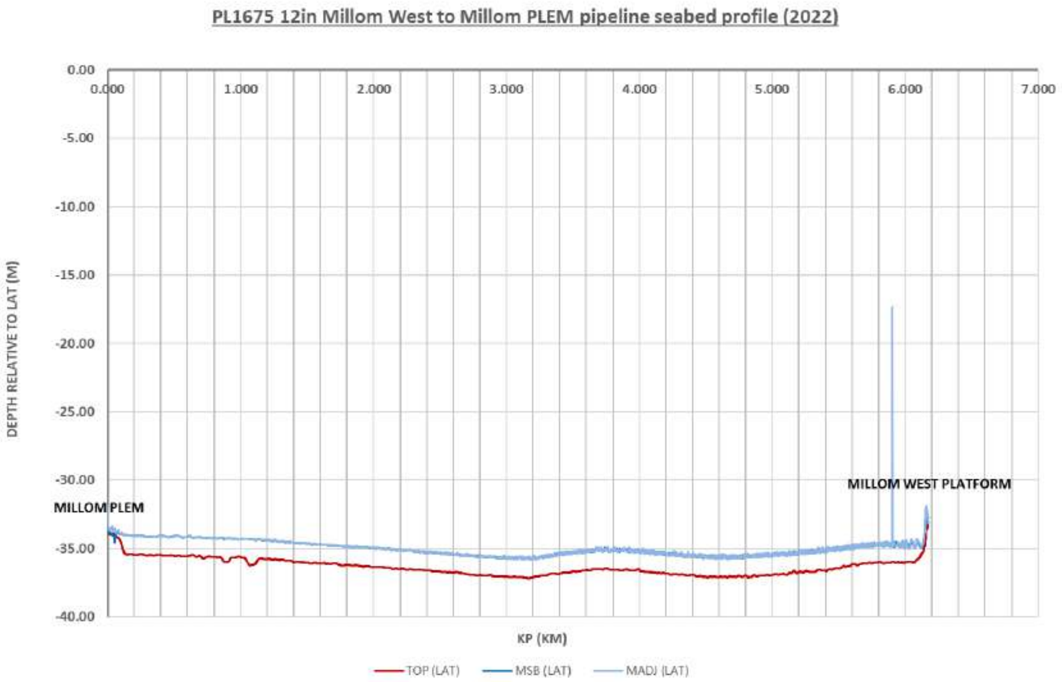


Figure 3.6.5: PL1675 pipeline seabed & burial profile (2022)

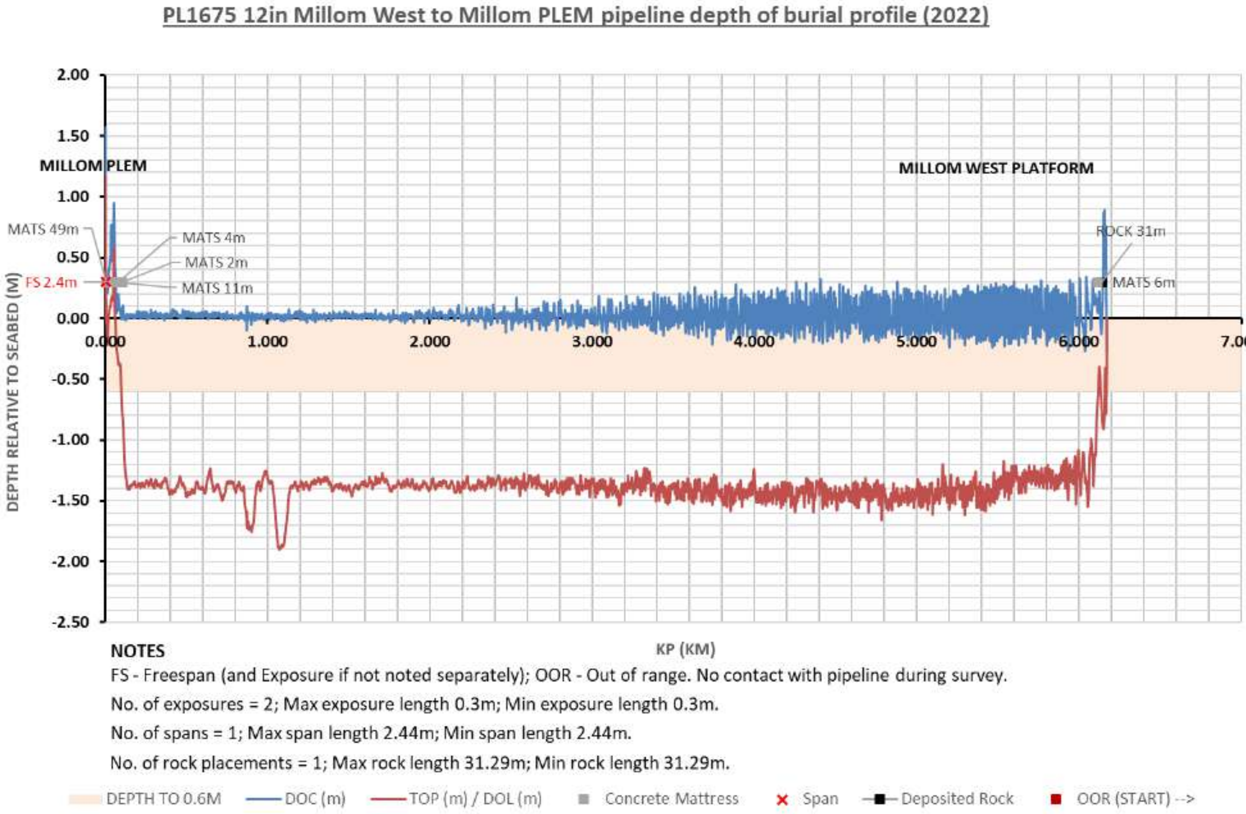


Figure 3.6.6: PL1675 pipeline burial profile (2022)

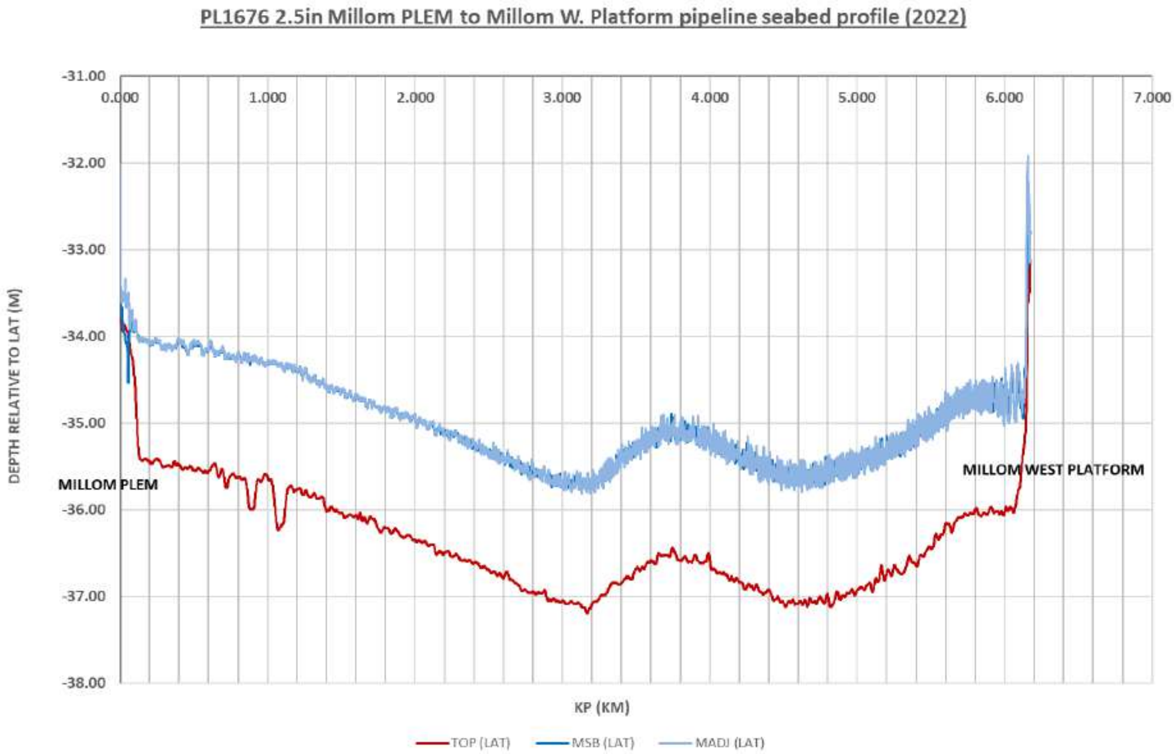


Figure 3.6.7: PL1676 pipeline seabed & burial profile (2022)

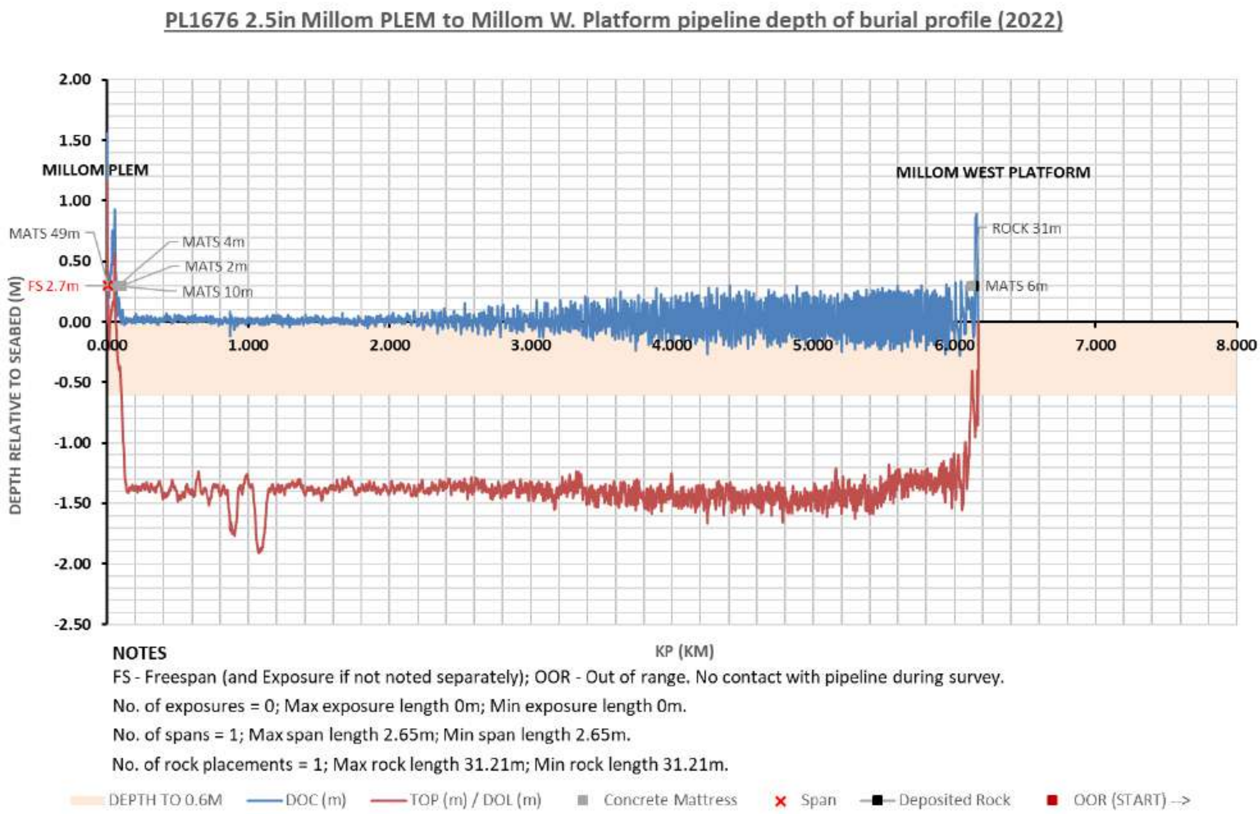


Figure 3.6.8: PL1676 pipeline burial profile (2022)

3.6.3 PL1677 8in pipeline Millom East Q1 to Millom PLEM

PL1677 is an 8in carbon steel pipeline that is coated with 3LPP throughout its length, and it is ~110m long. It is surface laid and protected and stabilised by concrete mattresses throughout its length.

For the purposes of the comparative assessment it is assumed that this pipeline will be completely removed.

3.6.4 PL1678.1 thru PL1678.5 umbilical DPPA to Millom PLEM

The chemical injection and controls umbilical PL1678 from DPPA to Millom PLEM comprises hoses, copper wire and filler protected by a double layer of galvanised steel wire, all of which is housed in a 113mm nominal diameter polyethylene outer sheath. For details of the cross-section refer Appendix A. The umbilical is ~8.8km long and buried except for the surface laid ends on the approaches which are protected and stabilised by concrete mattresses. The two Rhyl pipelines PL2969 and PL2970 cross over PL1678 on the final approach, close to DPPA.

Acoustic monitoring surveys were conducted in 2011, 2014 (locally around Millom PLEM, Q1, Q2 and Q3 installations only) and 2017 and a depth of burial survey was conducted in 2022 (Figure 3.6.10 and Figure 3.6.11). No exposures were noted in any of the surveys.

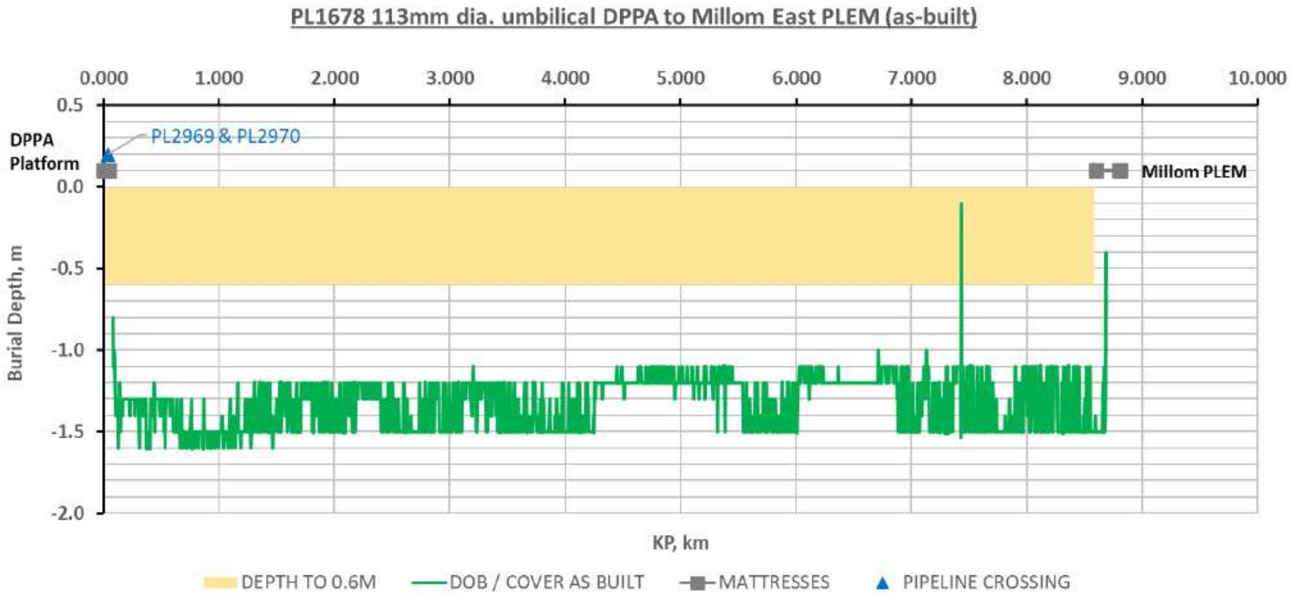


Figure 3.6.9: PL1678 umbilical 'as-built' burial profile

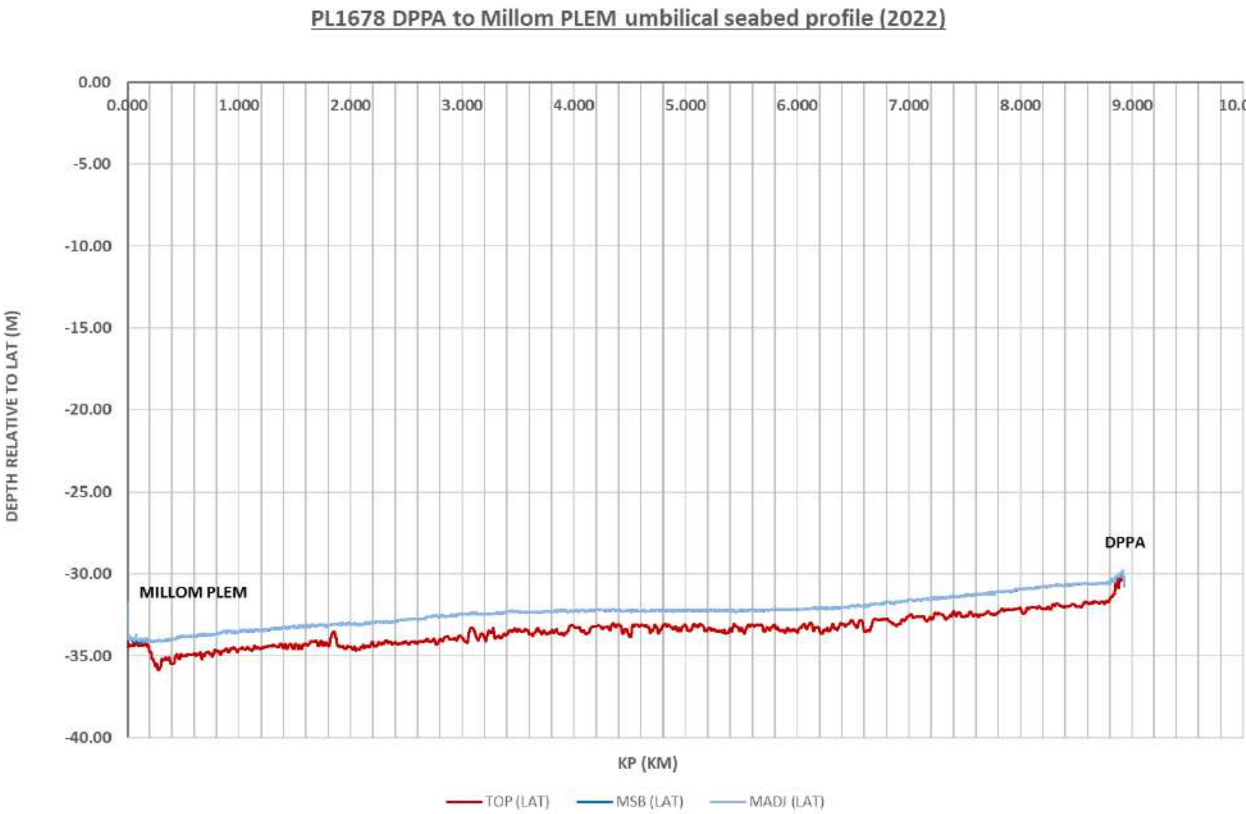


Figure 3.6.10: PL1678 umbilical seabed & burial profile (2022)

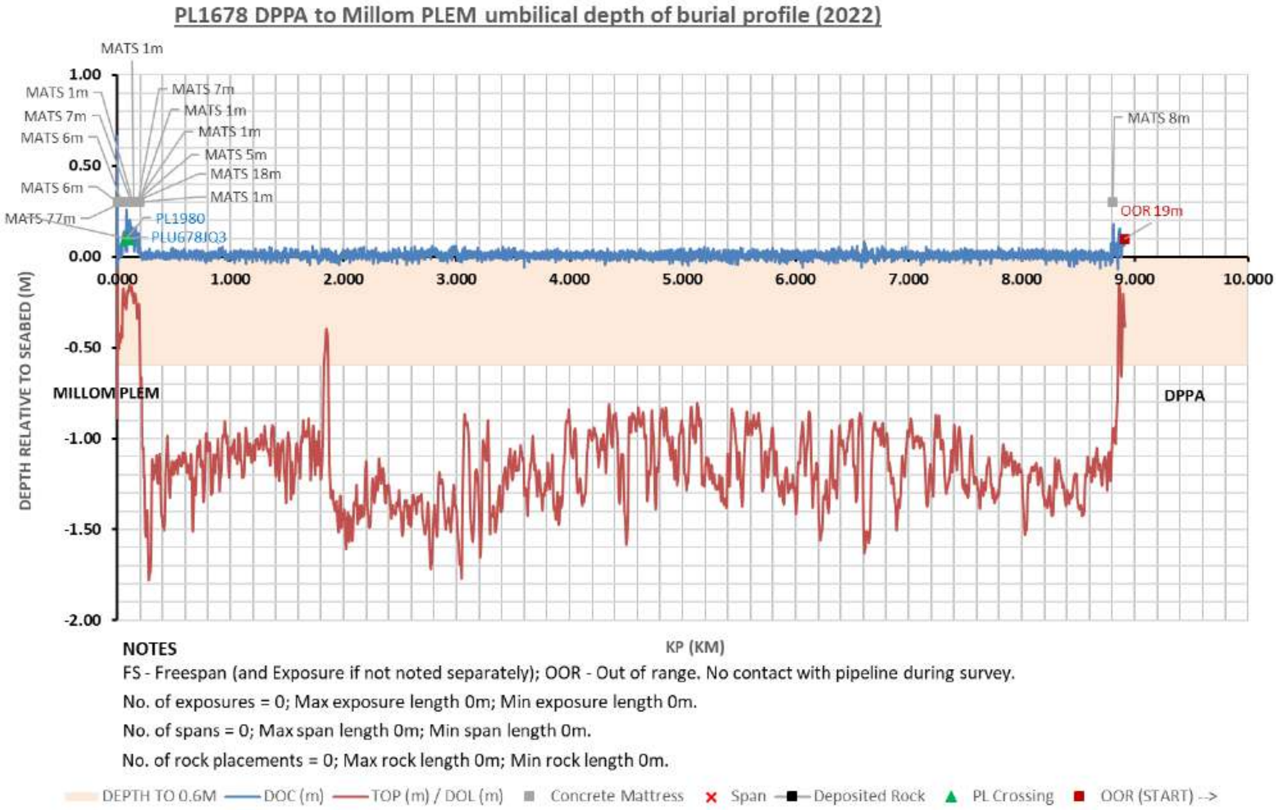


Figure 3.6.11: PL1678 umbilical burial profile (2022)

3.6.5 PLU1678JQ3 umbilical Millom PLEM to Q3

The chemical injection and controls umbilical PLU1678JQ3 from Millom PLEM to Millom Q3 comprises hoses, copper wire and filler and protected by a double layer of galvanised steel wire, all housed in a 111mm nominal diameter polyethylene outer sheath. For details of the cross-section refer Appendix A. The umbilical is ~247m long and surface laid, protected and stabilised by concrete mattresses. The route between Millom PLEM and Q3 is largely the same as that taken by PL1980.

