SAIPEM LTD						COMPANY ACCEPTANCE OF FINAL VERSION
Revision	**Date**	**Reason for issue**	**Prepared by**	**Checked by**	**Accepted by**	
1	2022.09.08	Issued for Information	Christopher TAIT Chris Tait Digitally signed by Chris Tait DN: cn=Chris Tait, o, ou, email=christopher.tait@saipem.com, c=GB Date: 2022.09.08 11:47:23 +01'00'	Ian McARTHUR Ian McArthur Digitally signed by Ian McArthur DN: cn=Ian McArthur, o=Saipem Ltd, ou=OHSE, email=ian.mcarthur@saipem.com, c=GB Date: 2022.09.08 12:09:48 +01'00'	Hugh THOMAS Digitally signed by Hugh Thomas DN: cn=Hugh Thomas, o=Saipem, ou=Saipem Ltd, email=hugh.thomas@saipem.com, c=GB Date: 2022.09.08 12:07:48 +01'00'	*(stamp, signature)*

Document Title:

ENVIRONMENTAL REPORTING: PHYSICAL LOSSES AND PHYSICAL DISTURBANCES OF THE SEABED – DENMARK

Responsible Party
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Page No.
40

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Company acceptance code	
☐	**1 – Accepted without comments**
☐	**2 –Accepted with comments to be incorporated**
☐	**3 – Not accepted, revise and resubmit**
☐	**4 – Issued for information**

TAG No.	**Language**	**External Document Number**
N/A	English	N/A

Registration codes		**Document Number**						
Contract No.	***Work package***	***Project No.***	***Contractor***	***Area No.***	***Discipline Code***	***Document Type Code***	***Sequence***	***Language***
1000035546	PER	**PL1**	**SAI**	**12**	**Z02**	**RA**	**00003**	**EN**
Area No.	***Area Description***	PL1-SAI-12-Z02-RA-00003-EN						
12	OFFSHORE DK							

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1. GENERAL INFORMATION

1.1. REVISION LOG TABLE

Revision	Date	Changes from previous revision	Prepared by	Checked by	Accepted by
0	2022.08.04	Issued for Information	Christopher TAIT	Ian McARTHUR	Hugh THOMAS
1	2022.09.08	Issued for Information	Christopher TAIT	Ian McARTHUR	Hugh THOMAS

1.2. HOLD RECORD TABLE

Hold No.	Section	Description of Hold
1.		

1.3. ABBREVIATIONS TABLE

Abbreviation	Definition
BPP	Baltic Pipe Project
DPFPV	Dynamically Positioned Fall Pipe Vessel
EU	European Union
KP	Kilometre Post
PCI	Projects of Common Interest
SSDV	Side Stone Dumping Vessel
UXO	Unexploded Ordnance

1.4. DEFINITIONS

For the purpose of the Procedure the following terms shall have the following meaning:

a) **Company** means Gaz-System S.A.
b) **Contract** means a written agreement between Company and Contractor.
c) **Contractor** means Saipem Ltd,. including their Subcontractors.
d) **Project** Baltic Pipe Project
e) **Subcontractor** means any entity contracted by Saipem Ltd. to undertake the Work for the Baltic Pipe Project.