For the purposes of the comparative assessment it is assumed that this umbilical will be completely removed.

3.6.6 PL1679.1 thru PL1679.2 umbilical Millom PLEM to Q1

The chemical injection and controls umbilical PL1679 from Millom PLEM to Millom Q1 comprises hoses, copper wire and filler and protected by a double layer of galvanised steel wire, all housed in a 100mm nominal diameter polyethylene outer sheath. For details of the cross-section refer Appendix A. The umbilical is ~74m long and surface laid, protected and stabilised by concrete mattresses. The route between Millom PLEM and Q2 is largely the same as that taken by PL1677.

For the purposes of the comparative assessment it is assumed that this umbilical will be completely removed.

3.6.7 PL6352 electrical cable from DPPA to Millom West

PL6352, the electrical cable from DPPA to Millom West mostly comprises 3x 70mm^2 copper power cores and a fibre-optic unit protected by a single layer of galvanised steel wire, all housed in a 58mm nominal diameter polyethylene outer sheath. For details of the cross-section refer Appendix A. The cable is ~15.3km long and buried except for the surface laid ends on the approaches which are protected and stabilised by concrete mattresses.

Acoustic monitoring surveys were conducted in 2011, 2014 (locally around Millom PLEM, Q1, Q2 and Q3 installations only) and 2017. As pipeline burial survey was conducted in 2022 (Figure 3.6.13 and Figure 3.6.14). Exposures were noted in each of these surveys but only at the DPPA pipeline ends, and these will be removed during decommissioning operations.

Figure 3.6.12: PL6352 electrical cable from DPPA to Millom West 'as-built' profile

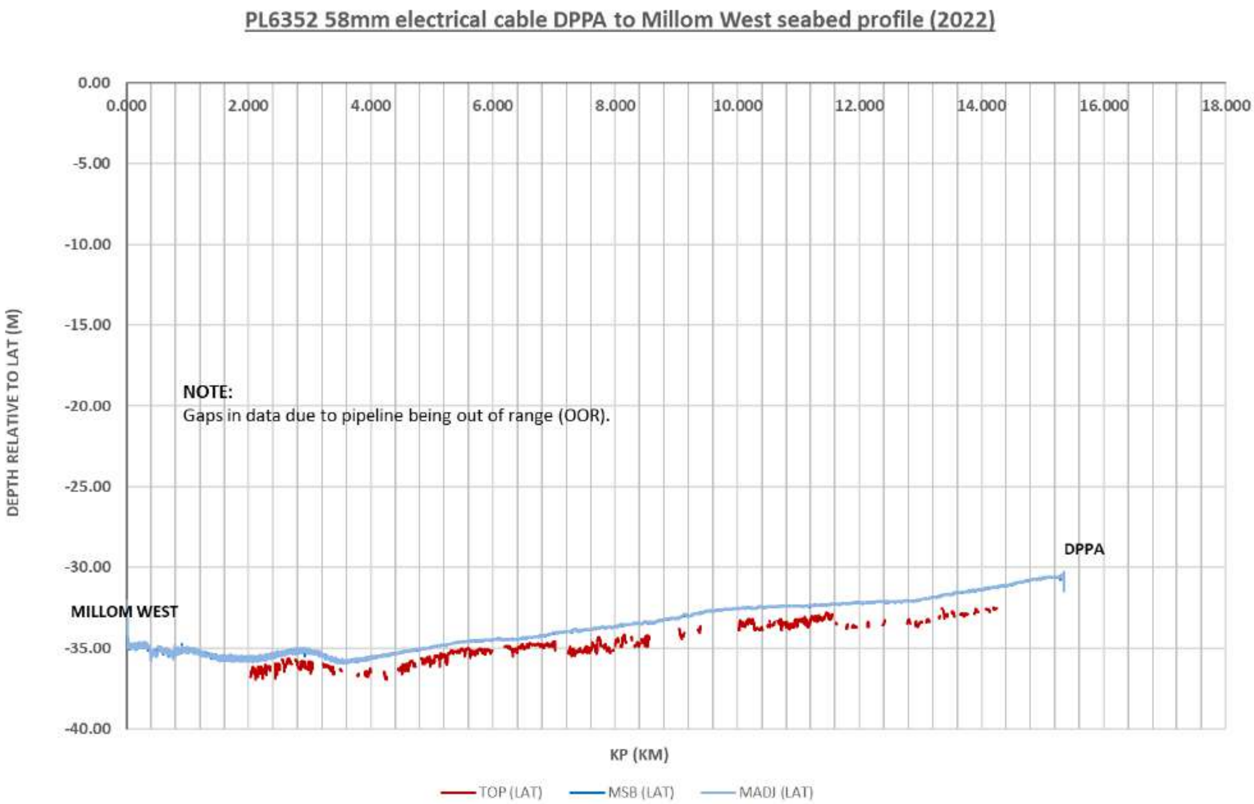


Figure 3.6.13: PL6352 electrical cable from DPPA to Millom West seabed & burial profile (2022)

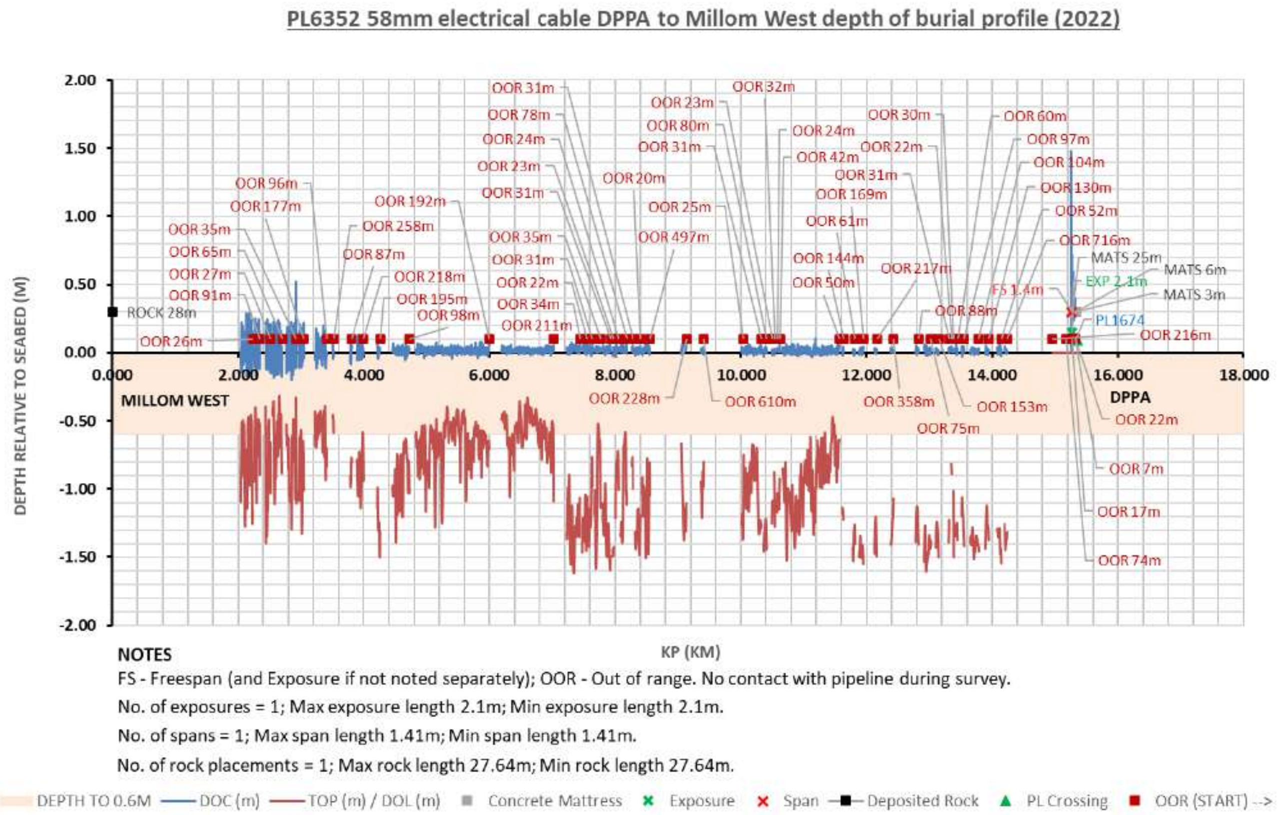


Figure 3.6.14: PL6352 electrical cable from DPPA to Millom West burial profile (2022)

3.6.8 PL1873 8in pipeline Millom Q2 to Millom PLEM

PL1873 is an 8in carbon steel pipeline that is coated with 3LPP throughout its length, and it is ~142m long. It is surface laid and protected and stabilised by concrete mattresses throughout. The route between Millom PLEM and Q2 is largely the same as that taken by PLU1874 with a slight deviation near the Millom PLEM.

For the purposes of the comparative assessment it is assumed that this pipeline will be completely removed.

3.6.9 PLU1874 umbilical Millom PLEM to Q2

The chemical injection and controls umbilical PLU1874 from Millom PLEM to Millom Q2 comprises hoses, copper wire and filler and protected by a double layer of galvanised steel wire, all housed in a 100mm nominal diameter polyethylene outer sheath. For details of the cross-section refer Appendix A. The umbilical is ~164m long and buried except for both the surface laid ends which are protected and stabilised by concrete mattresses. The route between Millom PLEM and Q2 is largely the same as that taken by PL1873.

For the purposes of the comparative assessment it is assumed that this pipeline will be completely removed.

3.6.10 PL1980 6in flowline Millom Q3 to Millom PLEM

PL1980 is a 6in flexible flowline manufactured from composite materials, 85% of which is steel, and it is ~248m long. It is surface laid and protected and stabilised by concrete mattresses throughout. The 8in carbon tie-spools (15m and 6.5m at either end) are included within the overall length.

For the purposes of the comparative assessment it is assumed that this pipeline will be completely removed.

3.7 Pipeline crossing summary

The pipeline crossings are summarised in Table 3.7.1, Table 3.7.2 and Table 3.7.3 below.

Calder pipeline crossings		
Pipeline description	Location	Protection / comment
ISLE OF MAN INTERCONNECTOR CABLE		
PL1965 & PL1966 cross over the Isle of Man Interconnector Cable	KP15.992 469547.14 E 5969005.79 N	Concrete mattresses. Refer Figure 3.4.12.
WINDFARM CABLE CROSSINGS		
Walney 3 windfarm cable crossing	KP23.2	Deposited rock KP23.229 - KP23.202
Walney 3 windfarm cable crossing	KP23.3	Deposited rock KP23.322 - KP23.347
Walney Ext windfarm cable crossing	KP23.6	Deposited rock KP23.616 - KP23.646
Walney windfarm cable crossing	KP31.56	Deposited rock KP31.551 - KP31.578
West of Duddon Sands windfarm cable crossing	KP35.6	Deposited rock KP35.586 - KP35.608
West of Duddon sands windfarm cable crossing	KP35.7	Deposited rock KP35.683 - KP35.707
Ormonde offshore windfarm cable crossing	KP35.9	Deposited rock KP35.898 - KP35.937
NOTES 1. All windfarm cables cross over PL1965 & PL1966. 2. KP measured from the start of the pipeline at Calder platform. 3. The KP for windfarm crossings are estimates, based on acoustic survey data.		

Table 3.7.1 Calder pipeline crossings

Dalton pipeline crossings		
Pipeline description	KP	Protection / comment
NORTH MORECAMBE DPPA 500M ZONE		
PL1668 & PL1671 are crossed over by Rhyl PL2969	~KP7.2	Concrete mattresses. Refer Figure B.6.1.
OUTSIDE NORTH MORECAMBE 500M ZONE		
IOM Interconnector Cable crosses over PL1668 (Note 1)	~KP7.47 455654.62 E 5978710.60 N	3x 5m x 2.5m x 0.15m concrete mattresses
IOM Interconnector Cable crosses over PL1671 (Note 1)	~KP0.8 455663.31 E 5978716.60 N	5x 5m x 2.5m x 0.15m concrete mattresses (3x inside trench, buried, 2x on seabed)
NOTES 1. The Isle of Man Interconnector was installed after the Dalton pipeline and umbilical. According to the supporting documentation the seabed was excavated to the top of the pipeline and umbilical and 3x mattresses were installed inside the trench to provide a minimum 300mm separation between the pipeline and umbilical and the IOM Interconnector Cable. For the umbilical 2x concrete mattresses were installed in the seabed as 'gateway' markers. The KP locations are estimated and approximate.		

Table 3.7.2 Dalton pipeline crossings

Millom pipeline crossings		
Pipeline description	KP	Protection
MILLOM EAST 500M ZONE		
PLU1978JQ3 & PL1980 cross over PL1674 near Millom PLEM.	Millom East 500m zone.	Refer Figure B.4.1.
PLU1978JQ3 & PL1980 cross over PL1678 near Millom PLEM.	Millom East 500m zone.	Refer Figure B.4.1.

Table 3.7.3 Millom pipeline crossings

4 Decommissioning options

4.1 Mattress decommissioning

Some mattresses were installed to protect and stabilise the subsea installations (WHPS) and pipeline end manifolds (PLEMs) and any surface laid infrastructure, and some were installed at the IOM Interconnector Crossing. As noted in Table 4.1.1 some fronded mattresses may have been installed around the base of the Calder and Millom West installations. The quantity of mattresses and their locations is summarised in Table 4.1.1 below:

Summary of concrete mattress locations and quantity		
Location	Quantity of mattresses	Comment
CALDER		
Calder platform	23	Fronded mattresses (T12, T25)
Surface laid & approaches	56	Calder, DPPA
IOM Interconnector crossing	29	PL1965 & PL1966
DALTON		
Dalton PLEM	-	
Dalton R1 & R2 WHPS	15	
Surface laid & approaches	131	PLEM, R1, R2 & DPPA
MILLOM		
Millom PLEM	27	All shaped fronded grout bags
Millom Q1, Q2 & Q3 WHPS	17	At Q1 (8x concrete), Q3 (9x fronded)
Surface laid & approaches	235	PLEM, Q1, Q2, Q3, MW, DPPA (Incl. 5x protection covers)
Millom West platform	18	Fronded mattresses (T12, T25)
Installations & structures	**101 (*41*)**	Incl. 27x shaped & fronded grout bags
IOM Interconnector Crossing	**29**	Left *in situ* if no snagging hazard
Surface laid & approaches	**247**	Removed

NOTES:

1. The indications are that anchored fronded mattresses were installed around both the Calder (23) and Millom West (18) platforms as mitigation for scour but, as the scour continued, further mitigation measures were taken, and deposited rock was installed around the bases of the legs. Their continued presence needs to be confirmed but it is likely that they will be buried under rock in which case they will be left *in situ*.
2. Incl. 2x concrete fronded mattresses (PL1980 at Millom PLEM), 1x shaped grout bag (Millom PLEM) & 5x concrete pipeline protection structures at Millom PLEM (2x) & Q3 (3x).

Table 4.1.1: Calder, Dalton, Millom infrastructure mattress summary

For the purposes of this comparative assessment it is assumed that as part of decommissioning operations all concrete mattresses will be removed in accordance with mandatory requirements. The reasons for this are as follows:

- The PLEMs and WHPS will all need to be removed anyway, and this will require the mattresses at and near the locations to be removed for access.
- It is assumed that all pipelines that are completely surface laid will be fully removed.
- Most of the remaining quantity of mattresses are associated with the approaches as the infrastructure emerges from burial and some of these will have been dislodged to allow the PLEMS and WHPS to be removed.

- Once the mattresses and surface laid infrastructure has been removed, the remaining infrastructure can be expected to remain buried should it be left *in situ* because of the recommendations of this comparative assessment.

Unless stated otherwise in the Decommissioning Programmes [7] it is assumed that any mattresses partly or fully buried under the deposited rock at the Calder and Millom West platforms will be left *in situ*. That is, the fate of these mattresses has not been determined by comparative assessment in this report.

4.2 Pipeline, umbilical or cable decommissioning

Although PL1965 is a candidate for CCUS [3][4], there is an implicit assumption that options for re-use of the pipelines have been exhausted before facilities and infrastructure move into the decommissioning phase and comparative assessment. Therefore, the re-use option has been excluded from this assessment. With the exception of the Calder trunklines (PL1965 & PL1966) none of the infrastructure has been found to be exposed along the buried sections meaning that the decommissioning options can be limited to the following:

- **Complete removal** – This would involve the complete removal of the pipelines by whatever means are the most practicable and acceptable from a technical perspective.
- **Partial removal or remediation** – This would involve removing exposed or potentially unstable sections of pipelines or carrying out remedial work to make the remaining pipeline safe for leaving *in situ.* This option is relevant for those pipelines that have known exposures or spans. There will likely be a need to verify the burial status of the remediated pipeline ends via future surveys. This option only applies to the Calder trunklines PL1965 and PL1966 between ~KP31.0 and the end of the pipeline at MLWM at KP42.424.
- **Leave *in situ*** – This would involve leaving the pipeline(s) *in situ* with no remedial works but verifying their burial status via future surveys.

For the purposes of the pipeline assessment the leave *in situ* options assume that the pipeline ends on the approaches would be fully recovered.

Decommissioning options and methods for all items			
Item Description	Complete removal	Partial removal	Leave *in situ*
All pipeline risers, and sections of umbilicals and cables inside J-tubes (applies to pipelines, that start or end at a platform (e.g. Calder, CPP1)	Completely remove.	Completely remove.	Completely remove.
All surface laid sections of pipelines from trench depth to bottom of riser or J-tube. This applies to the start of the trunklines and electrical cable at the Calder & CPP1 platforms	Remove any overlying mattresses and excavate to trench depth using MFE. Remove underlying pipespools, pipelines, umbilicals and electrical cables down to trench depth. Usually done using the 'cut and lift' method for short sections.	Completely remove.	Completely remove.
Buried sections in-between the surface laid ends. Piggybacked lines PL1965 & PL1966 Partial removal only applies for the Calder trunkline lines near the IOM interconnector crossing and between KP31.0 and MLWM.	Use MFE to uncover the buried sections of infrastructure. Completely remove piggybacked pipelines using the 'cut and lift' method. Leave trenched areas to naturally backfill, but mechanically backfill the excavations for the trunklines nearer to shore.	Use MFE uncover buried ends of the exposed sections and use the 'cut and lift' method for removing the pipelines; or, Post-trench the pipelines; or, Bury the exposed sections under deposited rock. Mechanically backfill the trenches.	Leave *in situ*.
This applies to the end of the electrical cable at the CPP1 platform	Remove any overlying mattresses and excavate to trench depth using MFE. Remove underlying electrical cables down to trench depth. This would usually be done using the 'cut and lift' method for short sections.	Applies only to PL1965 & PL1966. Activity as per complete removal.	Completely remove.
Legacy surveys	Not required	Likely required for sections prone to exposure	Assume required
NOTES: 1. Given the trenching difficulties encountered during installation (section 3.4.1) post-trenching is discounted as a practical alternative.			

Table 4.2.1: Options for decommissioning Calder pipelines

Decommissioning options and methods for all items		
Item Description	Complete removal	Leave *in situ*
All pipeline risers, and sections of umbilicals and cables inside J-tubes (applies to pipelines, that start or end at a platform (e.g. DPPA and Millom West).	Completely remove.	Completely remove.
All surface laid sections of pipelines from trench depth to bottom of riser or J-tube. This applies to the start of the pipelines, etc. at all platforms, WHPS and PLEMs.	Remove any overlying mattresses and excavate to trench depth using MFE. Remove underlying pipespools, pipelines, umbilicals and electrical cables down to trench depth. Usually done using the 'cut and lift' method for short sections.	Completely remove.
Buried sections in-between the surface laid ends. Piggybacked lines PL1675 & PL1676.	Use MFE to uncover the buried sections of infrastructure. Completely remove piggybacked pipelines using the 'cut and lift' method. Completely remove all 12in & 8in pipelines, umbilicals and electrical cables using the reverse reel method. The 'cut and lift' could be used for 12in & 8in pipelines as contingency. Leave trenched areas to naturally backfill.	Leave *in situ*.
All surface laid sections of pipelines from trench depth to bottom of riser or J-tube. This applies to the end of the pipelines at all platforms, subsea installations and PLEMs.	Remove any overlying mattresses and excavate to trench depth using MFE. Remove underlying pipespools, pipelines, umbilicals and electrical cables down to trench depth. This would usually be done using the 'cut and lift' method for relatively short sections.	Completely remove.
Legacy surveys	Not required	Assume required.