1.5. REFERENCE DOCUMENT SECTIONS

Ref.	Document Number	Rev.	Document Title
Company Documents			
/1/	-	-	Permit for Baltic Pipe Natural Gas Pipeline in the Baltic Sea
/2/	PL1-RAM-12-Z02-RA-00003-EN	-	Environmental Impact Assessment – Baltic Sea – Denmark
/3/	PL1-RAM-10-Y01-XD-00001-EN	7M	Alignment Sheets
Contractor Documents			
/4/	PL1-SAI-00-S00-KA-00008-EN	3	Environmental Monitoring Programme – Denmark (Offshore)
Subcontractor Documents			
/5/	PL1-SAI-12-J00-XF-42131-EN	-	Rohde Nielsen – Post Backfill Survey Charts (Denmark) – Area 1
/6/	PL1-SAI-12-J00-XF-42141-EN	-	Rohde Nielsen – Post Backfill Survey Charts (Denmark) – Area 2
/7/	PL1-SAI-12-J00-XF-42151-EN	-	Rohde Nielsen – Post Backfill Survey Charts (Denmark) – Area 3
/8/	PL1-SAI-12-Y03-XE-48013-EN	-	DEME – As-Built Drawing Danish Landfall Rock Placement
/9/	PL1-SAI-12-Y03-XE-48016-EN	-	DEME – As-Built Drawing Lock Berm KP26.781 – Post-Lay
/10/	PL1-SAI-12-Y03-XE-48005-EN	-	DEME – As-Built Drawing Lock Berm KP27.000 – Post-Lay
/11/	PL1-SAI-12-Y03-XE-48006-EN	-	DEME – As-Built Drawing Kriegers Flak EC Crossing – Post-Lay
/12/	PL1-SAI-12-Y03-XE-48007-EN	-	DEME – As-Built Drawing Lock Berm KP32.325 – Post-Lay
/13/	PL1-SAI-12-Y03-XE-48008-EN	-	DEME – As-Built Drawing C-Lion Crossing – Post-Lay
/14/	PL1-SAI-12-Y03-XE-48017-EN	-	DEME – As-Built Drawing Span Support KP164.026 – KP164.036
/15/	PL1-SAI-12-Y03-XE-48018-EN	-	DEME – As-Built Drawing Span Support KP164.071 – KP164.081
/16/	PL1-SAI-12-Y03-XE-48019-EN	-	DEME – As-Built Drawing Span Support KP164.891 – KP164.901
/17/	PL1-SAI-12-Y03-XE-48020-EN	-	DEME – As-Built Drawing Span Support KP164.928 – KP164.938
/18/	PL1-SAI-12-Y03-XE-48021-EN	-	DEME – As-Built Drawing Span Support KP165.130 – KP165.150
/19/	PL1-SAI-12-Y03-XE-48022-EN	-	DEME – As-Built Drawing Span Support KP166.102 – KP166.112
/20/	PL1-SAI-12-Y03-XE-48023-EN	-	DEME – As-Built Drawing Span Support KP167.015 – KP167.025
/21/	PL1-SAI-12-Y03-XE-48024-EN	-	DEME – As-Built Drawing Span Support KP167.042 – KP167.070
/22/	PL1-SAI-12-Y03-XE-48003-EN	-	DEME – As-Built Drawing – Post-Lay Rock Placement – Ronne Bank Stability Berm
/23/	PL1-SAI-12-Y03-XE-48004-EN	-	DEME – As-Built Drawing Span Support KP178.333 – Post-Lay

Ref.	Document Number	Rev.	Document Title
/24/	PL1-SAI-12-Y03-XE-48009-EN	-	DEME – As-Built Drawing Baltica Segment 3 Crossing – Post-Lay
/25/	PL1-SAI-12-Y03-XE-48010-EN	-	DEME – As-Built Drawing Nord Stream 1A Crossing – Post-Lay
/26/	PL1-SAI-12-Y03-XE-48011-EN	-	DEME – As-Built Drawing Nord Stream 1B Crossing – Post-Lay
/27/	PL1-SAI-12-Y03-XE-48012-EN	-	DEME – As-Built Drawing Nord Stream 2 Crossing – Post-Lay
/28/	PL1-SAI-12-J00-RA-43002-EN	-	Rohde Nielsen – Environmental Reporting: Restoration of the Seabed at Micro-Tunnel Exit – Denmark

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2. INTRODUCTION

2.1. PROJECT DESCRIPTION

The Baltic Pipe Project is being developed by both GAZ-SYSTEM S.A. and Energinet.dk as co-investors. The 36" Baltic Pipe offshore pipeline was installed between the east coast of Denmark and the northern coast of Poland with first gas scheduled to flow from Denmark to Poland in October 2022.

Baltic Pipe is recognised as an EU PCI project, with the purpose of the project being to further strengthen the European internal energy market by reaching the EU's energy policy objectives of affordable, secure and sustainable energy.

The Baltic Pipe Project involves the construction of a new bi-directional gas pipeline system that will connect the existing gas transmission systems of Denmark and Poland and for the first time enable shippers to flow gas directly from Norway to the markets in Denmark, Poland and their neighbouring markets. Baltic Pipe will also allow shippers to flow gas from Poland to the Danish and Swedish markets.

The Baltic Pipe project includes five major components:

1. Tie-in to the Norwegian offshore gas fields and pipeline back to Danish onshore gas transmission system;
2. Investments in strengthening of the Danish onshore gas transmission system for transit of gas to Poland;
3. A new compressor station on the east coast of Denmark;
4. Offshore pipeline linking east coast of Denmark and northern coastline of Poland which allows bi-directional gas transmission;
5. Investment in strengthening of the existing onshore Polish gas transmission system to receive gas from Denmark.

Energinet is responsible for the delivery of Item 1 to 3, while Gaz-System is responsible for Items 4 and 5. This document relates to the delivery of Item 4, the offshore pipeline between the east coast of Denmark and the northern coast of Poland.

A schematic of the five major components of the Baltic Pipe project is presented in Figure 2-1 below. The solid dark line indicates the Baltic Pipe offshore pipeline.