Table 4.2.2: Options for decommissioning Dalton & Millom pipelines

5 Comparative Assessment

5.1 Method

The comparative assessment is largely qualitative, carried out at a level that is sufficient to differentiate between the options. However, in some cases, for example such as cost, it can be necessary to examine the differences in more detail and quantitatively to provide clarity. The comparative assessment considers generic evaluation criteria and specific sub-criteria in line with the OPRED guidance notes [17]. These elements are considered for short-term work as the assets are decommissioned as well as over the longer-term as 'legacy' impacts and risks. The criteria and sub-criteria for the pipelines, flexible flowlines, umbilicals and cables are presented in Table 5.1.1 below.

No scores have been determined and no weightings are used. However, risk matrices have been used to determine if the planned and unplanned impacts would be, for example, broadly acceptable, possibly acceptable, unlikely to be acceptable or not acceptable.

The coloured cells for each of the technical, safety, environment, socio-economic and cost elements being considered are used in Appendix D. Cells coloured red indicate high risk, high impact, and less desirable outcomes. Green coloured cells indicate less risk, less impact, and more desirable outcomes. Cells coloured orange sit in-between red and green and may or may not be less, or more, desirable. High costs also attract a less desirable outcome, but differences are compared relative to each other. A relatively high cost where the cost by difference would be an order of magnitude higher than the lowest cost option therefore would be coloured red, a less than order of magnitude higher cost would be coloured orange and the lowest cost option would be coloured green. It should be noted that the societal assessment examined beneficial outcomes as well as detrimental outcomes. Where comparison of options varies by shades of green rather than by red or orange it means there is little to choose between the options.

For the majority of the assessment the complete removal decommissioning option is compared to the leave *in situ* option. The exception is the Calder trunklines (PL1965 & PL1966) between KP31.0 and KP42.424 which have been found with multiple exposures over a number of different surveys, so the Calder trunklines are also assessed for the partial removal option.

Criteria and sub-criteria for pipelines, umbilicals and cables			
Criteria	Definition	Sub-criteria (Short-term & Legacy)	Comments
Technical	A technical evaluation of the complexity of a job that can be expected to proceed without major consequence or failure if it is adequately planned and executed.	Risk of project failure.	Assesses the chances of failure, whether equipment is available, maturity of the technology, any integrity concerns, and would contingency planning be needed?
		Technological challenge.	
		Technical challenge.	
Safety	An assessment of the potential health and safety risk to people directly or indirectly involved in the programme of work offshore and onshore, or who may be exposed to risk as the work is carried out.	Health and safety risks for project personnel carrying out decommissioning activities offshore.	Assesses typical offshore and onshore hazards. Offshore hazards include loss of dynamic positioning, sudden movements during mattress recovery works, dropped objects, collision between vessels. This would vary with the quantity of material being recovered. After decommissioning has been completed typical hazards could relate to exposed mattresses, leading to possibility of snagging of fishing nets. Onshore hazards might include dealing with large quantities of bulk items, onshore cutting, or crushing, sudden movements or dropped objects and these would increase with the quantity of material being handled.
		Residual risks to marine users on successful completion of decommissioning.	
		Safety risks for project personnel engaged in carrying out decommissioning activities onshore.	
Environmental	An assessment of the significance of the threats or impacts to the environmental receptors because of operational activities or the legacy aspects.	Energy and emissions to atmosphere.	With the exception of PL1965 and PL:1966 which pass through the Liverpool Bay/Bae Lerpwl (~9km PL1965/PL1966 inside the SPA) and Morecambe Bay and Duddon Estuary SPAs (final ~5km of PL1965/PL1966 inside the SPA), the pipelines are not located inside an environmentally sensitive area. Where applicable, assesses the effect on the seabed, the effect on the conservation objectives, extent of temporary and permanent disturbance in comparison to the overall area of the Liverpool Bay/Bae Lerpwl (2,528km^2, [10]) and Morecambe Bay and Duddon Estuary SPAs (669km^2, [2]), noise considerations, type of material being left in situ, compares fate of materials, requirement for materials needing to be manufactured to compensate for materials left *in situ*.
		Effect on seabed: Seabed disturbance and area affected.	
		Disturbance to protected areas & impact on conservation objectives of the area (e.g., SAC, SPA, SSSI).	
		Effect on water column: • Liquid discharges to sea. • Noise.	
		Waste creation and use of resources such as landfill. Recycling and replacement of materials.	

Criteria and sub-criteria for pipelines, umbilicals and cables			
Criteria	Definition	Sub-criteria (Short-term & Legacy)	Comments
Socio-economic	An assessment of the significance of the impacts on societal activities, including offshore and onshore activities associated with the complete programme of work for each option and the associated legacy impact. This includes all the "direct" societal effects (e.g., employment on vessels undertaking the work) as well as "indirect" societal effects (e.g., employment associated with services in the locality to onshore work scope, accommodation, etc.).	Effects on commercial activities e.g., fishing Employment. Communities or impact on amenities.	Decommissioning of infrastructure involves work that is temporary. Assesses impact on commercial activities and job creation.
Cost	Difference in cost.	Difference in cost compared for like-for-like activities. Normalised to demonstrate a sense of scale.	Examines cost by difference for the complete removal and leave *in situ* options. Where applicable, the partial removal option is also examined. Common activities such as engineering and management costs, mobilisation and demobilisation of the same vessels are ignored in the assessment. All other criteria and sub-criteria being equal, cost would be the final differentiator.

Table 5.1.1: Pipelines comparative assessment method – criteria & sub-criteria

6 Comparative Assessment

The comparative assessment is split into two parts:

- Calder pipelines – section 6.1
- Dalton & Millom pipelines – section 6.2

6.1 Calder pipeline comparative assessment

Calder trunklines PL1965 & PL1966 are piggybacked. The 'complete removal', and 'leave *in situ*' decommissioning options are compared for the two Calder trunklines PL1965 & PL1966 up to KP 31.0 and the electrical cable (PL6340). The 'partial removal' option is only considered for the two Calder trunklines between KP31.0 and MLWM.

6.1.1 Technical considerations

It would be technically feasible to recover all the pipelines. The method used would depend on size, the material of manufacture, whether a pipeline is concrete weight coated and whether the pipelines are piggybacked. The most likely methods that would be used would be 'cut and lift' for the larger piggybacked pipelines and reverse reel for pipelines less than 16in nominal diameter, umbilicals and cables. The 'cut and lift' method of removal has been used for relatively short lengths, but it could be used as a fall-back should it not be considered viable to use the reverse reel method. There is limited experience in reverse reeling individual trenched and buried pipelines and for this method it is likely that the overlying sediment would need to be removed to uncover the pipelines inside the trench before they would be recovered.

The Calder 24in pipeline PL1965 is concrete weight coated and piggybacked by a 3in pipeline (PL1966). These pipelines would be candidates for recovery using the 'cut and lift' method. Reverse reeling is generally not considered viable for concrete coated or piggybacked pipelines. Concrete coated pipelines cannot be reeled onto the reel without the coating cracking and falling off the pipeline and the concrete coated pipe is not designed to develop the bending stresses expected with reverse reeling when taking account of the weight of concrete coating. Reverse S-lay would not be feasible for concrete coated or piggybacked pipelines so these would need to be recovered in sections using 'cut and lift'. There are also potential issues with the deterioration of the concrete coating over time which may result in sections falling off during recovery. There could also be uncertainties over the condition and structural integrity of the pipeline which could lead to failure during recovery. To the author's knowledge reverse S-lay has not been used for recovering pipelines in the industry.

Although repetitive, the 'cut and lift' method would be feasible but would take a significant amount of time to achieve. Should the pipelines be recovered in road transportable lengths between 10m and 12m long this would mean between 80 and 100 sections being recovered per km of pipeline. For the Calder pipelines ~42.424km long to MLWM, recovery using the 'cut and lift' method it would be an unrealistic prospect, albeit technically feasible.

As the Calder trunklines approach the shore and the water depth reduces, different resources (vessel type work barges, etc) would be required for the removal operations, but nevertheless the removal operations could be considered feasible.

For PL1965 & PL1966, considering the partial removal option, it would be technically feasible to recover exposed sections of the concrete weight coated and piggybacked trunklines near the IOM interconnector crossing at KP15.992 and between KP31 to KP42.424. The most likely method used would be the 'cut and lift' method of removal, which has been used for relatively short lengths. For those parts of the pipelines that are not exposed, the overlying sediment would need to be removed to uncover the pipelines inside the trench before they would be recovered and to mechanically backfill the excavation when the work has been completed. Depending on the seabed movements excavated trenches could also be left to backfill naturally as was the case for the trunklines when they were originally installed. The deposition of rock on the exposed sections of pipeline could be considered a technically feasible alternative to partial removal. Given the trenching difficulties encountered during installation, the post-trenching option for the Calder trunklines is not considered technically feasible for at least some of the exposed sections.

From a technical perspective the leave *in situ* decommissioning option is also feasible.

6.1.2 Safety considerations

The difference in potential safety risk between the options is sufficiently large that a HAZID was not considered necessary at this stage. A HAZID would ordinarily be carried out as part of the preparatory activities.

Safety risk to offshore project personnel

The key differences between the options are as follows.

- Risk to divers and personnel on the vessel – divers if used, and risk to personnel on the vessel from hydrocarbon or hazardous substance releases from recovered pipelines would be greater for complete and partial removal options than for leave *in situ* due to the larger volumes of material recovered.
- Risk associated with 'cut and lift' operations. Assuming the pipelines could successfully be excavated, from a technical perspective the operation should be relatively straightforward. However, to ensure road transportable lengths of between 10m and 12m, the 'cut and lift'; operations would require between ~80 to ~100 sections of pipe to be removed *per km* of pipeline. Arguably, from a safety perspective this would likely be manageable, but the associated risks would increase with the number of operations needing to be performed and the amount of material being transferred and handled on the vessel; no such risks would be incurred for the leave *in situ* option.
- Risk associated with reverse reeling operations and risks associated with the vessel being attached to the pipelines. The risk to personnel and assets would therefore be greater for complete removal option should this method be used, than for leave *in situ*.
- Increased risk to all activities due to adverse weather would be greater for the complete and partial removal options than for leave *in situ* as the vessels would be in the field for longer.
- Risk associated with deposition of rock along part of the trunklines. The operational risks would increase with the amount of material involved but can be expected to be low. To have to carry out the operation at all would present more of a risk than doing nothing at all.
- Risk associated with post-trenching along part of the trunklines. The operational risks are such that any safety concerns would be low, but to have to carry out the operation at all would present more of a risk than doing nothing at all.
- Risk associated with legacy survey activities. The risks associated with vessels being used for future surveys would be greater for the leave *in situ* option than for complete removal. The partial removal option would likely take a similar amount of time as the leave *in situ* option. The operational risks are such that any safety concerns would be low, but to have to carry out the surveys at all would present more of a risk than doing nothing. Typically, in the UK a minimum of three legacy surveys would be required to confirm the condition of subsea pipelines left *in situ*.

Given that the activities and techniques are frequently used in the North Sea and manageable, and most, if not, all the work would likely be conducted using remote operations, it is assumed that the health and safety risks from all hazards would be broadly acceptable.

Short-term safety risk to fishermen and other marine users

The risk to mariners in the short-term is aligned with the duration of the activities in the field. While decommissioning operations are underway the duration of vessels in the field would be longer for either the complete removal or partial removal options than for leave *in situ*. Reverse reel and to an extent 'cut and lift' would mean that the vessel is attached to a pipeline and could not move out of the way quickly.

For the leave *in situ* option at most only the pipeline ends would be dealt with and the duration of the vessels in the field would be much shorter for this option.

Therefore, while decommissioning activities are occurring, the risk to fishermen and other marine users would be least for the leave *in situ* option. Fishing activity in the EIS area is very low in frequency and principally by smaller and more manoeuvrable vessels, some with towed gear, some with pots and traps. It could be expected that any interference would take the form of minor alterations to normal operating practices. Such deviations would be so small as to not be significant. On this basis the potential impact associated with either of the three decommissioning options can be considered low.

The short-term safety risk for the partial removal option would sit in-between the complete removal and leave *in situ* decommissioning options with the work being carried out relatively close to the shoreline (<12km from MLWM) rather than out at sea.

The complete or partial removal activities would give rise to a higher short-term safety threat to others than the leave *in situ* option and conversely there would be no short-term safety threat to others for the leave *in situ* decommissioning option as no decommissioning works would be carried out.

Residual safety risk to fishermen and other marine users

The greatest risk relating to marine users was likely to be concerned with snagging of fishing gear. The type of fishing in the area is some infrequent trawling by a small number of vessels for a few days each year targeting demersal fish. For demersal trawling activities, therefore, there is a potential for snagging on equipment left on the seabed, including spoil mounds. In this instance, once the pipeline ends have been dealt with and buried, the pipelines being considered here – excluding the Calder trunklines between KP31.0 and KP42.424 that are candidates for partial removal, the pipelines can be expected to remain buried with no exposures.

From this it can be reasoned that decommissioning activities that minimise the disturbance to the seabed, reduce the likelihood of creating snag hazards or spoil mounds and that leave the seabed free of equipment will minimise the impact on local fishing activities; this will be no different from the current situation in areas outside of the 500m safety zones. In the short-term both complete removal and leave *in situ* options would leave the seabed free of potential snagging hazards unless any spans are reportable to FishSAFE, but no exposures have been found over the years except at the pipeline ends which will be removed anyway as part of the planned decommissioning operations.

Although the complete removal and partial removal options have the potential to leave spoil mounds that present snagging hazards, it is possible that with extra effort these could be dispersed or given the location would disappear over time.

There would likely be no increased snagging risk associated with the leave *in situ* option and the situation would be no different to what it is now. This could change with the occurrence of any pipeline spans with reportable dimensions and so surveys will need to be done in future to verify that the risk of snagging would remain low for the foreseeable future. The risk of snagging would already seem low for the infrastructure although the burial status and stability of the pipelines will need to be confirmed by depth of burial surveys and risk assessed.

The type of fishing in the area involves some infrequent trawling by a small number of vessels for a few days of every year targeting demersal fish or using pots and traps. For demersal trawling activities there is a potential for snagging on any exposed sections of pipeline left on the seabed as well as spoil mounds. The water depths where the exposures have been found to occur are <17m and are such that the vessels used for fishing in the area might typically be <10m length and therefore potentially more vulnerable to being affected by snagged equipment and adversely affected by spans of smaller dimensions than those reported to FishSAFE.

As indicated in Figure 3.4.3 the overall length and number of exposures has varied over the years from 18x exposures with an overall length of 619m in 2011 to 25x exposures with an overall length 1,417m in 2007. The maximum length has also varied quite significantly from 120m in 2011 to 216m in 2008. In 2017, 22x exposures were noted with an overall length of 1,229m and a maximum length of 141m. The number of spans has also varied from zero (0x) in 2008 and 2011 to ten (10x) being noted in 2017. In 2022 an 18m long freespan is noted near the IOM Interconnector crossing, but the suspended pipeline is underneath concrete mattresses and might present more of a pipeline issue concern rather than a snagging hazard. None of the span dimensions were reportable to FishSAFE. A few short exposures (3x, total length 5.3m) were also found near the IOM Interconnector crossing.

For the Calder pipelines near the IOM interconnector cable at KP15.992 and between KP31.0 and KP42.424 and the partial removal option, the greatest threat relating to marine users is likely to be concerned with snagging of fishing gear for any exposed sections of the pipeline being left *in situ* as any exposed pipelines degrade they could pose more of a snag hazard, although this can be expected to occur over a period of tens if not over a hundred years [9], especially for the concrete coated pipelines.

The partial removal option may leave the seabed free of snag hazards in the short-term, but as the survey data have shown (Figure 3.4.3) the seabed in this area is mobile, so the situation could change. The cut ends of multiple exposures remediated today could become snag hazards in the future even though the exposed cut ends would be remediated. Remediation such as addition of deposited rock could lead to a change in topography, movement of the sediment and unpredictable scour patterns. Arguably, the existence of remediated (buried) cut pipeline ends could be worse than exposed pipelines.

There can be instances where post-trenching would be suitable, but it would not be certain that the trunkline(s) would not reappear. Indeed trenching difficulties were encountered between KP35.6 and KP38.4 during installation so it would be reasonable to discount post trenching as an option here.

A compromise solution for the partial removal option would be to carry out additional surveys and risk assess those spans that would benefit from any remediation.

To summarise, complete removal would remove potential snagging hazards in perpetuity, partial removal could remove potential snagging hazards in perpetuity but apparent movements in the topography of the seabed will mean that additional exposures could appear and leave *in situ* without remediation would mean that exposures and thus potential snagging hazards would remain. The deposition of rock could be a potential alternative solution to partial removal, but more exposures and spans could arise in future.

Health & safety risk to onshore project personnel

The key differences between the options are as followed:

- Risks associated with cutting the pipeline resulting in injury would increase with the quantity of material being returned to shore and so would be greatest for the complete removal option followed by the partial removal option compared with the leave *in situ* option.
- Risks associated with lifting and handling pipeline sections would also increase with the quantity of material being returned to shore.
- Should deposition of rock be required instead of partial removal for example, there would be threats associated with the quarrying of rock, its transportation, and transfer to a rock discharge vessel at quayside, although the risks might be expected to be well managed, and so would be low.

Based on the differences, the leave *in situ* option gives rise to lower risks to onshore personnel for the following reasons:

- Less offshore work.
- Less onshore handling.
- Unloading cut pipes from a vessel has been done before, but to do this at all for the complete removal option would increase the risk to onshore personnel compared to the leave *in situ* option.

- Unspooling of electrical cable from a reel has been done before, but to have to do this at all for either the complete or partial removal options would increase the risk for onshore personnel compared to the leave *in situ* option.

6.1.3 Environmental considerations

Planned and unplanned energy use, emissions, and discharges

The amount of cutting, lifting and disposal requirements are related to the length of pipeline (or cable) being recovered and this will be reflected in vessel time. The duration that vessels would be required in the field for the complete removal and partial removal option would be longer than required for leave *in situ.* Despite the piece-meal nature of partial removal activities for PL1965 & PL1966, the activities would still take less time than complete removal. This would be reflected in the liquid discharges to sea, noise, energy requirements and resulting missions to air. Conversely, the legacy survey requirements for partial removal and leave *in situ* would be greater than for complete removal, and in the case of partial removal the possibility of remedial works could increase with the number of cut pipeline ends.

Energy requirements and emissions to air would be such that there would be a difference between options. However, the gap between complete removal, partial removal and leave *in situ* would narrow slightly when indirect emissions and energy requirements – such as that required for replacement of unrecovered material – are accounted for.

Planned and unplanned impacts on the seabed sediments

The complete removal option would result in no materials left in the seabed. That said, it is during removal operations for the concrete coated pipelines, that the likelihood of concrete spalling or breaking off during cutting and lifting operations would be greatest, and some of this material – despite best intentions, may be left *in situ*.

The leave *in situ* options would result in materials being left to degrade naturally. The main pipelines are predominantly manufactured from steel and, for the larger Calder pipeline (PL1965), concrete, this would not be detrimental to the local environment as the deposition of degraded concrete and steel materials would likely occur very gradually over tens if not hundreds of years [9]. The umbilicals and electrical cables have a higher content of composite materials (~10%) and so would take much longer than steel to decompose. The deposition of the composite materials into the marine environment would also likely occur very gradually over hundreds of years, and so would cause little detriment to the local marine environment.

If it can be assumed that the removal of all the buried trunklines and electrical cable would affect a 10m wide corridor, the overall area affected would be ~0.505km^2. This would be the equivalent of ~0.016% of the combined area (3,197km^2) of the Liverpool Bay / Bae Lerpwl and the Morecambe Bay & Duddon Estuary SPAs and can be considered very small[9].

Partial removal of the trunklines would result in a much smaller proportion of the overall area being affected than complete removal. For example, if it can be assumed that up to 1.5km of exposures would need to be removed, the overall area affected would be ~0.015km^2, the equivalent of 0.0005% of the combined area of the SPAs (or 0.0021% of the Morecambe Bay & Duddon Estuary SPA).

If it can be assumed that leaving all the buried pipelines *in situ* would affect a 5m wide corridor, the overall area affected would be half of the area affected by removal operations and can also be considered negligible.

[9] Note that only part of the two trunklines (PL1965 & PL1966) from Calder to the Rivers Gas Terminal pass through the Liverpool Bay / Bae Lerpwl SPA (~9km) and the Morecambe Bay and Duddon Estuary SPA (~5km) so comparison of areas affected as a proportion of the two SPAs can be considered conservative. This figure includes the full length of both trunklines up to MLWM.

Impact on the conservation objectives of the Liverpool Bay / Bae Lerpwl SPA (PL1965 & PL1966 only)

The conservation objectives of the protected (and designated) features of this site are to ensure that the seabed either remains in or reach a favourable condition for the protection of various species of birds. The ability to achieve these objectives can be affected by its sensitivity to pressures associated with activities taking place within or near a protected site. Only ~9km of the Calder trunklines (PL1965 & PL1966) pass through this SPA, with the electrical cable (PL6340) being located outside.

The complete removal option would result in a disruption, albeit temporary, of the seabed. The seabed can be expected to fully recover over a relatively short space of time once the removal activities have been completed. The area of the SPA impacted would be relatively small, but nevertheless there would still be a disruption that could be avoided should removal activities not be carried out. Any removal activities – particularly inside the SPA, would need to be timed carefully to minimise disruption to the bird populations that use the area.

Should the infrastructure be left *in situ*, there would be no disruption – temporary or otherwise to the seabed, and there would be no disruption to the bird populations that use the area.