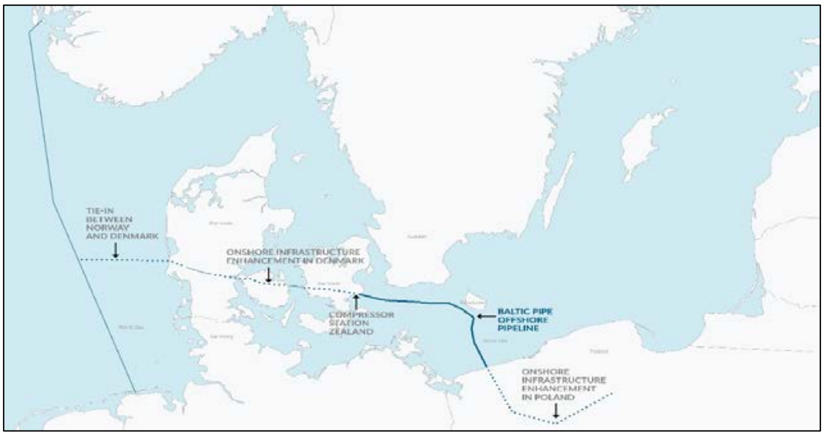


Figure 2-1: Baltic Pipe Overview

2.2. PURPOSE OF DOCUMENT

Saipem Ltd. previously prepared a document with title *Environmental Monitoring Programme – Denmark (Offshore)* [Ref. /4/], which was approved by the Danish Energy Agency, to satisfy Condition 14 of *Permit for Baltic Pipe Natural Gas Pipeline in the Baltic Sea* [Ref. /1/].

Section 4.2.2 of the aforementioned document describes the planned monitoring activities in relation to physical losses and physical disturbances of the seabed and outlines the reporting to be submitted to the Danish Energy Agency upon completion of the works.

The purpose of this document is to present the monitoring results to the Danish Energy Agency.

3. SUMMARY OF OFFSHORE CONSTRUCTION ACTIVITIES

3.1. PIPELINE ROUTE AND KP DEFINITION

Key locations along the pipeline route in Denmark are provided in Table 3-1. These locations are referenced relative to the pipeline Kilometre Post (KP) distance stated in the Alignment Sheets [Ref. /3/], where KP0.000 refers to the first dry weld on the Danish landfall site and KP273.947 refers to the first dry weld on the Polish landfall site.

Table 3-1: Key Locations on Pipeline Route – Denmark

Location	Position	WGS 84	
		Latitude – N	Longitude – E
First Dry Weld – Denmark Landfall Site	0.000	55° 11' 18.64"	12° 07' 11.76"
Micro-Tunnel Exit	1.005	55° 11' 13.21"	12° 08' 07.77"
Danish Territorial Waters Boundary	38.106	55° 11' 13.24"	12° 08' 07.49"
Danish EEZ Boundary	47.111	55° 08' 35.48"	12° 51' 09.27"
Danish EEZ Boundary	132.102	55° 06' 19.35"	14° 10' 55.64"
Danish Territorial Waters Boundary	141.862	55° 06' 00.10"	14° 20' 01.26"
Danish Territorial Waters Boundary	192.175	54° 48' 42.95"	14° 51' 13.13"
Danish EEZ Boundary	217.806	54° 35' 02.41"	14° 51' 33.04"

3.2. SEABED INTERVENTION

The following seabed intervention was undertaken:

- **Boulder Removal:** Removal of boulders on the seabed within the pipelay corridor.
- **Pre-Lay Dredging:** Pre-lay dredging of approximately twenty-four (24) kilometres of the pipelay route in Faxe Bugt and approximately four (4) kilometres of the pipelay route off Bornholm Island.
- **Concrete Mattress Installation:** Installation of concrete mattresses at various pipeline and cable crossing locations.
- **Pre-Lay Rock Installation:** Pre-lay rock installation at crossing and span support locations.
- **Post-Lay Rock Installation:** Post-lay rock installation in vicinity of micro-tunnel exit and at various crossing, span support and stability berm locations.
- **Post-Lay Backfilling:** Post-lay backfilling (including localised rectification work) of all dredged areas after pipelay and post-lay rock installation.

A detailed list of all seabed intervention locations in Danish waters is provided in Table 4-4. Boulder removal locations have not been considered due to the localised nature of the work undertaken.