Impact on the conservation objectives of the Morecambe Bay & Duddon Estuary SPA (PL1965 & PL1966 only)

Only the last 5km or so of the Calder trunklines pass through the Morecambe Bay and Duddon Estuary SPA.

The conservation objectives of the protected (and designated) features of this site are to ensure that the seabed either remains in or reach favourable condition for the protection of various species of birds. The ability to achieve these objectives can be affected by sensitivity of the SPA to pressures associated with activities taking place within or near the site.

The complete removal option and partial removal option of the last 5km (or part thereof) or so of the Calder trunklines would occur inside the SPA and would result in a disruption, albeit temporary, of the seabed in this area. The seabed can be expected to fully recover over a relatively short space of time once the removal activities have been completed. The area of the SPA impacted itself would be relatively small, but nevertheless there would still be a disruption that could be avoided should removal activities not be carried out at all. Any removal activities – particularly inside the SPA, would need to be timed carefully to minimise disruption to the bird populations in the area.

Should alternative remedial works such as the deposition of rock on to the exposed sections of pipelines instead of the partial removal option the seabed would be permanently affected, and a small proportion – albeit negligible, of the sandy seabed would no longer be available as feeding grounds for the fish and local birds.

Should the infrastructure or part-thereof, be left *in situ*, there would be no disruption, temporary or otherwise to the seabed, and there would be no disruption to the bird populations that use the area.

Waste management

The amount of material made available for reuse , recycling or destined for landfill would be directly related to the quantity recovered. However, experience would suggest that very little material would be destined for landfill once recovered. The concrete weight coating would likely be crushed and recycled along with the steel material. Any plastics recovered would be recycled as recovered energy. Conversely, any material left *in situ* would need to be replaced by the manufacture of new material.

Electrical cables are readily recovered by reverse reeling as part of a decommissioning programme. Such materials can theoretically be reused but proving that the integrity of the complex multi-layered structure of such components has not been compromised during the handling and operational process is difficult, and often recycling is the only realistic option.

6.1.4 Societal considerations

Commercial

The main commercial activity in the area is demersal fishing. Some scallop dredging and potting may still occur on a local scale. While the vessels are present in the field and activities are being undertaken the area would not be accessible for fishing. The potential effects could be loss of fishing revenue due to exclusion from fishing grounds, disturbance of the seabed or loss or damage of fishing equipment. The magnitude of the impact is related to the number and duration of vessels and type of damage, for example, to the static equipment used for lobster pots, etc.

Both the leave *in situ* and partial removal options (PL1965 & PL1966 only) would involve leaving buried pipelines behind, presenting a potential snag hazard. This means that there would be a greater chance that fishing gear could be lost or damaged, and this would have an impact on the ability to continue fishing until the damaged equipment had been replaced. However, the pipelines that would be left *in situ* can be expected to remain buried and intensity of fishing activity in the area is relatively low. The surveys have indicated that once any exposures or spans have been remediated, no exposures or spans would remain, and there have been no reports of snagging. Therefore, it is unlikely that the leave *in situ* option would be detrimental to fishing equipment and thus commercial fishing activities.

Therefore, during decommissioning activities, in the short-term the complete and partial removal options can be expected to have a greater impact on fishing activities as it would have the longest duration and the greatest amount of activity disturbing the seabed. The leave *in situ* option and to a lesser extent the partial removal option would involve leaving most of the pipelines where they are, with a small chance of snagging hazards arising in future. For the partial removal option sections of the trunklines will have been removed with the cut ends being reburied or covered in deposited rock.

For all decommissioning options verification of a clear seabed and risk assessments would be done to verify that the threat of residual snagging hazards and associated loss of damage to equipment remains low.

The partial removal option for the Calder trunklines would result in part of them being removed. Both of the trunklines would otherwise be left *in situ*, with a small chance of snagging hazards arising in future. The leave *in situ* option would involve leaving the buried pipelines where they are, again with a small chance of snagging hazards arising in future. Surveys would need to be undertaken to confirm that the pipelines remain buried. While these surveys are being undertaken fishing activity may be disrupted for a short time, but the impact can be expected to be minimal. Typically, one post-decommissioning survey would be required followed by one or more legacy surveys; the exact magnitude of impact will be dependent on the type, frequency and duration of the surveys needed but they would not normally be disruptive to fishing activities unless for example, lobster pots are being placed along the pipelines.

Employment

The complete removal option and to a lesser extent the partial removal option (PL1965 & Pl1966 only) for the Calder pipelines would require a longer vessel duration and waste management requirements, and therefore impact more positively on employment than leave *in situ*. For individual pipelines, the effect on employment would result in the continuation of existing jobs, rather than lead to the creation of new employment opportunities although collective recovery of both the trunklines and the electrical cable could result in creation of new jobs, although they might only be short-term. The significance of the positive impact can, however, be assessed as low.

Communities

The port and the disposal site have yet to be established. However, they would be existing sites which are used for oil and gas activities and hold the required permits for waste management. The communities around the port and the waste disposal sites are therefore expected to be adapted to the types of activities required and the decommissioning activities associated with this project would be an extension of the existing situation. Therefore, the effect on communities is not considered a significant differentiator between options.

6.1.5 Cost considerations

More details of the cost assessment by difference for the pipelines are presented in Appendix F, Table F.3.1.

Using the assumption that PL1965 & piggybacked PL1966 (~42.7km long to MLWM) would be removed using the 'cut and lift' method the cost would be an order of magnitude greater than for either partial removal or leave *in situ*.

Using the assumption that the Calder electrical cable (PL6340, 7.6km long) would be removed using the reverse reel method the cost would be less than an order of magnitude more than for leave *in situ*.

The difference in cost increases as the length of the pipeline increases. The method of removal will also affect the difference in cost, with the 'cut and lift' method of removal used for the piggybacked pipelines being the most expensive to achieve.

6.2 Dalton & Millom pipeline comparative assessment

The Millom West pipelines PL1675 & PL1676 are piggybacked, but all other pipelines were installed individually. The 'complete removal' and 'leave *in situ'* decommissioning options are compared for all of the buried pipelines, umbilicals and cables. The partial removal option is not required.

6.2.1 Technical considerations

It would be technically feasible to recover all the pipelines. The method used would depend on size, the material of manufacture, and whether the pipelines are piggybacked. None of the Dalton or Millom pipelines are concrete weight coated. The most likely methods that would be used would be 'cut and lift' for the larger piggybacked pipelines and reverse reel for individual pipelines less than 16in nominal diameter, umbilicals and cables. The 'cut and lift' method of removal has been used for relatively short lengths, but it could be used as a fall-back should it not be considered viable to use the reverse reel method. There is limited experience in reverse reeling individual trenched and buried pipelines and for this method of removal given the depth of burial it is likely that the overlying sediment would need to be removed to uncover the pipelines inside the trench before they would be recovered.

The Millom West 12in pipeline PL1675 is piggybacked by PL1676, a 2.5in pipeline. These pipelines would be candidates for recovery in sections using the 'cut and lift' method. Reverse reeling is not generally considered a viable for piggybacked pipelines. Reverse S-lay is unlikely to be feasible for piggybacked pipelines. To the author's knowledge reverse S-lay has not been used for recovering pipelines in the industry.

Although repetitive, the 'cut and lift' method would be feasible but would take a significant amount of time to achieve. Should the pipelines be recovered in road transportable lengths between 10m and 12m long this would mean between 80 and 100 sections being recovered per km of pipeline. The piggybacked pipelines between Millom West to Millom PLEM are ~6.2km long so the prospect of using 'cut and lift' would be a significant and repetitive undertaking but it could be done.

The remaining 12in (2x – Dalton PLEM to DPPA and Millom PLEM to DPPA), 8in (1x – Dalton R2), umbilicals (5x) and electrical cables (2x) would all likely be candidates for recovery using the reverse reel. The pipelines would be deformed as they are recovered onto a reel, so they would not be available for reuse and would need to be recycled when recovered to shore. The structural integrity of the steel pipelines in particular would need to be assured before commencing the removal works but should any issues arise the contingency method of recovery would be the 'cut and lift' technique.

From a technical perspective the leave *in situ* decommissioning option is also feasible.

6.2.2 Safety considerations

The difference in potential safety risk between the options is sufficiently large that a HAZID was not considered necessary at this stage. A HAZID would ordinarily be carried out as part of the preparatory activities.

Safety risk to offshore project personnel

The key differences between the options are broadly the same as those discussed in section 6.1.2 above and so the discussion shall not be repeated here.

Given that the activities and techniques are frequently used in the North Sea and manageable, and most, if not, all the work would likely be conducted using remote operations, it is assumed that the health and safety risks from all operational hazards would be broadly acceptable.

Short-term safety risk to fishermen and other marine users

The key differences between the options are broadly the same as those discussed in section 6.1.2 above and so the discussion shall not be repeated here.

Residual safety risk to fishermen and other marine users

The key differences between the options are broadly the same as those discussed in section 6.1.2 above and so the discussion shall not be repeated here.

To summarise, complete removal would remove potential snagging hazards in perpetuity, but the burial profiles of the Dalton and Millom pipelines and umbilicals that could be left *in situ* are such that there is little chance of snagging hazards appearing in future.

Health & safety risk to onshore project personnel

The key differences between the options are broadly the same as those discussed in section 6.1.2 above and so the discussion shall not be repeated here.

6.2.3 Environmental considerations

Planned and unplanned energy use, emissions, and discharges

The key differences between the options are broadly the same as those discussed in section 6.1.3 above and so for brevity the discussion shall not be repeated here.

Planned and unplanned impacts on the seabed sediments

The complete removal option would result in no materials left in the seabed. The leave *in situ* options would result in materials being left to degrade naturally. The main pipelines are predominantly manufactured from steel, and this would not be detrimental to the local environment because the deposition of degraded steel materials would likely occur very gradually over tens if not hundreds of years [9]. The umbilicals and electrical cables have a higher content of composite materials (~10%) and so would take much longer than steel to decompose. The deposition of the composite materials would also likely occur very gradually over hundreds of years, and so would at little detriment to the local marine environment.

If it can be assumed that the removal of all the buried Dalton & Millom pipelines would affect a 10m wide corridor, the overall area affected would be ~0.621km^2. Although none of the pipeline removal activities would be done in the protected areas, for comparison this would be the equivalent of ~0.019% of the combined area (3,197km^2) of the Liverpool Bay / Bae Lerpwl and the Morecambe Bay & Duddon Estuary SPAs and can be considered very small.

If it can be assumed that leaving all the buried pipelines *in situ* would affect a 5m wide corridor, the overall area affected would be half of the area affected by removal operations and can be considered negligible.

Waste management

Ignoring the partial removal option explored for the Calder trunklines, the key differences between the options are broadly the same as those discussed in section 6.1.3 above. For brevity the discussion shall not be repeated here.

6.2.4 Societal considerations

Ignoring the partial removal option explored for the Calder trunklines the key differences between the options are broadly the same as those discussed in section 6.1.4 above. For brevity the discussion shall not be repeated here.

6.2.5 Cost considerations

More details of the cost assessment by difference for the pipelines are presented in Appendix F, Table F.3.1.

Using the assumption that PL1975 & piggybacked PL1976 (~6.2km) would be removed using the 'cut and lift' method the costs would be less than an order of magnitude greater than for leave *in situ*.

Using the assumption that the individual 8in (PL1669. ~1km) & 12in (PL1668 & PL1674, ~7.2km & ~8.9km long respectively) pipelines would be removed using the reverse reel method, the costs would be less than an order of magnitude more than for leave *in situ*.

Using the assumption that the longer umbilicals PL1671 (~7.2km) and PL1678 (~8.8km) would be removed using the reverse reel method, the costs would be less than an order of magnitude more than for leave *in situ*.

Using the assumption that the shorter umbilical PL1672 (~1km) would be removed using the reverse reel method the costs would be about 2x the cost of removing just the ends and leaving *in situ*.

Using the assumption that the longer Millom West electrical cables (15.5km long) would be removed using the reverse reel method the costs would be an order of magnitude more than for leave *in situ*.

The difference in cost increases as the length of the pipeline increases. The method of removal will also affect the difference in cost, with the 'cut and lift' method of removal used for the piggybacked pipelines being the most expensive to achieve.

7 Conclusions and recommendations

7.1 Conclusions

7.1.1 Calder pipelines

Except for approaches the Calder trunklines and electrical cable are mostly trenched and buried with historical survey data suggesting that for PL1965 & PL1966 some exposures can be expected near the IOM Interconnector and as the pipelines approach within the last ~12km of the shoreline towards near Walney Island. The survey in 2022 only extended as far as KP36.3. The rest of the pipeline(s) between KP36.4 and MLWM is due to be surveyed in 2023.

The assessment found that for the complete removal option the technical feasibility, short-term safety risk to offshore project personnel would be acceptable but least-preferred rather than broadly acceptable and preferred. Otherwise, except for cost there was little to differentiate the options. For the project personnel dealing with waste onshore, the safety risk is deemed to be tolerable but non-preferred compared with partial removal and leave *in situ*. This is because large quantities of material would either be transferred to shore in bundles or need to be taken off reels. Although onshore activities would be mechanised as far as it would be practicable to do so, and procedures would be put in place to deal with the material safely. Holistically, however, the safety risk to onshore personnel would increase with the quantity of material being managed. Transfer of material in this manner has been done before, but to have to do this at all for either the complete or partial removal options would increase the risk for onshore personnel compared to the leave *in situ* option.

From a safety, environmental and societal perspective, once the pipeline ends have been removed, notwithstanding short-exposed sections of the Calder trunklines, over the long term there would be little to choose between the complete removal and leave *in situ* option. Once the exposed sections of the Calder trunklines had been dealt with – either by removal, or by the deposition of additional rock, theoretically there would be little to choose between partial removal and either of the other two decommissioning options, but there would remain the possibility that exposures occur in a similar location in future.

Energy and emissions, the discharges to sea, noise in water from cutting and lifting, and the associated impacts would all be greater for the complete removal and partial removal (to a lesser extent, applying to only the Calder pipelines) options than for leave *in situ*.

The complete removal option would theoretically result in no materials left in the seabed although it is possible small quantities of concrete may spall during the recovery of PL1965, and despite best intentions some of this material could be left on the seabed. However the effect of this is not likely to be significant.

If it can be assumed that the removal of all of the buried pipelines would affect a 10m wide corridor, the overall area affected including the combined area of the Liverpool Bay / Bae Lerpwl and the Morecambe Bay & Duddon Estuary SPAs and can be considered very small, and the area of seabed affected by material left *in situ* can also be considered to be very small.

The partial removal decommissioning option for the Calder pipelines would result in a short length of pipeline in the area being temporarily affected as the exposed section of pipeline are removed. Should the partial removal option be replaced by the deposition of rock over the exposed sections the area of seabed that is currently used by the bottom feeding fish, the birds and fauna would be permanently lost. Albeit it very small (Maximum 1.5km x ~10m wide = 0.015km^2), this would be yet another increase on the area already permanently lost due to the deposition of rock on other infrastructure such as windfarm cables, etc.

The leave *in situ* options would result in materials being left to degrade naturally. The main pipelines are predominantly manufactured from steel and, for the larger Calder pipeline, concrete, this would not be detrimental to the local environment as the deposition of degraded concrete and steel materials would likely occur very gradually over tens if not hundreds of years. The electrical cable have a higher content of composite materials (~10% to 15%) and so would take much longer than steel to decompose. The deposition of the composite materials into the marine environment would also likely occur very gradually over hundreds of years, and so would be little detriment to the local marine environment.

The main commercial activity in the area is demersal fishing but over the past few years, the fishing effort has been limited just a few days of the year, using relatively small vessels (<10m). In the short-term there should be no real disruption to commercial fishing activities, and if there is it would be relatively short-lived. Over the longer-term should the partial removal of the Calder pipelines be replaced by the deposition of rock, the feeding grounds of bottom feeding fish would be affected but as discussed earlier, the area of seabed lost and the knock on-effect on fishing activity would be very small.

The collective recovery of all the pipelines in the Calder area could result in creation of new jobs, although they might only be short-term. The significance of the positive impact can, however, be assessed as low.

For material that is brought to shore, the port and the disposal site would likely be existing sites which are used for oil and gas activities and hold the required permits for waste management. The effect on communities is not considered a significant differentiator between options.

The difference in cost increases as the length of the pipeline increases. The method of removal will also affect the difference in cost, with the 'cut and lift' method of removal used for the piggybacked pipelines being the most expensive to achieve.

Using the assumption that PL1965 & piggybacked PL1966 (~42.7km long to MLWM) would be removed using the 'cut and lift' method the costs would be an order of magnitude greater than for partial removal and leave *in situ*.

7.1.2 Dalton & Millom pipelines

It is assumed that the pipelines such as (PL1670, PL1673 (Dalton), PL1677, PLU1678JQ3, PL1679, PL1873 and PLU1874 (Millom) that have been surface laid will be fully removed and that the pipelines on the approaches will be removed down to trench depth. All surface laid protection and stabilisation features associated with these pipelines will be fully removed in accordance with mandatory requirements, except possibly for those features that are buried under deposited rock near the Millom West platform as these will likely be left *in situ*.

Except for approaches all the remaining individual pipelines are trenched and buried. The assessment found that for the complete removal option the technical feasibility, short-term safety risk to offshore project personnel would be acceptable but less preferred rather than for leave *in situ*. For the project personnel dealing with waste onshore, the safety risk is deemed to be tolerable but non-preferred compared with leave *in situ*. It is noted that onshore activities would be mechanised as far as it would be practicable to do so, and procedures would be put in place to deal with the material safely. But for the complete removal option large quantities of material would either be transferred to shore in bundles or need to be taken off reels. Transfer of material in this manner has been done before, but to have to do this at all for the complete removal option would increase the risk for onshore personnel compared to the leave *in situ* option. The safety risk to onshore personnel would increase with the quantity of material being handled.

From a safety, environmental and societal perspective, once the pipeline ends have been removed, over the long term there would be little to choose between the complete removal and leave *in situ* option.

Energy and emissions, the discharges to sea, noise in water from cutting and lifting, and the associated impacts would all be greater for the complete removal than for leave *in situ*.

If it can be assumed that the removal of all the buried Dalton & Millom pipelines would affect a 10m wide corridor, the overall area affected would be ~0.621km^2. Although none of the pipeline removal activities would be done in the protected areas, for comparison this would be the equivalent of ~0.019% of the combined area

(3,197km^2) of the Liverpool Bay / Bae Lerpwl and the Morecambe Bay & Duddon Estuary SPAs and can be considered very small.

The complete removal option would result in no materials left in the seabed. The leave *in situ* option would result in materials being left to degrade naturally. The main pipelines are mostly manufactured from steel, and this would not be detrimental to the local environment as the deposition steel corrosion products would occur very gradually over tens if not hundreds of years. The umbilicals and electrical cables have a higher content of composite materials (~10% -~15%) and so would take much longer than steel to decompose. The deposition of the composite materials would also likely occur very gradually over hundreds of years, and so would be little detriment to the local marine environment.

The main commercial activity in the area is demersal fishing but over the past few years, the fishing effort has been relatively limited, using relatively small vessels (<10m). In the short-term there should be no real disruption to commercial fishing activities, and if there is it would be relatively short-lived and manageable.

The collective recovery of all the pipelines in the Dalton and Millom areas would most likely result in the continuity of existing jobs. The significance of the positive impact can be assessed as low.

For material that is brought to shore, the port and the disposal site would likely be existing sites which are used for oil and gas activities and hold the required permits for waste management. The effect on communities is not considered a significant differentiator between options.

The difference in cost increases as the length of the pipeline increases. The method of removal will also affect the difference in cost, with the 'cut and lift' method of removal used for the piggybacked pipelines being the most expensive to achieve.

As a result of the cost assessment the indications are that the cost for the removal of the Millom West electrical cables would each be an order of magnitude greater than the leave *in situ* option.

The cost of removing the piggybacked pipelines (PL1975 & PL1976), individual pipelines (PL1669, PL1668 & PL1674), and the umbilicals (PL1671 & PL1678) would be less than an order of magnitude less than leave *in situ*, where just the ends would be removed. The cost of removing the shorter umbilical (PL1672) is about double the cost of leaving the umbilical *in situ*.

7.2 Recommendations

7.2.1 Calder pipelines

The following recommendations arise because of this comparative assessment:

- Carry out additional burial surveys, the result of which will inform the current burial status of the pipelines and thereby help determine or confirm the proposed decommissioning strategy. The burial status of PL1965 & PL1966 near the windfarm cable crossings has been found to vary over the years.
- Completely remove surface laid pipeline ends down to burial depth, and completely remove the associated protection and stabilisation features.
- Leave the buried sections of the pipelines *in situ.*
- Leave the Isle of Man (IOM) Interconnector crossing protection and stabilisation features *in situ*. As it is not protected by a 500m safety zone this would be no different to the current situation. Confirm that no snagging hazards remain to the satisfaction of all stakeholders.
- Meantime, check the status of PL1965 & PL1966 near the IOM Interconnector crossing. Unsupported section of the pipelines - all be they covered with mattresses - was observed in 2014 (25m long), 2017 (7.2m long) and 2022 (18m long) and this is thought to be attributed to local scour. The pipelines may be sufficiently protected by mattresses with no further action. Carry out remediation work as per company Inspection, Repair and Maintenance procedures for the pipeline(s) until they are decommissioned.

- Remediate the exposed sections of Calder trunklines PL1965 & PL1966. The preference would be for the exposed sections to be removed, minimising the number of remaining cut ends as they could re-appear as exposures. The option to bury the exposed sections under rock especially near the cable crossings remains a valid approach but given the sensitivity of the area, consideration should be given to the loss of native habitat, however small. It may be appropriate to bury the exposures near the cable crossings under deposited rock (e.g. sporadically between KP35.5 and KP36.4, total length ~250m c.f. 206m) while removal of the exposed sections of pipelines between KP36.4 and KP41.02 (minimum length ~1,023m) would result in all the exposures documented in 2017 as being remediated. Total length remediated ~1.3km. The 2017 survey data present a slightly worst case than the combined 2022 and 2023 survey data.

The decommissioning options are summarised in Table 7.2.1 below:

Calder pipeline, umbilical and cable decommissioning summary				
Description	Route	Burial	Length (km)	Decommissioning option
PL6340 62mm electrical cable	CPP1 to Calder	Buried	~7.6	Leave *in situ*
PL1965 24in pipeline	Calder to MLWM	Buried	~42.7	Leave most of pipelines *in situ*, remediate exposed sections
PL1966 3in pipeline	MLWM to Calder	Buried	~42.6	

Table 7.2.1: Calder pipeline and electrical cable decommissioning summary[10]

7.2.2 Dalton & Millom pipelines

The following recommendations arise from this comparative assessment:

- Completely removal all surface laid pipelines and associated protection and stabilisation features.
- Completely remove surface laid pipelines, and remove pipeline ends down to burial depth. Completely remove the associated protection and stabilisation features.
- Leave the buried sections of the pipelines *in situ*.

The decommissioning options are summarised in Table 7.2.2 and Table 7.2.3 below:

Dalton pipeline, umbilical and cable decommissioning summary				
Description	Route	Burial	Length (km)	Removal option
PL1668 12in pipeline	Dalton PLEM to DPPA	Buried	~7.3	Leave *in situ*
PL1669 8in pipeline	R2 to Dalton PLEM	Buried	~1.0	Leave *in situ*
PL1670 8in pipeline	R1 to Dalton PLEM	Surface laid	~0.1	Complete removal
PL1671 113mm umbilical	DPPA to Dalton PLEM	Buried	~7.2	Leave *in situ*
PL1672 100mm umbilical	Dalton PLEM to R2	Buried	~1.0	Leave *in situ*
PL1673 100mm umbilical	Dalton PLEM to R1	Surface laid	~0.1	Complete removal

Table 7.2.2: Dalton pipeline, umbilical and cable decommissioning summary

[10] For the leave *in situ* decommissioning option, the surface laid ends will be removed down to trench depth.

Millom pipeline, umbilical and cable decommissioning summary				
Description	Route	Burial	Length (km)	Removal option
58mm electrical cable	DPPA to Millom West	Buried	~15.3	Leave *in situ*
PL1674 12in pipeline	Millom PLEM to DPPA	Buried	~8.9	Leave *in situ*
PL1675 12in pipeline	Millom West to PLEM	Buried	~6.2	Leave *in situ*
PL1676 2.5in pipeline	Millom PLEM to MW	Buried	~6.3	Leave *in situ*
PL1677 8in pipeline	Q1 to Millom PLEM	Surface laid	~0.1	Complete removal
PL1678 113mm umbilical	DPPA to Millom PLEM	Buried	~8.8	Leave *in situ*
PLU1678JQ3 111mm umbilical	Millom PLEM to Q3	Surface laid	~0.3	Complete removal
PL1679 100mm umbilical	Millom PLEM to Q1	Surface laid	~0.1	Complete removal
PL1873 8in pipeline	Q2 to Millom PLEM	Surface laid	~0.1	Complete removal
PLU1874 100mm umbilical	Millom PLEM to Q2	Surface laid	~0.2	Complete removal
PL1980 6in flexible flowline	Q3 to Millom PLEM	Surface laid	~0.3	Complete removal

Table 7.2.3: Millom pipeline, umbilical and cable decommissioning summary

8 References

Please note the link names presented below have been abbreviated.

[1] Barrow Offshore Wind Limited (2008) Barrow Offshore Wind Farm Post Construction Monitoring Report, First Annual Report. Weblink last accessed 11 Oct 2021: BOWind Ltd MR.

[2] BEIS (2016) Morecambe Bay and Duddon Estuary SPA Citation. Weblink last accessed 16 Oct 2021: MB&DE SPA Citation.pdf.

[3] BEIS (2019) Re-use of Oil and Gas Assets for Carbon Capture Usage and Storage Projects. Weblink last accessed: 10 June 2020: BEIS CCUSP Link.

[4] BEIS (2019) Re-use of Oil and Gas Assets for Carbon Capture Usage and Storage Projects, Annex A. Weblink last accessed 10 June 2020: BEIS CCUSP Annex A Link.

[5] BEIS (2021) Morecambe Bay & Duddon Estuary SPA Factsheet. Weblink last accessed 14 Oct 2021: MB&DE SPA Factsheet.

[6] EIB Org (2005) Ormonde Offshore Wind Farm Environmental Impact Statement. Weblink last accessed 11 Oct 2021: Ormonde WF EIA.

[7] Harbour Energy (2021) Calder, Dalton & Millom Decommissioning Programmes, HBR-EIS-E-XX-P-PM-12-00001.

[8] Harbour Energy (2021) Calder, Dalton & Millom Environmental Appraisal, HBR-EIS-E-XX-X-HS-02-00001.

[9] HSE (Health and Safety Executive) (1997) The abandonment of offshore pipelines: Methods and procedures for abandonment. Offshore Technology report. HSE Books, Norwich. ISBN-7176-1421-2.

[10] JNCC (2021) Liverpool Bay / Bae Lerpwl SPA. Weblink last accessed 14 Oct 2021: JNCC Base Lerpwl SPA.

[11] MMO (2020) 2015-2021 UK fleet landings by ICES rectangle, weblink (added to previously held 2015 data) last accessed 04 Nov 2022: 2016_to_2020_UK_fleet_landings_by_ICES_rectangle.ods.

[12] Natural England (2019) European Site Conservation Objectives for Morecambe Bay & Duddon Estuary Special Protection Area Site Code: UK9020326. Weblink last accessed 14 Oct 2021: NE MB&DESPA CO.

[13] NWIFCA (2015) Liverpool Bay/Bae Lerpwl Non-Occurring Activities. Weblink last accessed 15 Oct 2021: NWIFCA-LB-SPA-001_Non-Occurring-Activities.pdf.

[14] NWIFCA (2015) Morecambe Bay and Duddon Estuary – Non-Occurring Activities. Weblink last accessed 15 Oct 2021: NWIFCA-MB-EMS-001_Non-Occurring-Activities.pdf.

[15] NWIFCA (2015) Morecambe Bay and Duddon Estuary – Non-Occurring Activities. Weblink last accessed 15 Oct 2021: NWIFCA-MB-EMS-001A_Non-Occurring-Activities.pdf.

[16] NWIFCA (2017) Light Otter Trawling. Weblink last accessed 14 Oct 2021: NWIFCA-MB-EMS-002_Light-Otter-Trawling.

[17] OPRED (2018) Offshore Oil and Gas Decommissioning Guidance Notes. Weblink last accessed 27 Jan 2020: OPRED Guidance Notes Nov 2018.

[18] Ørsted (2020) Our Offshore Wind Farms. Weblink last accessed 11 Oct 2021: Orsted WOWF Summary.

[19] The National Archives (1998) The Petroleum Act (Latest available). Weblink last accessed 28 April 2023: The Petroleum Act

[20] Vattenfall (2021) Ormonde Offshore Wind Farm. Weblink last accessed 11 Oct 2021: Vattenfall OOWF.

Appendix A Cable construction

Appendix A.1 PL6340 CPP1 to Calder 11kV electrical cable

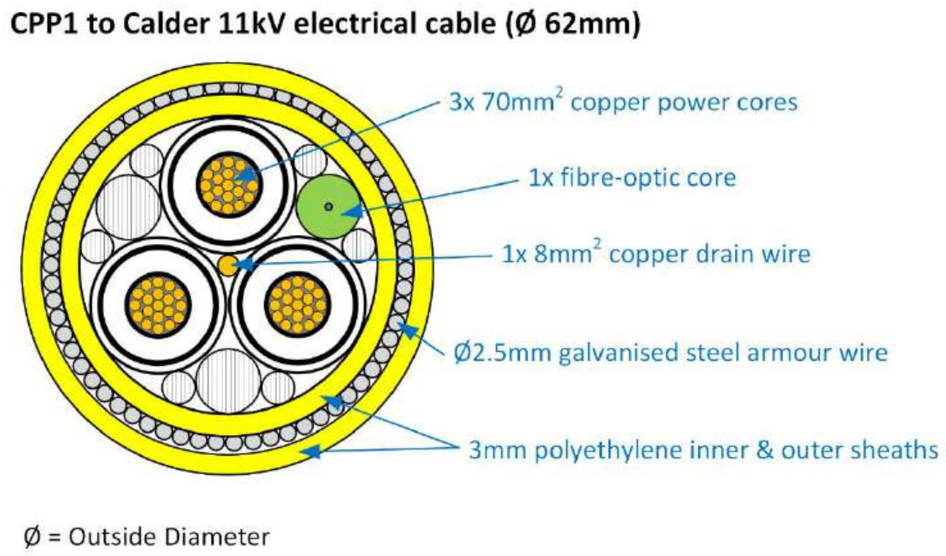


Figure A.1.1: PL6340 CPP1 to Calder 11kV electrical cable construction

Appendix A.2 PL6352 DPPA to Millom West 11kV electrical cable

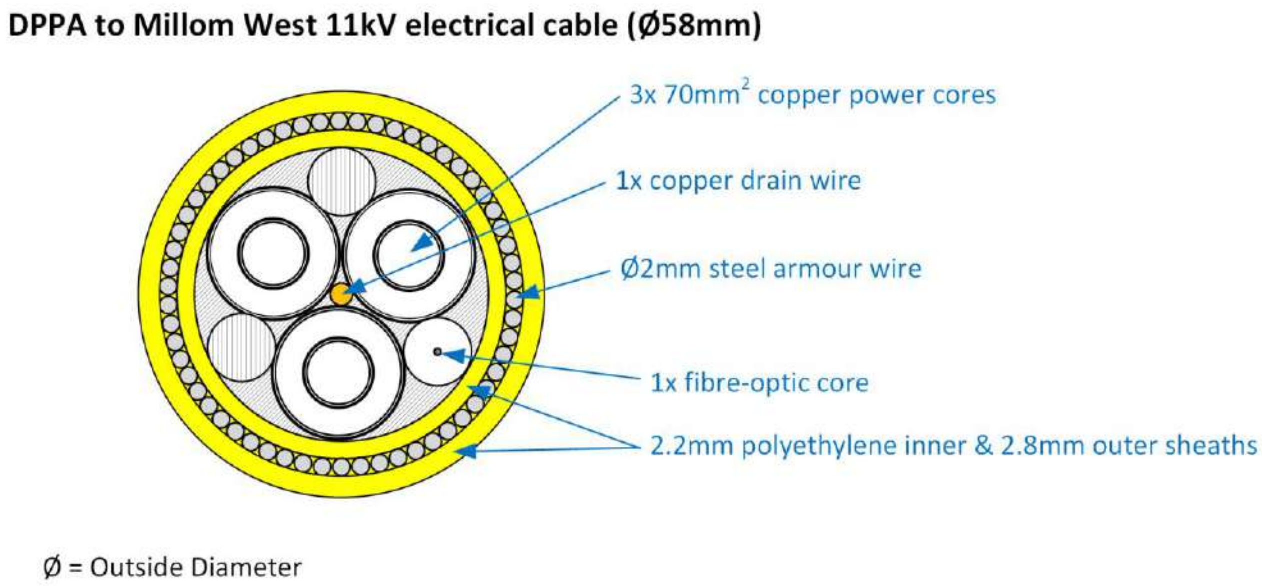


Figure A.2.1: PL6352 DPPA to Millom West 11kV electrical cable construction

Appendix A.3 DPPA to Dalton & Millom PLEM umbilicals

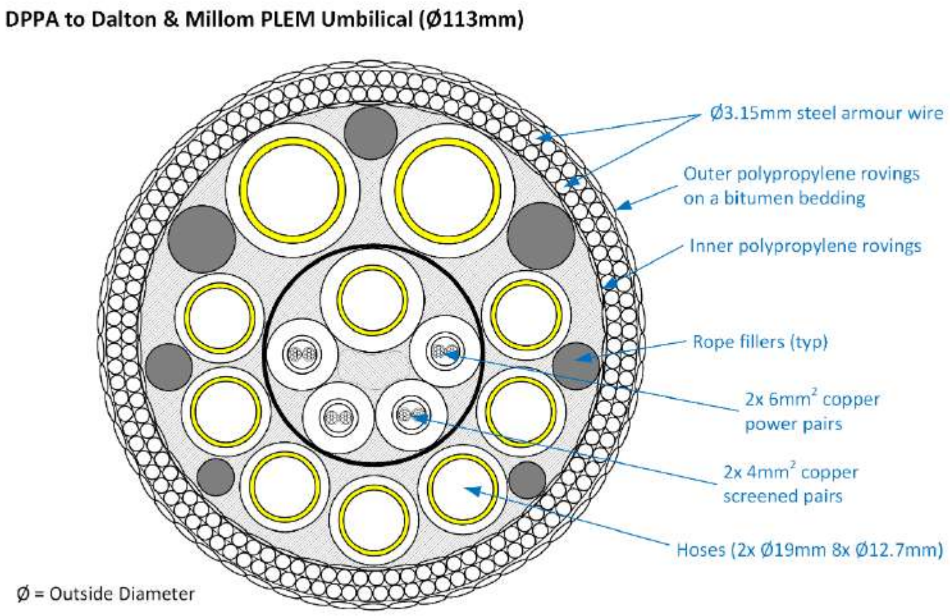


Figure A.3.1: DPPA to Dalton & Millom PLEMs Umbilical construction[11]

Appendix A.4 Dalton R1 & R2 & Millom Q1 & Q2 umbilical jumpers

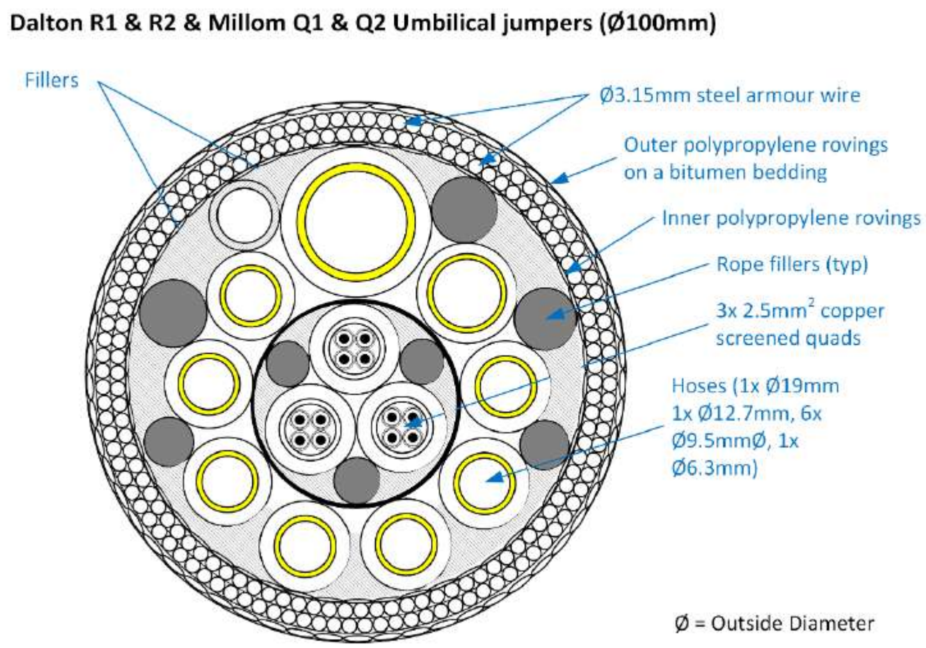


Figure A.4.1: Dalton R1, R2 & Millom Q1, Q2 umbilical jumper construction[12]

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[11] Pipeline IDs PL1671 (Dalton) & PL1678 (Millom).
[12] Pipeline IDs PL1672, PL1673 (Dalton), PL1679 & PLU1874 (Millom).

Appendix A.5 Millom Q3 umbilical jumper

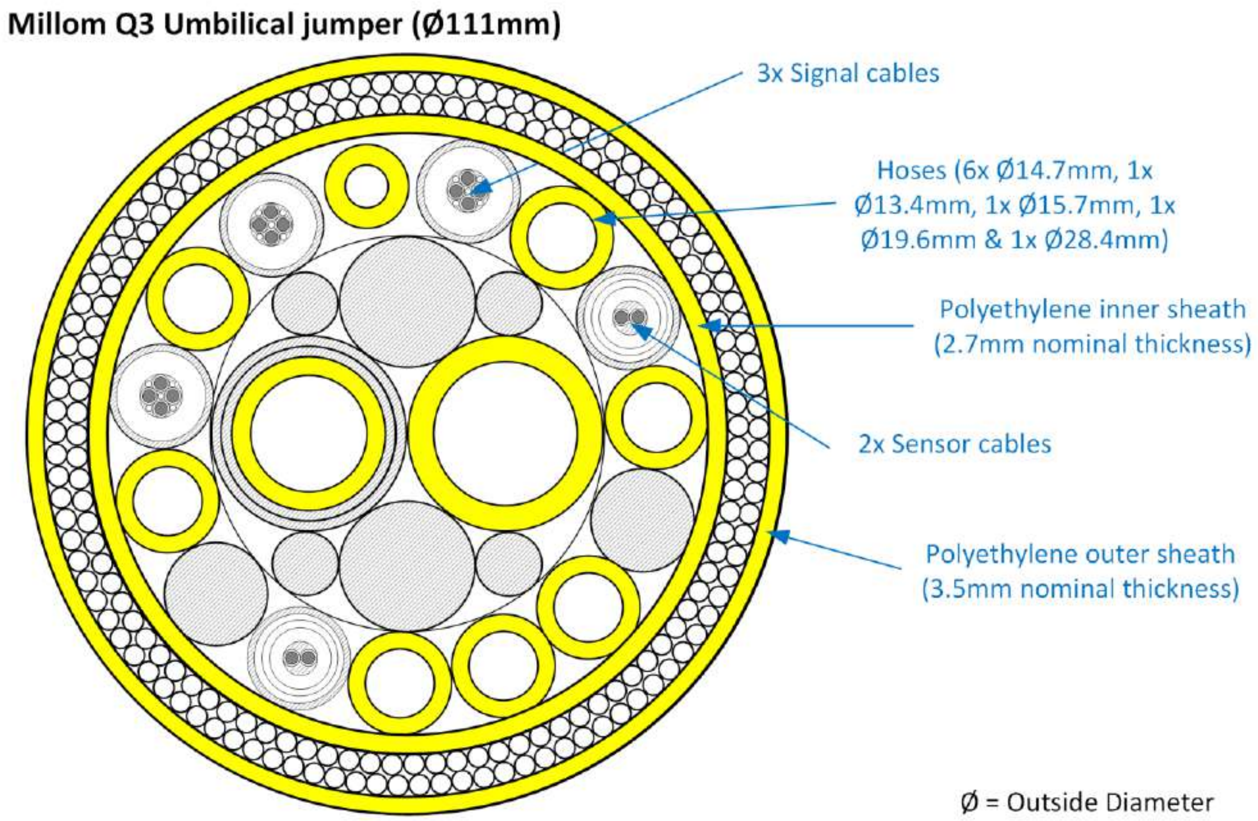


Figure A.5.1: Millom Q3 Umbilical jumper construction[13]

[13] Pipeline ID: PLU1678JQ3 (Millom).

Appendix B Schematics

Appendix B.1 Calder

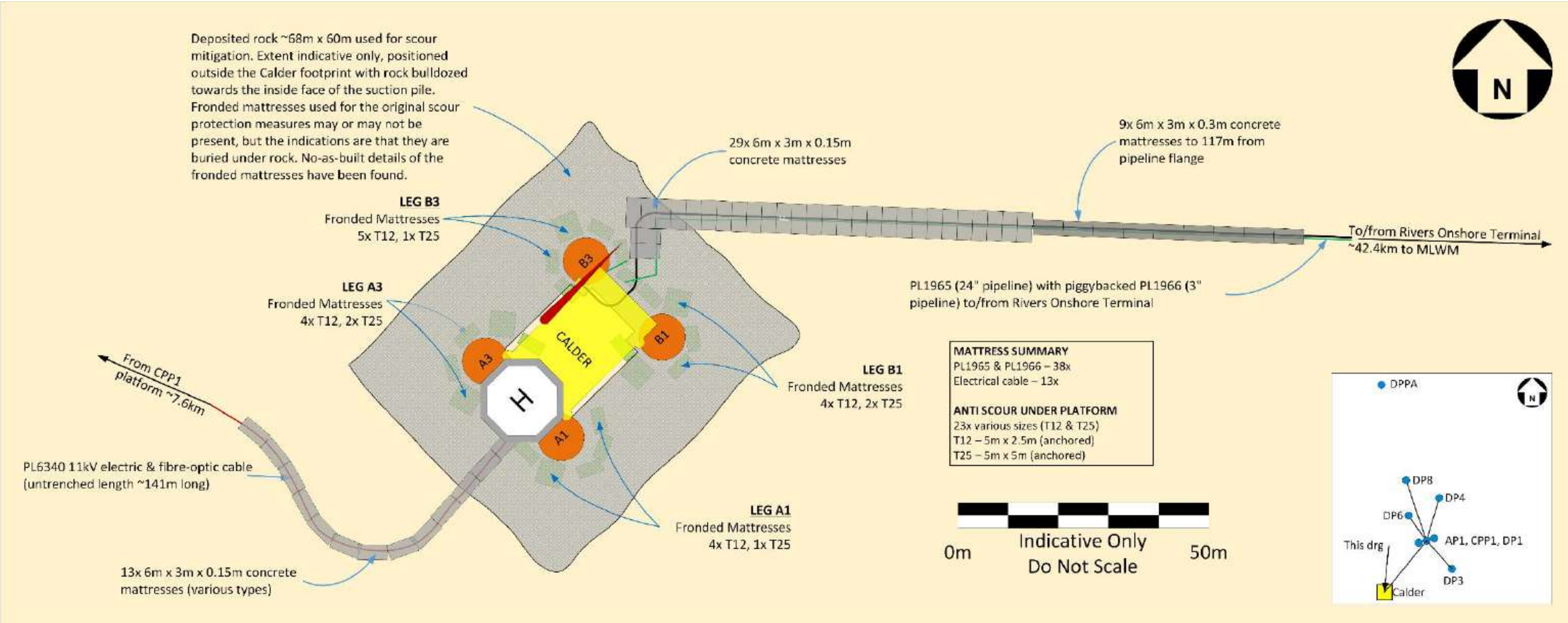


Figure B.1.1: Calder approach schematic

Appendix B.2 Dalton PLEM & R1

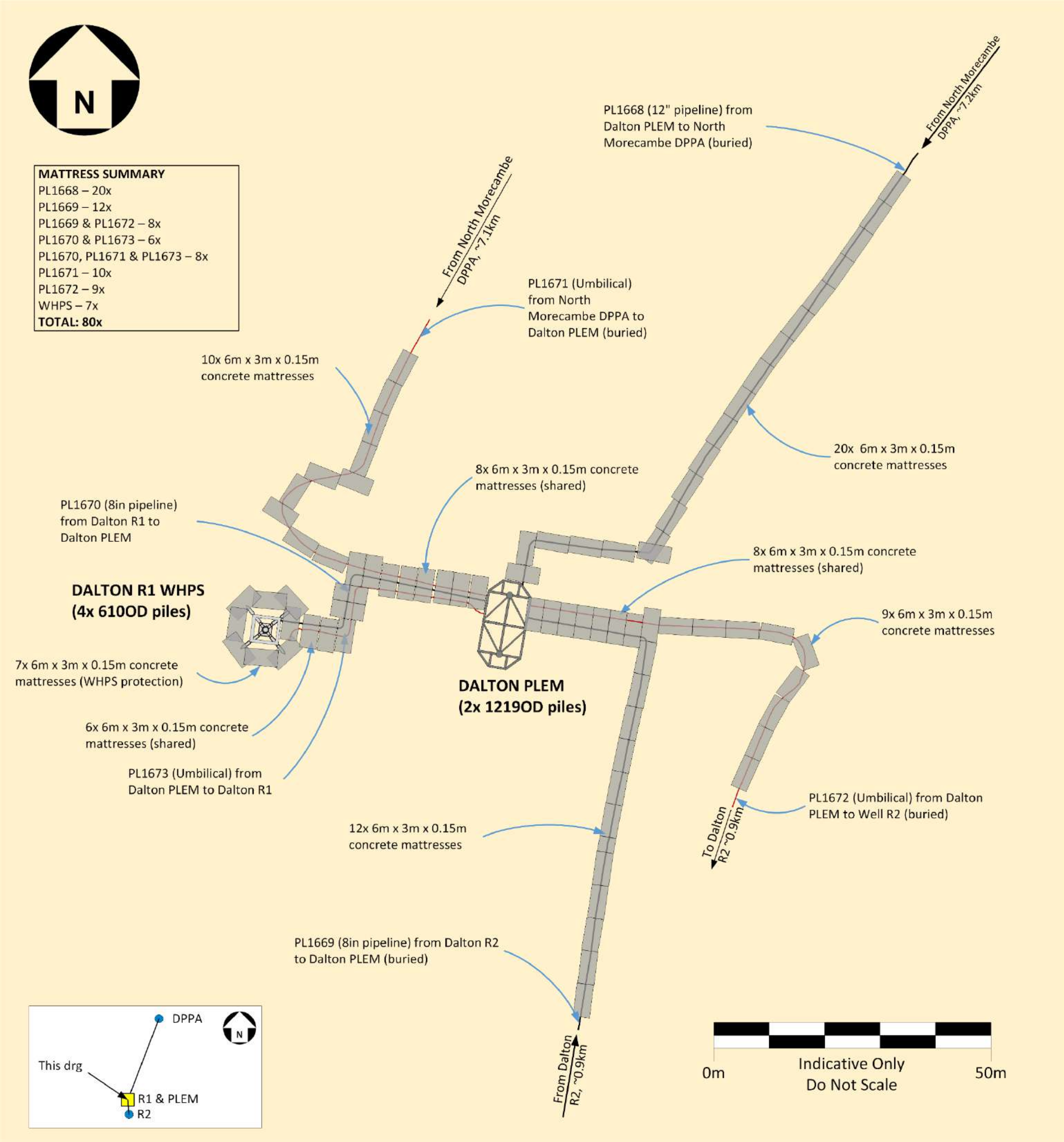


Figure B.2.1: Dalton PLEM & Well R1 approach schematic

Appendix B.3 Dalton R2

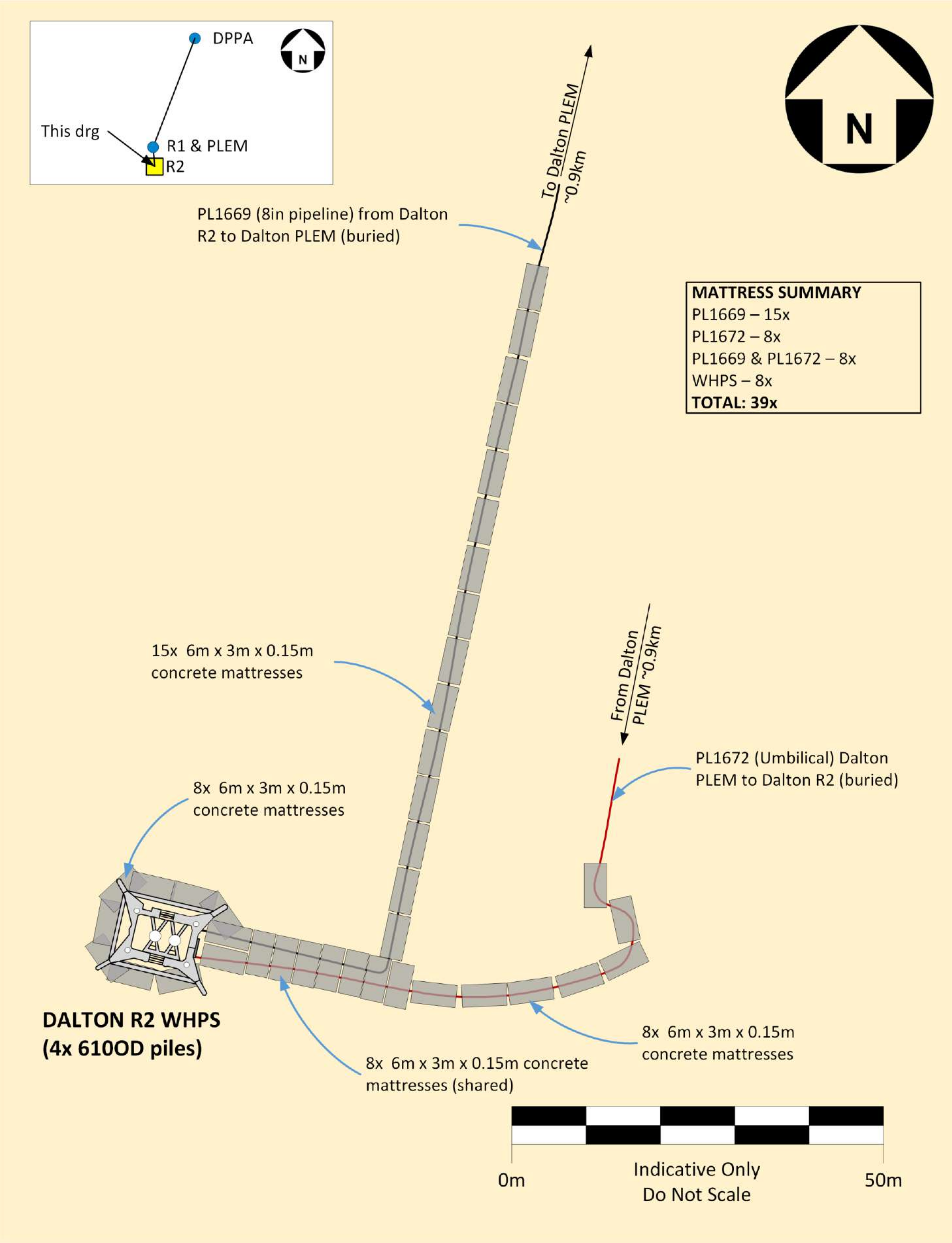


Figure B.3.1: Dalton Well R2 approach schematic

Appendix B.4 Millom PLEM, Q1, Q2 & Q3

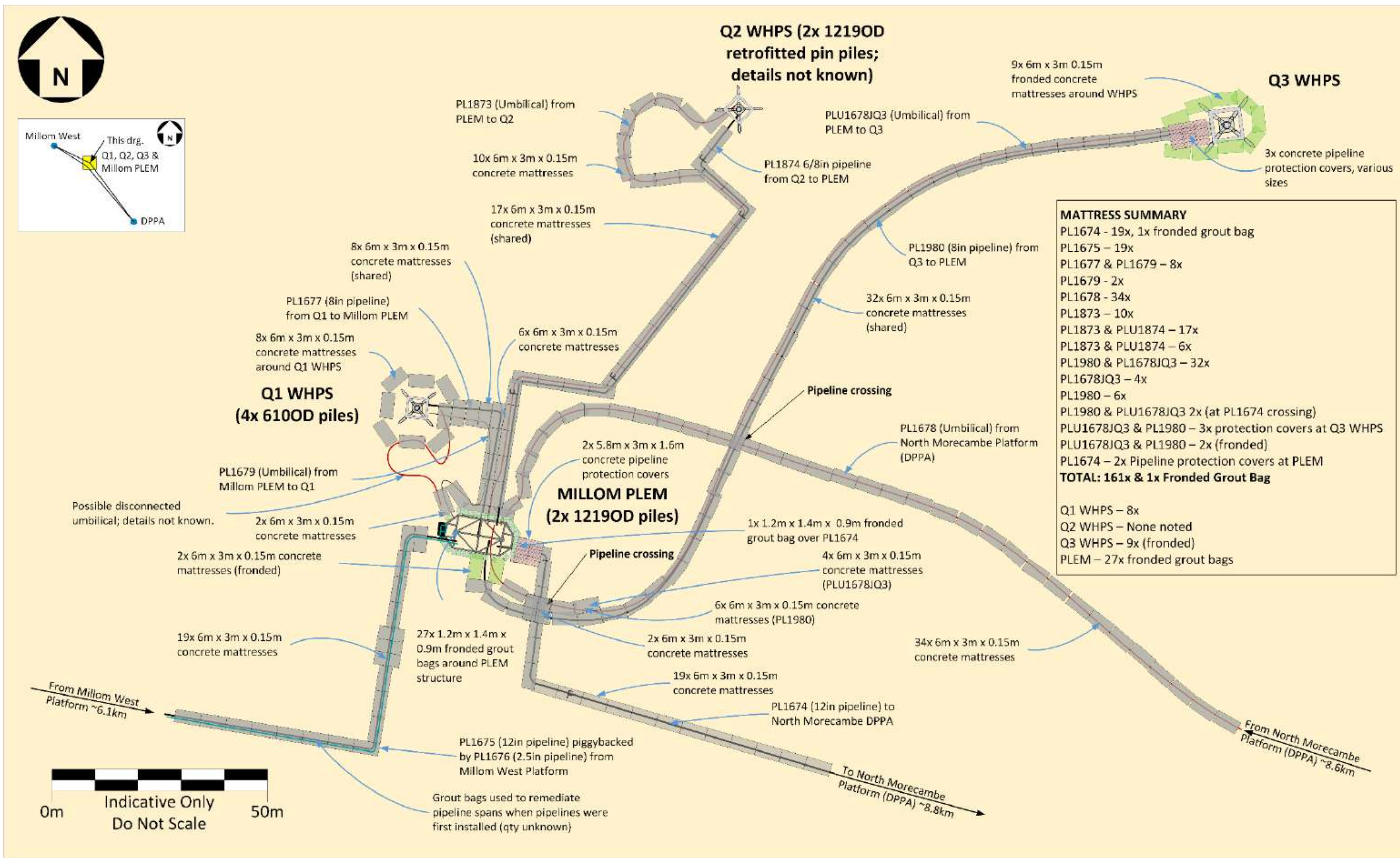


Figure B.4.1: Millom PLEM, Well Q1, Well Q2 & Q3 approach schematic

Appendix B.5 Millom West

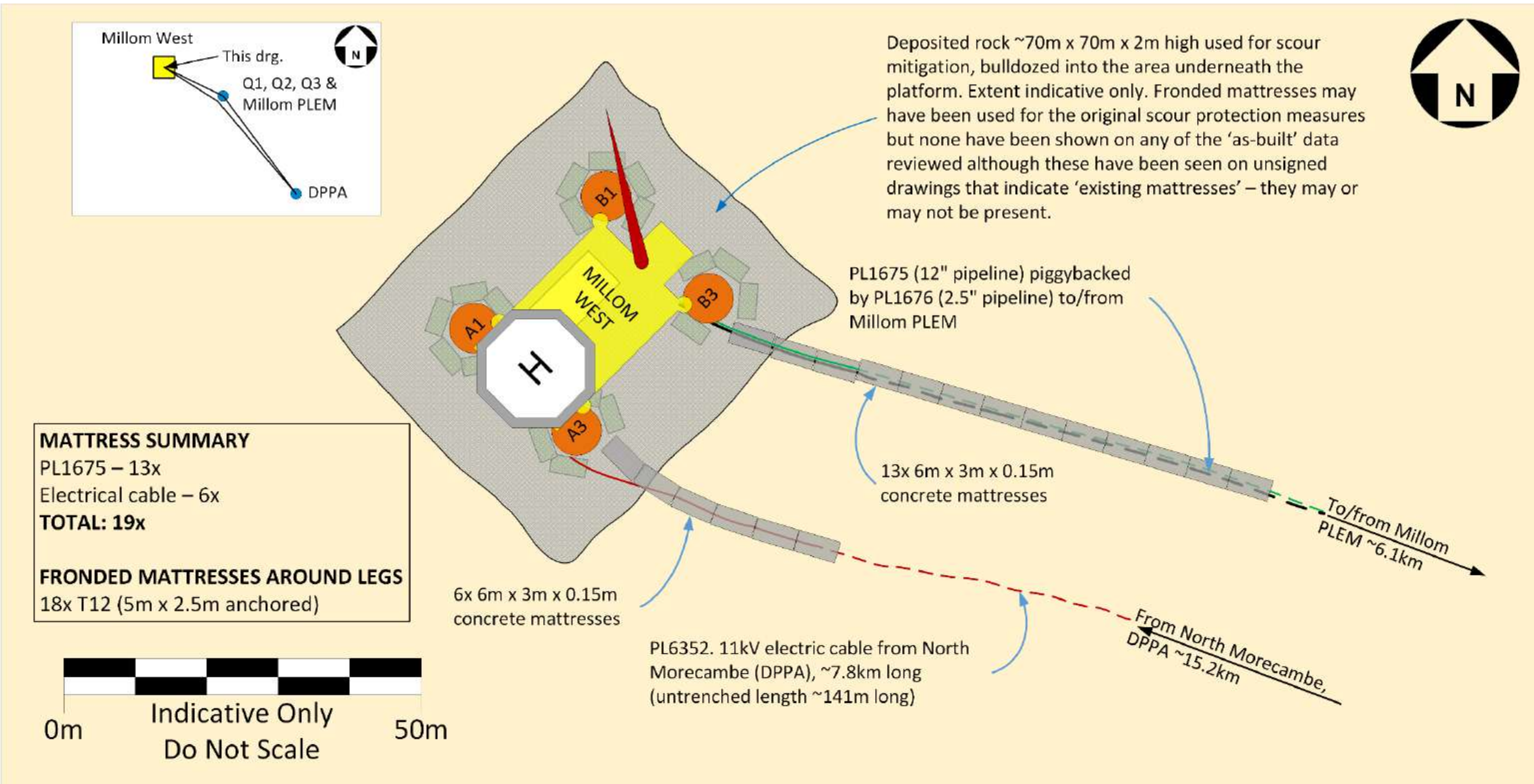


Figure B.5.1: Millom West platform approach schematic

Appendix B.6 North Morecambe DPPA

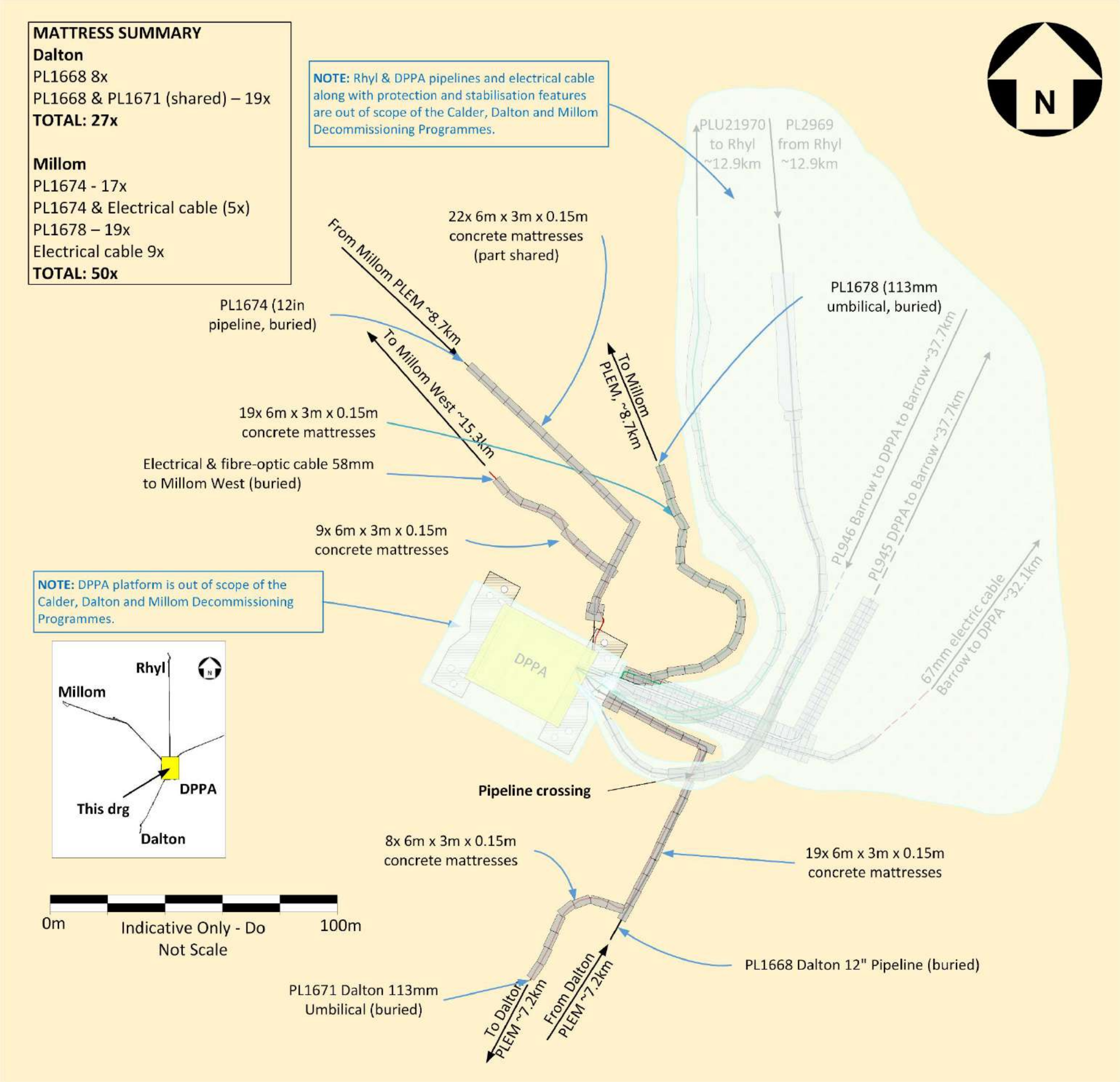


Figure B.6.1: North Morecambe DPPA approach schematic

Appendix B.7 South Morecambe Central Processing Platform CPP1

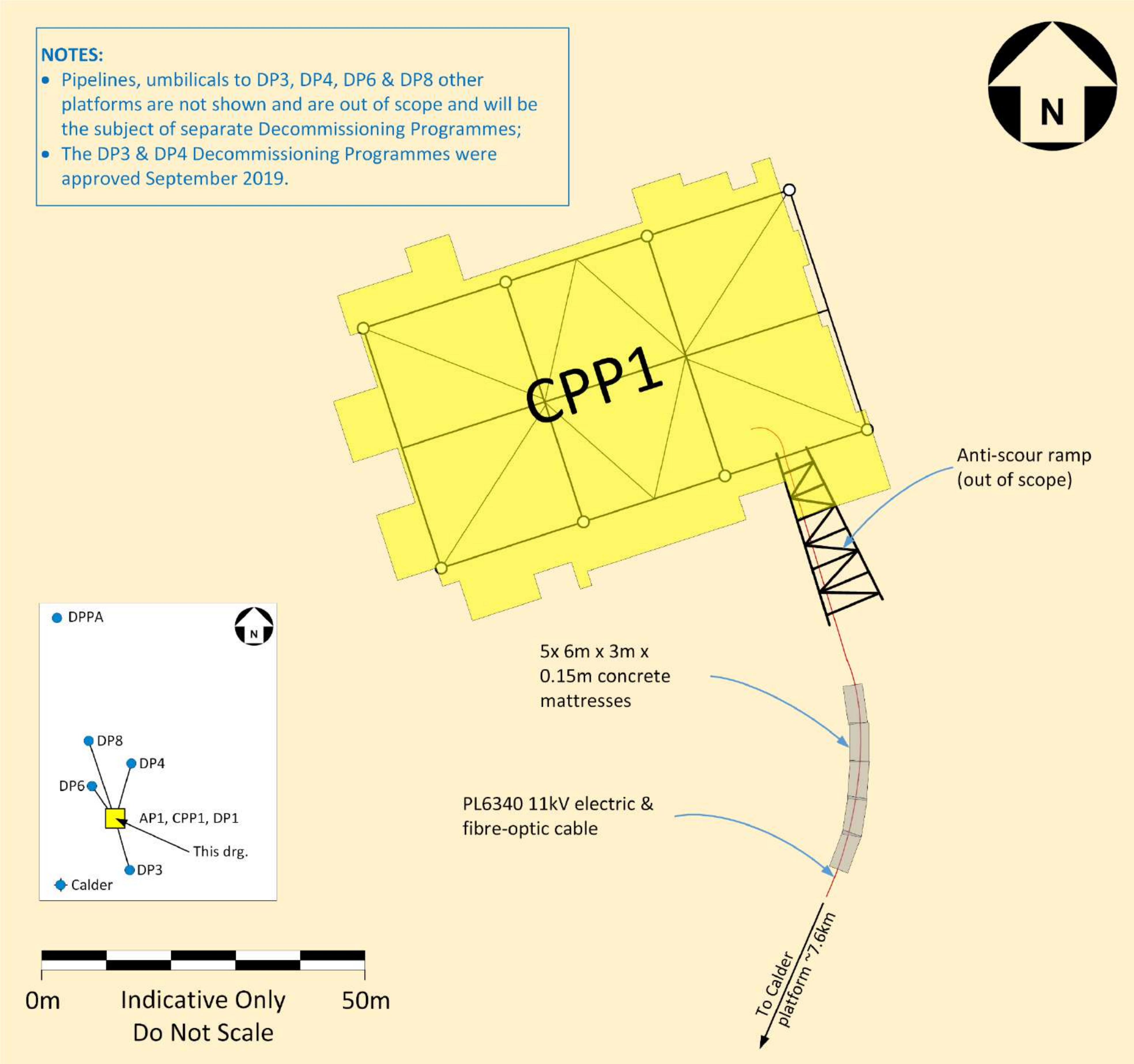
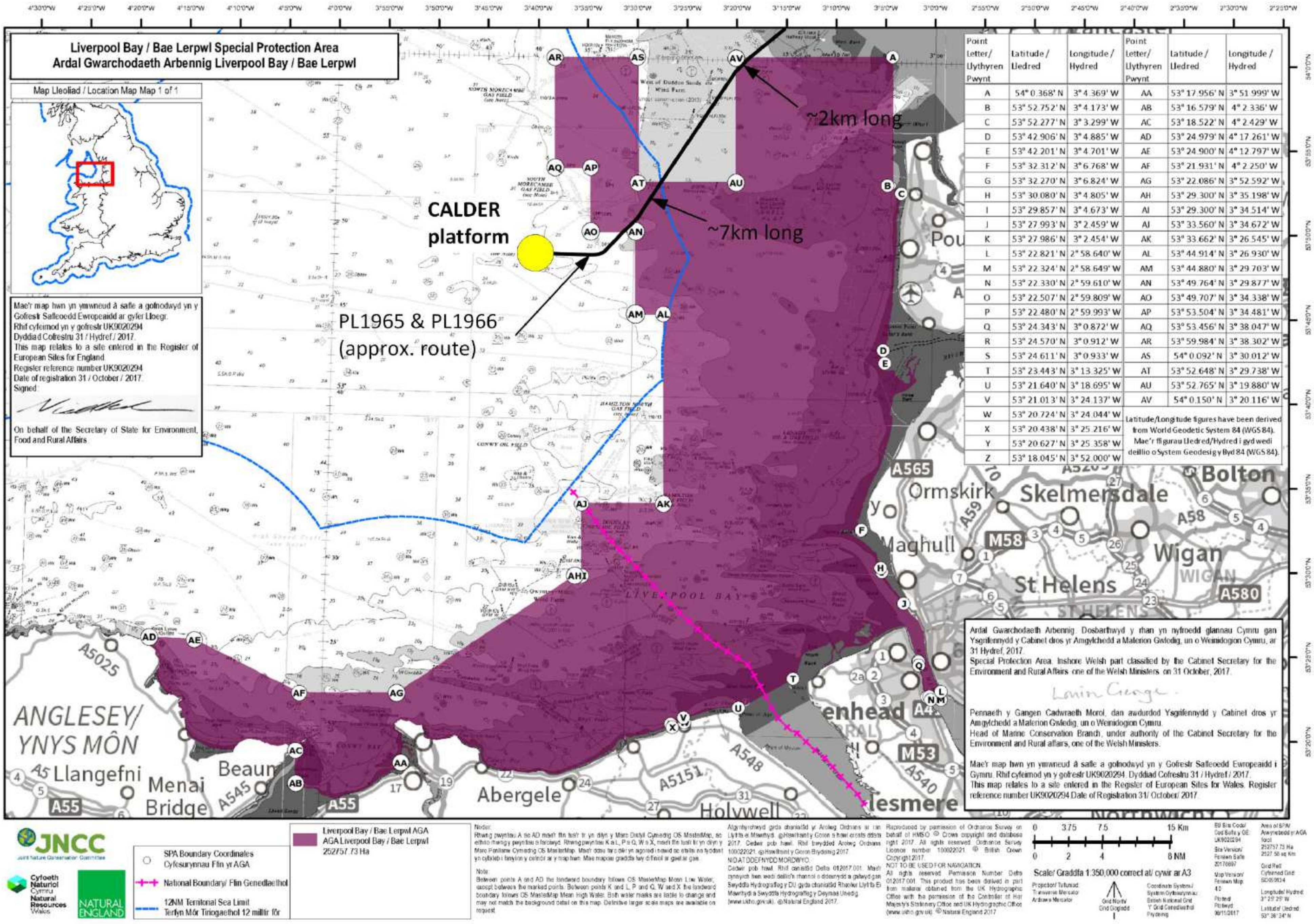


Figure B.7.1: South Morecambe CPP1 approach schematic (PL6340)

Appendix C Special Protected Areas (SPA)

Appendix C.1 Liverpool Bay / Bae Lerpwl SPA



Point Letter/ Llythyren Pwynt	Latitude / Lledred	Longitude / Hydred	Point Letter/ Llythyren Pwynt	Latitude / Lledred	Longitude / Hydred
A	54° 0.368' N	3° 4.369' W	AA	53° 17.956' N	3° 51.999' W
B	53° 52.752' N	3° 4.173' W	AB	53° 16.579' N	4° 2.336' W
C	53° 52.277' N	3° 3.299' W	AC	53° 18.522' N	4° 2.429' W
D	53° 42.906' N	3° 4.885' W	AD	53° 24.979' N	4° 17.261' W
E	53° 42.201' N	3° 4.701' W	AE	53° 24.900' N	4° 12.797' W
F	53° 32.312' N	3° 6.768' W	AF	53° 21.931' N	4° 2.250' W
G	53° 32.270' N	3° 6.824' W	AG	53° 22.086' N	3° 52.592' W
H	53° 30.080' N	3° 4.805' W	AH	53° 29.300' N	3° 35.198' W
I	53° 29.857' N	3° 4.673' W	AI	53° 29.300' N	3° 34.514' W
J	53° 27.993' N	3° 2.459' W	AJ	53° 33.560' N	3° 34.672' W
K	53° 27.986' N	3° 2.454' W	AK	53° 33.662' N	3° 26.545' W
L	53° 22.821' N	2° 58.640' W	AL	53° 44.914' N	3° 26.930' W
M	53° 22.324' N	2° 58.649' W	AM	53° 44.880' N	3° 29.703' W
N	53° 22.330' N	2° 59.610' W	AN	53° 49.764' N	3° 29.877' W
O	53° 22.507' N	2° 59.809' W	AO	53° 49.707' N	3° 34.338' W
P	53° 22.480' N	2° 59.993' W	AP	53° 53.504' N	3° 34.481' W
Q	53° 24.343' N	3° 0.872' W	AQ	53° 53.456' N	3° 38.047' W
R	53° 24.570' N	3° 0.912' W	AR	53° 59.984' N	3° 38.302' W
S	53° 24.611' N	3° 0.933' W	AS	54° 0.092' N	3° 30.012' W
T	53° 23.443' N	3° 13.325' W	AT	53° 52.648' N	3° 29.738' W
U	53° 21.640' N	3° 18.695' W	AU	53° 52.765' N	3° 19.880' W
V	53° 21.013' N	3° 24.137' W	AV	54° 0.150' N	3° 20.116' W
W	53° 20.724' N	3° 24.044' W			
X	53° 20.438' N	3° 25.216' W			
Y	53° 20.627' N	3° 25.358' W			
Z	53° 18.045' N	3° 52.000' W			

Figure C.1.1: Liverpool Bay / Bae Lerpwl SPA c/w PL1965 & PL1966 routing[14]

[14] Original SPA Map courtesy of JNCC. Weblink last accessed 25 Oct 2021: liverpool-bay-bae-lerpwl-adjacent-spas-map.pdf

Appendix C.2 Morecambe Bay & Duddon Estuary SPA

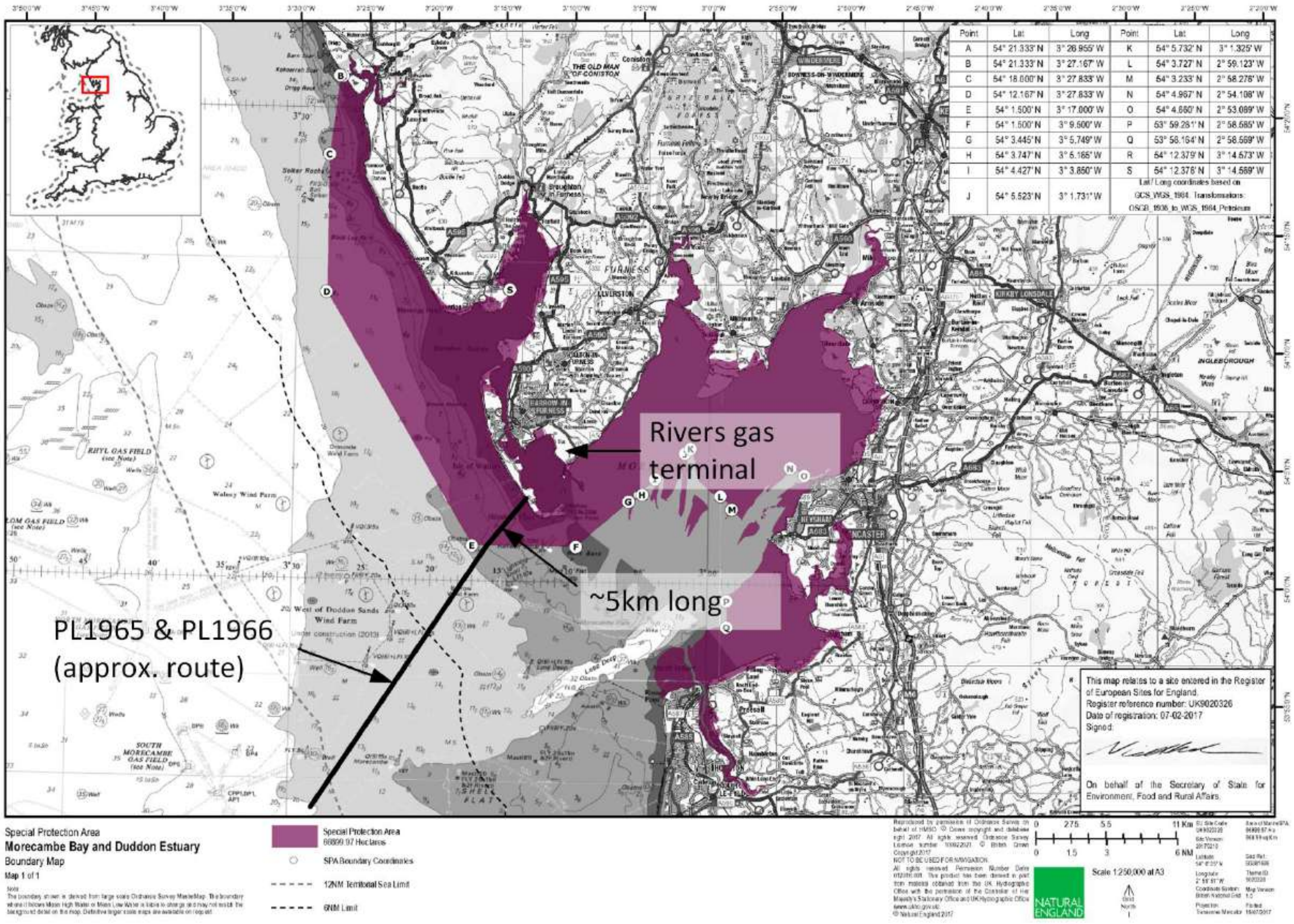


Figure C.2.1: Morecambe Bay & Duddon Estuary SPA c/w PL1965 & PL1966 routing[15]

[15] Original SPA Map courtesy of Natural England. Weblink last accessed 25 Oct 2021: morecambe-duddon-final-map.pdf

Appendix D Calder pipeline CA tables

Appendix D.1 Technical assessment

Criteria	Aspect	Sub-criteria	Complete removal	Partial removal	Leave *in situ*
Technical	**Offshore Execution**	Risk of project failure.	Technically, complete removal of the pipelines would most likely be achievable, but complications could arise because the pipelines, umbilicals and electrical cables are buried within the seabed. There is relatively little experience in UKCS with reverse reeling slightly larger pipelines, but it would most probably be achievable. The 'cut and lift' would be technically achievable for any of the pipelines with little risk of project failure. Total length of buried pipelines ~93,05km.	Buried pipe has been uncovered and the 'cut and lift' method can and has been used for removing relatively short sections of piggybacked pipe so this would be achievable. The lengths of pipelines removed would be less than 5% of the length that would otherwise be removed as part of the complete removal option. Total length of exposures <1.5km (conservative).	Technically, the pipelines, umbilicals and cables could be left *in situ*.
		Technological challenge.	Technology is currently available to excavate, cut and lift, or reverse reel the electrical cable.	Technology is currently available to excavate, cut and recover the pipelines.	n/a
		Technical challenge.	Excavation of pipelines buried in the seabed could prove problematic but achievable. 'Cut and lift' method could be used for the main trunklines and piggybacked pipelines, but the reverse reel method could also be used for recovery of the smaller electrical cable with the 'cut and lift' method available as fall a back method of recovery.	Excavation of partly exposed pipelines in the seabed would likely prove less problematic than for the complete removal option. 'Cut and lift' method can be used for recovery of pipelines to shore.	Stable and buried pipelines have been left *in situ* before so this approach would be achievable.
Technical	**Legacy**	Risk of project failure.	No pipeline surveys would be required in future.	Pipeline surveys have been undertaken in the past although sometimes there can be issues with detectability of umbilicals and cables, as it depends on the amount of steel armour. However, with the right equipment umbilicals and cables can usually be surveyed for depth of burial unless they are buried too deeply.	
		Technological challenge.	As above.	The technology is currently available for carrying out pipeline surveys.	
		Technical challenge.	As above.	In this instance there should be no technical issues associated with carrying out pipeline surveys in future.	

NOTES:
1. The partial removal option is only applicable to the Calder pipelines PL1965 & PL1966.

Table D.1.1: Pipelines - technical assessment

Appendix D.2 Safety assessment

Criteria	Aspect	Sub-criteria	Complete removal	Partial removal	Leave *in situ*
Safety	**Offshore Execution**	Health & safety risk offshore project personnel.	More offshore work than leave *in situ*. Excavation of the pipelines and recovery, either using 'cut and lift' or reverse reel for electrical cable. The work associated with 'cut and lift' would be repetitive (typically ~80 to ~100 lengths of pipe per km) but manageable from an HSE perspective. With appropriate engineering and pipeline integrity checks and planning reverse reel method would also be manageable from an HSE perspective. Most of the work could be done using equipment operated remotely and achieved without using divers. Material handling on vessel decks could be automated given the right resources and focus.	Less work than complete removal but more work than leave in situ. The 'cut and lift' method of removal would be repetitive but on a much smaller scale (perhaps <10% of the full length of the pipelines) than would be required for full removal.	At most only the pipeline ends would be dealt with; less offshore work than for complete removal. Significantly less work and therefore a shorter duration of activities than for complete removal.
		Health & safety risk to mariners.	The risk to mariners in the short term would be aligned with the duration the activities would be undertaken in the field. Duration of vessels in the field would be longer than for leave *in situ*. Using the reverse reel method would mean that the vessel would be attached to a pipeline and could not move out of the way quickly. Using the 'cut and lift' method would also restrict the ability of a vessel to move out of the way, but for a relatively short time.	The risk to mariners in the short term would be aligned with the duration the activities would be undertaken in the field. Duration of vessels in the field would be longer than for leave *in situ*. Using the 'cut and lift' method would restrict the ability of a vessel to move out of the way, but for a relatively short time. The work would be carried out less than ~12km from the coast rather than out at sea.	At most only the pipeline ends would be dealt with; duration of vessels in the field would be significantly shorter than for complete removal.
		Safety risk onshore project personnel.	Significantly more off-loading, off-reeling, onshore cutting, lifting, and material handling associated with disposal of the pipelines; presents an increased safety risk to personnel. However, the work would all be manageable from an HSE perspective.	Significantly less off-loading, onshore cutting, lifting, and material handling associated with disposal of the pipelines than for the complete removal option and so would present less of a safety risk to personnel than for complete removal but more of a safety risk than for leave *in situ*. The work would all be manageable from an HSE perspective.	No onshore work except for that possibly associated with the pipeline ends, which would be required for any of the decommissioning options.
Safety	**Legacy**	Health & safety risk offshore project personnel.	No pipeline surveys or remediation related activities would be required.	Pipeline surveys would be required, but this activity is considered routine with well managed risks.	Pipeline surveys may be required, but this activity is considered routine with well managed risks.
		Health & safety risk to mariners.	No infrastructure left *in situ* therefore no residual snag hazards. Lower risk as potential snag hazards completely removed.	Once the exposures had been dealt with the remaining pipelines have a good depth of burial. Depending on the success of decommissioning activities additional exposures could occur in future, leading to new snagging hazards. However, the level of commercial fishing activity in the area is very low.	With the exception of a relatively short length of the Calder pipelines within 12km of the shoreline, all the buried sections of the pipelines have a good depth of burial. With the exception of the Calder pipelines there would be no increase in snagging risk as a result of their being left *in situ*.
		Safety risk onshore project personnel.	n/a	PL1965 & PL1966 only. Materials may be required for future remedial works. If exposures had been remediated as part of decommissioning it might be considered less likely that they would occur in future.	Exposures unlikely to occur for the pipelines that exhibit good depth of burial. PL1965 & PL1966 only. Future remedial works may be required for pipelines within 12km of the shoreline.

NOTES:
1. The partial removal option is only applicable to the Calder pipelines PL1965 & PL1966.

Table D.2.1: Pipelines – safety assessment

Appendix D.3 Environmental assessment

Criteria	Aspect	Sub-criteria	Complete removal	Partial removal	Leave *in situ*
Environmental	**Offshore Execution**	Energy & emissions.	Energy use and resulting emissions for this option would be higher than for leave *in situ*, but no energy and emissions would be needed to create new steel.	Energy use and resulting emissions for this option slightly more than needed for leave *in situ*, but no energy and emissions would be needed to create new steel. Significantly less energy use than needed for complete removal.	Least amount of energy used, and least emissions generated in the short term, although any gains would be offset by the energy and emissions required to create new steel to replace that which would be left *in situ*.
		Seabed disturbance, area affected.	The amount of seabed disturbed would be directly related to the length of pipeline being removed. The area affected (0.505km^2) would be largest for this option.	The amount of seabed disturbed would be directly related to the length of pipeline being removed. The area affected by the removal of up to (say) 1.4km of pipeline (0.14km^2) would be much than affected by the complete removal of the whole of the Calder pipelines (0.505km^2).	The least area of seabed would be disturbed for the leave *in situ* decommissioning option.
		Direct disturbance to Protected Area (Liverpool Bay / Bae Lerpwl SPA, 669km^2) and (Morecambe Bay and Duddon Estuary SPA, 2,528 km^2). Combined area 3,197 km^2.	Only PL1965 & PL1966 pass through the SPA. ~9km of the pipelines pass through the Liverpool Bay / Bae Lerpwl SPA and ~5km of the pipelines pass through the Morecambe Bay & Duddon Estuary SPA. The total area directly affected (~0.14 km^2 or 0.0004%) would be negligible.	Only the last 5km or so of the Calder pipelines pass through the Morecambe Bay & Duddon Estuary SPA with potentially up to (for example) ~1.4km of exposures requiring remediation. The area of SPA affected (0.014km^2) as a percentage of the Morecambe Bay & Duddon SPA (~0.0021%) would be negligible. Deposition of rock up to (for example) 1.4km in length would be contrary to the conservation objectives of the SPA but the area affected would be similarly negligible.	This option would result in the least disruption to the SPAs although the materials being left behind would be alien to the local fauna.
		Effect on Water Column: • Liquid discharges to sea; • Noise.	Discharges and releases to the water column are related to the duration of activities being undertaken and would therefore be greatest for the complete removal option.	Discharges and releases to the water column are related to the duration of activities being undertaken and would be less than 5% (for example) 1.4km c.f. 42.4km) associated with the complete removal of the Calder trunklines.	Discharges and releases would be least for the leave *in situ* option, at least in the short-term.
		Waste creation and use of resources such as landfill. Recycling and replacement of materials.	This option would result in the largest mass of material being returned to shore. No material would be lost as no material would be left *in situ*.	This option would result in some of the Calder pipelines being returned to shore. Most material associated with the Calder pipelines would be lost as material would be left *in situ*.	No material would be returned to shore for recycling and so the material would be lost, and new material would be needed to replace the loss.
Environmental	**Legacy**	Energy & emissions.	No pipeline status or burial surveys required.	It can be expected that future surveys would be required. Remediation of future exposures in the Calder pipelines may be required.	It can be expected that future surveys would be required. Remediation of exposures in the Calder pipelines may be required.
		Seabed disturbance, area affected.	As above.	n/a	No remedial activities would be required for buried pipelines.
				PL1965 & PL1966 only. Theoretically if the exposures in the Calder pipelines had been dealt with as part of the decommissioning works, no further remediation would be required. However, further remedial activities are a possible requirement.	PL1965 & PL1966 only. A likely requirement for remediation of exposures the Calder pipelines if they are not dealt with as part of planned decommissioning works.
		Disturbance to protected areas (SPAs).	As above.	The area of SPA affected by remedial work of exposures in the Calder pipelines as a percentage of the Morecambe Bay & Duddon SPA would be negligible.	Remedial work will likely required for the Calder pipelines as they approach the shoreline. The area of SPA affected (<0.015km^2) as a percentage of the Morecambe Bay & Duddon SPA (~0.0006%) would be negligible.

Criteria	Aspect	Sub-criteria	Complete removal	Partial removal	Leave *in situ*
		Effect on water column: • Liquid discharges to sea; • Noise.	As above.	Discharges and releases to the water column are related to the duration of activities being undertaken. Further remedial activities are a possible requirement.	Discharges and releases to the water column are related to the duration of activities being undertaken. Further remedial activities are a probable requirement.
		Waste creation and use of resources such as landfill. Recycling and replacement of materials.	No activity required.	Some additional exposures in the Calder pipelines may result in material being brought to shore, but otherwise little to differentiate options from a waste perspective.	
NOTES: 1. The partial removal option is only applicable to the Calder pipelines PL1965 & PL1966.					

Table D.3.1: Pipelines – environmental assessment

Appendix D.4 Societal assessment

Criteria	Aspect	Sub-criteria	Complete removal	Partial removal	Leave *in situ*
Societal	**Offshore Execution**	Effect on commercial activities.	The impact of decommissioning vessel traffic on local commercial activities such as fishing would be greatest for complete removal.	The impact of decommissioning vessel traffic on local commercial activities such as fishing would be less than for complete removal but slightly more than for the leave *in situ* option.	Impact of decommissioning vessel traffic on local commercial activities such as fishing would be least for leave *in situ*.
		Employment.	Decommissioning activities associated with complete removal would contribute greatest to continuity of employment.	Little to differentiate the partial removal and leave *in situ* options.	Decommissioning activities associated with leave *in situ* would contribute the least to continuity of employment.
		Communities or impact on amenities.	Decommissioning activities associated with complete removal would contribute the most to continuity of work in ports and disposal sites.	Decommissioning activities would contribute to continuity of work in ports and disposal sites much less than for complete removal but more than for leave *in situ* option.	Decommissioning activities associated with leave *in situ* would contribute the least to continuity of work in ports and disposal sites.
Societal	**Legacy**	Effect on commercial activities.	No impact as no legacy related activities would be required.	Impact of survey vessel traffic on local commercial activities such as fishing would be less than for the complete removal option but about the same as for the leave *in situ* option.	Impact of survey vessel traffic on local commercial activities such as fishing would be more than for complete removal but where applicable about the same as for the partial removal option.
		Employment.	No future opportunities for continuation of employment.	The possibility of remedial work could be slightly higher for the partial removal option due to the number of cut pipeline ends that could become exposed in future. However, this would not be a reason for pursuing this option.	Should the pipeline(s) be left *in situ* the opportunity for continuation of employment would be associated with survey work and any remedial works, but it is expected that any future remedial works would be limited to dealing with potential exposures in only the Calder pipelines, but this would not be a reason for pursuing this option.
		Communities or impact on amenities.	No opportunities for continuity of work in ports and disposal sites.	As above.	There would be few opportunities for continuity of work in ports and disposal sites other than associated with survey related and possible remedial work.

NOTES:
2. The partial removal option is only applicable to the Calder pipelines PL1965 & PL1966.

Table D.4.1: Pipelines – societal assessment

Appendix D.5 Cost assessment

Criteria	Aspect	Complete removal	Partial removal	Leave *in situ*
Cost	**Offshore Execution**	Using the assumption that PL1965 & piggybacked PL1966 would be removed using the 'cut and lift' method the costs would be an order of magnitude greater than for partial removal and leave *in situ*.	Using the assumption 'cut and lift' method would be used, partial removal would cost less than an order of magnitude greater than leave *in situ*. By inspection it would be cheaper to deposit rock rather than to partially remove PL1965 & Pl1966 but more expensive than leave *in situ*.	The cost of leave *in situ* would be the least expensive of the three decommissioning options.
		If the Calder electrical cable would be removed using the reverse reel method the costs would cost less than an order of magnitude more than for leave *in situ*.	n/a	The cost of leave *in situ* would be the least expensive of the options.
	Legacy	Should the pipeline(s) have been completely removed no pipeline burial surveys would be required in future.	Future burial surveys will be required. The premise is that if three successive surveys demonstrate that the pipeline remains stable no more surveys would be required. This will be the same for both the partial removal and leave *in situ* decommissioning options.	

NOTES:
1. For details please refer to Appendix F.3
2. The leave *in situ* options assume that the surface laid ends have been removed to burial depth inside the trench. This means that any difference in cost would be increased should the ends be decommissioned *in situ*
3. The assessment assumes 1x post decommissioning survey would be required irrespective of the decommissioning options, and 3x legacy surveys would be required for any pipelines being left *in situ*.

Table D.5.1: Pipeline – cost assessment

Appendix E Dalton & Millom pipeline CA tables

Appendix E.1 Technical assessment

Criteria	Aspect	Sub-criteria	Complete removal	Leave *in situ*
Technical	**Offshore Execution**	Risk of project failure.	Technically, complete removal of the pipelines would most likely be achievable, but complications could arise because the pipelines, umbilicals and electrical cables are buried within the seabed. There is relatively little experience in UKCS with reverse reeling slightly larger pipelines, but it would most probably be achievable. The 'cut and lift' would be technically achievable for any of the pipelines with little risk of project failure. Total length of buried pipelines ~106km.	Technically, the pipelines, umbilicals and cables could be left *in situ.*
		Technological challenge.	Technology is currently available to excavate, cut and lift, or reverse reel the pipelines to shore.	n/a
		Technical challenge.	Excavation of pipelines buried in the seabed could prove problematic but achievable. 'Cut and lift' method could be used for the main trunklines and piggybacked pipelines, but the reverse reel method could also be used for recovery of the smaller pipelines, umbilicals and electrical cables and 'cut and lift' method available as fall a back method of recovery.	Stable and buried pipelines have been left *in situ* before so this approach would be achievable.
Technical	**Legacy**	Risk of project failure.	No pipeline surveys would be required in future.	Pipeline surveys have been undertaken in the past although sometimes there can be issues with detectability of umbilicals and cables, as it depends on the amount of steel armour. However, with the right equipment umbilicals and cables can usually be surveyed for depth of burial unless they are buried too deeply.
		Technological challenge.	As above.	The technology is currently available for carrying out pipeline surveys.
		Technical challenge.	As above.	In this instance there should be no technical issues associated with carrying out pipeline surveys in future.

Table E.1.1: Pipelines - technical assessment

Appendix E.2 Safety assessment

Criteria	Aspect	Sub-criteria	Complete removal	Leave *in situ*
Safety	**Offshore Execution**	Health & safety risk offshore project personnel.	More offshore work than leave *in situ*. Excavation of the pipelines and recovery, either using 'cut and lift' or reverse reel for smaller pipelines. The work associated with 'cut and lift' would be repetitive (typically ~80 to ~100 lengths of pipe per km) but manageable from an HSE perspective. With appropriate engineering and pipeline integrity checks and planning reverse reel method would also be manageable from an HSE perspective. Most of the work could be done using equipment operated remotely and achieved without using divers. Material handling on vessel decks could be automated given the right resources and focus.	At most only the pipeline ends would be dealt with; less offshore work than for complete removal. Significantly less work and therefore a shorter duration of activities than for complete removal.
		Health & safety risk to mariners.	The risk to mariners in the short term would be aligned with the duration the activities would be undertaken in the field. Duration of vessels in the field would be longer than for leave *in situ.* Using the reverse reel method would mean that the vessel would be attached to a pipeline and could not move out of the way quickly. Using the 'cut and lift' method would also restrict the ability of a vessel to move out of the way, but for a relatively short time.	At most only the pipeline ends would be dealt with; duration of vessels in the field would be significantly shorter than for complete removal.
		Safety risk onshore project personnel.	Significantly more off-loading, off-reeling, onshore cutting, lifting, and material handling associated with disposal of the pipelines; presents an increased safety risk to personnel. However, the work would all be manageable from an HSE perspective.	No onshore work except for that possibly associated with the pipeline ends, which would be required for any of the decommissioning options.
Safety	**Legacy**	Health & safety risk offshore project personnel.	No pipeline surveys or remediation related activities would be required.	Pipeline surveys may be required, but this activity is considered routine with well managed risks.
		Health & safety risk to mariners.	No infrastructure left *in situ* therefore no residual snag hazards. Lower risk as potential snag hazards completely removed.	With the exception of a relatively short length of the Calder pipelines within 12km of the shoreline, all the buried sections of the pipelines have a good depth of burial. With the exception of the Calder pipelines there would be no increase in snagging risk as a result of their being left *in situ*.
		Safety risk onshore project personnel.	n/a	Exposures unlikely to occur for the pipelines that exhibit good depth of burial. PL1965 & PL1966 only. Future remedial works may be required for pipelines within 12km of the shoreline.

Table E.2.1: Pipelines – safety assessment

Appendix E.3 Environmental assessment

Criteria	Aspect	Sub-criteria	Complete removal	Leave *in situ*
Environmental	**Offshore Execution**	Energy & emissions.	Energy use and resulting emissions for this option would be higher than for leave *in situ*, but no energy and emissions would be needed to create new steel.	Least amount of energy used, and least emissions generated in the short term, although any gains would be offset by the energy and emissions required to create new steel to replace that which would be left *in situ*.
		Seabed disturbance, area affected.	The amount of seabed disturbed would be directly related to the length of pipeline being removed. The area affected (1.05km^2) would be largest for this option.	The least area of seabed would be disturbed for the leave *in situ* decommissioning option.
		Direct disturbance to Special Protected Area	n/a	n/a
		Effect on Water Column: • Liquid discharges to sea • Noise.	Discharges and releases to the water column are related to the duration of activities being undertaken and would therefore be greatest for the complete removal option.	Discharges and releases would be least for the leave *in situ* option, at least in the short-term.
		Waste creation and use of resources such as landfill. Recycling and replacement of materials.	This option would result in the largest mass of material being returned to shore. No material would be lost as no material would be left *in situ*.	No material would be returned to shore for recycling and so the material would be lost, and new material would be needed to replace the loss.
Environmental	**Legacy**	Energy & emissions.	No pipeline status or burial surveys required.	It can be expected that future surveys would be required. Remediation of exposures in the Calder pipelines may be required.
		Seabed disturbance, area affected.	As above.	No remedial activities would be required for buried pipelines. PL1965 & PL1966 only. A likely requirement for remediation of exposures the Calder pipelines if they are not dealt with as part of planned decommissioning works.
		Direct disturbance to protected areas (SPAs).	n/a	n/a
		Effect on water column: • Liquid discharges to sea; • Noise.	As above.	Discharges and releases to the water column are related to the duration of activities being undertaken. Further remedial activities are a probable requirement.
		Waste creation and use of resources such as landfill. Recycling and replacement of materials.	n/a	n/a

Table E.3.1: Pipelines – environmental assessment

Appendix E.4 Societal assessment

Criteria	Aspect	Sub-criteria	Complete removal	Leave *in situ*
Societal	**Offshore Execution**	Effect on commercial activities.	The impact of decommissioning vessel traffic on local commercial activities such as fishing would be greatest for complete removal.	Impact of decommissioning vessel traffic on local commercial activities such as fishing would be least for leave *in situ*.
		Employment.	Decommissioning activities associated with complete removal would contribute greatest to continuity of employment.	Decommissioning activities associated with leave *in situ* would contribute the least to continuity of employment.
		Communities or impact on amenities.	Decommissioning activities associated with complete removal would contribute the most to continuity of work in ports and disposal sites.	Decommissioning activities associated with leave *in situ* would contribute the least to continuity of work in ports and disposal sites.
Societal	**Legacy**	Effect on commercial activities.	No impact as no legacy related activities would be required.	Impact of survey vessel traffic on local commercial activities such as fishing would be more than for complete removal but where applicable about the same as for the partial removal option.
		Employment.	No future opportunities for continuation of employment.	Should the pipeline(s) be left *in situ* the opportunity for continuation of employment would be associated with survey work and any remedial works, but none can be expected.
		Communities or impact on amenities.	No opportunities for continuity of work in ports and disposal sites.	There would be few opportunities for continuity of work in ports and disposal sites other than associated with survey related and possible remedial work.

Table E.4.1: Pipelines – societal assessment

Appendix E.5 Cost assessment

Criteria	Aspect	Complete removal	Leave *in situ*
Cost	**Offshore Execution**	Using the assumption that PL1965 & piggybacked PL1966 would be removed using the 'cut and lift' method the costs would be an order of magnitude greater than for partial removal and leave *in situ*.	The cost of leave *in situ* would be the least expensive of the three decommissioning options.
		Using the assumption that the individual 8in (PL1669) & 12in (PL1668 & PL1674) pipelines would be removed using the reverse reel method the costs would be less than an order of magnitude more than for leave *in situ*.	The cost of leave *in situ* would be the least expensive of the decommissioning options.
		Using the assumption that the longer umbilicals PL1671 and PL1678 would be removed using the reverse reel method the costs would be greater than for leave *in situ* but less than an order of magnitude greater.	
		Using the assumption that the shorter umbilical PL1672 would be removed using the reverse reel method the costs would be about 2x the cost of removing just the ends and leaving *in situ*.	
		Using the assumption that the longer Calder & Millom West electrical cables would be removed using the reverse reel method the costs would cost an order of magnitude more than for leave *in situ*.	
	Legacy	Should the pipeline(s) have been completely removed no pipeline burial surveys would be required in future.	Future burial surveys will be required. The premise is that if three successive surveys demonstrate that the pipeline remains stable no more surveys would be required.

NOTES:

4. For details please refer to Appendix F.3;
5. It is assumed that as PL1670, PL1673 (Dalton), PL1677, PLU1678JQ3, PL1679, PL1873 and PLU1874 (Millom) are all surface laid and <300m long, they will be fully removed, so they are not included in this cost assessment
6. The leave *in situ* options assume that the surface laid ends have been removed to burial depth inside the trench. This means that any difference in cost would be increased should the ends be decommissioned *in situ*
7. The assessment assumes 1x post decommissioning survey would be required irrespective of the decommissioning options, and 3x legacy surveys would be required for any pipelines being left *in situ*.

Table E.5.1: Pipeline – cost assessment

Appendix F Pipeline cost assessment

Appendix F.1 Overview

The following section details the qualitative comparative assessment made to distinguish the decommissioning options. Note that the figures quoted do not account for the overall costs of decommissioning the pipelines – they only account for the difference in cost once activities common to both options have been discounted.

The costs have been normalised relative to the cheapest option and categorised as indicated in Table F.1.1.

High / Intolerable & not acceptable	Medium / Tolerable non-preferred	Low/Broadly acceptable & most preferred	Low/Broadly acceptable but least preferred
More than 10x (order of magnitude) the cheapest cost	More than 2x the cheapest cost	Cheapest cost	Less than 2x more than cheapest cost

Table F.1.1: Categories of impact – cost assessment

Appendix F.2 Assumptions

The following key assumptions have been used in the cost by difference assessment:

- Operator and contractor management and engineering costs are excluded on the basis that this cost would be incurred whichever decommissioning option would be pursued.
- Any pipelines being removed would need to be excavated but would be left to naturally backfill.
- Piggybacked pipelines would be removed using the 'cut and lift' method; vessel deck capacity assumed to be 750Te before a port call is required.
- Pipelines less than 16in, umbilicals and electrical cables or parts thereof, would be removed using the reverse reel method assuming that they integrity could be assured. Reel capacity of the recovery vessel is assumed to be 2.5km, maximum 2x reels.
- All activities could be achieved using remotely operated equipment guided by ROVs, no diving related activities would be required.
- All pipeline and recovery operations could be achieved using a subsea support vessel or similar, supported by the necessary equipment spreads such as ROVs, excavation tools, hydraulic shears, mattress recovery equipment, etc. The services of a pipelay vessel would not be required.
- Mobilisation and demobilisation cost of construction vessels are excluded for two reasons: The first is because mobilisation and demobilisation costs would be incurred for the overall decommissioning activity, not just for one pipeline, and the other is that for the purposes of this assessment it has been assumed that the same type of vessel – an anchor handling vessel, furnished with reels, ROV equipment, excavation equipment and hydraulic cutting spread would be used.
- Port calls have been accounted for on the basis that a vessel needs to transit to port to offload materials recovered from the seabed.
- NPT on marine operations is taken as 15%.
- No allowance has been made for the deposition of small quantities of rock on cut pipeline ends; it may not be required, and these costs are unlikely to be significant.
- No account has been made for efficiency. For example, to an extent it might be possible to reduce the number of port calls by using a cargo barge in the field. However, any advantages of this approach would need be offset

by the need for appropriate weather conditions and transit tugs.

- For surveys it has been assumed that 1x post decommissioning pipeline survey would be required for each pipeline, and 3x legacy pipeline surveys for those instances where a pipeline or part thereof would be left *in situ* following completion of decommissioning activities. The legacy survey requirement would be based on risk assessments following post-decommissioning surveys and would typically be documented in the close out report.
- The costs associated with mobilisation and demobilisation of survey vessels is excluded since it is not a differentiator, and because mobilisation and demobilisation costs would be incurred for the overall survey activity, not just for one pipeline.
- The costs associated with piggybacked pipeline have been combined on the basis that both of the piggybacked pipelines would be dealt with at the same time.
- Leave *in situ* costs relate to the cost of recovering the surface laid pipeline ends and mattresses on approach to the installations, and PLEMs and includes the cost of 1x post decommissioning survey and 3x legacy pipeline surveys.
- Partial removal concerns removal of the surface laid pipeline ends at Calder as well as an exposed length of pipeline and includes the cost of 1x survey following decommissioning and 3x legacy surveys.
- Complete removal costs relate to complete recovery of the pipelines to shore as well as the mattresses and includes the cost of 1x survey following completion of decommissioning.

Appendix F.3 Cost by difference table

Pipeline ID	Pipeline Type(s)	End Removal Length	Partial Removal Length	Complete Removal Length	Mattresses	Leave *In Situ* (MM)	Partial Removal (Incl. Ends) (MM)	Complete Removal (MM)	Leave *In Situ*	Partial removal	Complete removal
PL1965 & PL1966	24"CWC & 3"	212m	1,441m	42,660m	51	£1.260	£2.348	£45.542	0.1	0.3	5.0
PL6340	62mm	241m	n/a	7,597m	5	£0.061	n/a	£0.493	0.6	n/a	5.0
PL1668	12"	180m	n/a	7,268m	41	£0.262	n/a	£1.396	0.9	n/a	5.0
PL1669	8"	166m	n/a	979m	22	£0.175	n/a	£0.637	1.4	n/a	5.0
PL1671	113mm	63m	n/a	7,170m	24	£0.145	n/a	£0.591	1.2	n/a	5.0
PL1672	101mm	188m	n/a	1,007m	10	£0.075	n/a	£0.143	2.6	n/a	5.0
PL1674	12"	102m	n/a	8,825m	40	£0.243	n/a	£1.632	0.7	n/a	5.0
PL1675 & PL1676	12" & 2.5"	203m	n/a	6,260m	32	£0.183	n/a	£1.186	0.8	n/a	5.0
PL1678	113mm	63m	n/a	8,800m	42	£0.234	n/a	£0.785	1.5	n/a	5.0
PL6352	58mm	200m	n/a	15,327m	13	£0.109	n/a	£1.358	0.4	n/a	5.0

NOTES:

1. The number of mattresses for PL1965 & PL1966 excludes those used at the pipeline crossing over the IOM Interconnector (Figure 3.4.12).
2. The leave *in situ* options assume that the surface laid ends have been removed to burial depth, and that the protection and stabilisation features have also been removed; there may be slight differences between the end removal lengths quoted here and the final lengths proposed in the pipeline Decommissioning Programme.
3. The assessment assumes 1x post decommissioning survey would be required irrespective of the decommissioning options, and 3x legacy surveys would be required for any pipelines being left *in situ*.
4. Full removal: piggybacked – 'cut & lift', individual pipelines, flowlines, umbilicals and cables – 'reverse reel', surface laid end sections - 'cut & lift' or reverse reel if possible.

Table F.3.1: Pipeline cost by difference assessment