Table 3-2: List of Seabed Intervention Locations

KP		Seabed Intervention				
Start	End	Pre-Lay Dredging	Concrete Mattresses	Pre-Lay Rock Installation	Post-Lay Rock Installation	Post-Lay Backfilling
0.951	25.030	Y (1)	-	-	Y (2)	Y
26.781	26.801	-	-	-	Y	-
27.000	27.300	-	-	-	Y	-
29.747	30.250	-	Y (3)	-	Y	-
32.325	32.625	-	-	-	Y	-
140.972	141.022	-	Y (3)	-	Y	-
164.026	164.036	-	-	-	Y	-
164.071	164.081	-	-	-	Y	-
164.891	164.901	-	-	-	Y	-
164.928	164.938	-	-	-	Y	-
165.130	165.150	-	-	-	Y	-
166.102	166.112	-	-	-	Y	-
167.015	167.025	-	-	-	Y	-
167.042	167.070	-	-	-	Y	-
167.400	171.500	-	-	-	Y	-
173.825	178.302	Y (1)	-	-	-	Y
178.307	178.390	-	-	Y (3)	Y	-
180.759	180.809	-	Y (3)	-	Y	-
188.524	188.678	-	Y (3)	Y (3)	Y	-
188.735	188.865	-	Y (3)	Y (3)	Y	-
206.064	206.298	-	Y (3)	Y (3)	Y	-

Notes:

(1) The spoil storage philosophy adopted during performance of the pre-lay dredging scope is described in Section 3.2.1.

(2) Post-lay rock installation was undertaken within part of the reported KP range prior to undertaking post-lay backfilling. The extent of post-lay backfilling encompasses the areas of post-lay rock installation.

(3) Concrete mattresses and /or pre-lay rock installation was undertaken within part of the reported KP range prior to pipeline installation. The extent of post-lay rock installation encompasses the pre-lay seabed intervention works.

3.2.1. Spoil Storage Philosophy

The philosophy adopted for the temporary storage of the dredged material varied for each location based on a range of factors including environmental restrictions, the extents of the permitted construction corridor and vessel specific minimum water depth requirements. The approach taken in Danish waters is summarised below.

The excavated material produced from the dredging operations was stored in the following manner:

- **Dredging at TBM Exit Pit [1]:** Excavated material was stored in the temporary spoil storage areas at KP1.660 and KP13.000.
- **Dredging of Pipeline Trench in Water Depth >7m:** Excavated material was side cast (i.e. deposited) alongside the pipeline trench. The spoil heaps were located within the +/- 125m construction corridor – offset no greater than 20m from the route centreline.
- **Dredging of Pipeline Trench in Water Depths <7m [2]:** Excavated material was stored at the aforementioned temporary spoil storage areas at KP1.660 and KP13.000.

Notes:

(1) The "Environmental Impact Assessment – Denmark – Baltic Sea" [Ref. /2/] specified that spoil excavated from the exit pit and trench transition must be stored in water depths greater than 7m to avoid covering the eel grass meadow in the vicinity of the exit pit.

(2) The "Environmental Impact Assessment – Denmark – Baltic Sea" [Ref. /2/] specified that trench spoil could only be side cast in water depths greater than 7m whether related to the exit pit, trench transition or any other trenching operations.

The boundary co-ordinates of the temporary spoil storage areas at KP1.660 and KP13.000 are detailed in Table 3-3 and Table 3-4 respectively. Both storages areas were located within the UXO surveyed zone extending up to +/-1000m from the pipeline route centreline.

Table 3-3: Boundary Co-ordinates - Temporary Spoil Storage Area at KP1.660

ID	WGS 84		UTM 33N	
	Latitude – N	Longitude – E	Easting	Northing
1	55° 10' 45.91"	12° 08' 51.77"	318 384.68	6 118 469.94
2	55° 10' 49.10"	12° 08' 52.74"	318 405.80	6 118 567.69
3	55° 10' 51.86"	12° 08' 24.90"	317 917.07	6 118 673.28
4	55° 10' 48.68"	12° 08' 23.93"	317 895.95	6 118 575.54

Table 3-4: Boundary Co-ordinates - Temporary Spoil Storage Area at KP13.000

ID	WGS 84		UTM 33N	
	Latitude – N	Longitude – E	Easting	Northing
5	55° 09' 35.96"	12° 18' 50.22"	328 883.53	6 115 888.22
6	55° 09' 32.76"	12° 18' 49.42"	328 865.58	6 115 789.84
7	55° 09' 33.67"	12° 19' 18.18"	329 375.41	6 115 798.45
8	55° 09' 30.47"	12° 19' 17.38"	329 357.46	6 115 700.08

3.3. PIPELINE CONFIGURATION ALONG ROUTE

The configuration of the pipeline along the route, which is determined giving consideration to the seabed intervention activities described in Section 3.2, is summarised in Table 3-5.

Table 3-5: Pipeline Configuration Along Route

KP		Pipeline Configuration		
Start	End	Trenched & Buried	Rock Dumped	Exposed on Seabed
0.951	25.030	Y	-	-
25.030	26.781	-	-	Y
26.781	26.801	-	Y	-
26.801	27.000	-	-	Y
27.000	27.300	-	Y	-
27.300	29.747	-	-	Y
29.747	30.250	-	Y	-
30.250	32.325	-	-	Y
32.325	32.625	-	Y	-
32.625	47.111	-	-	Y
132.102	140.972	-	-	Y
140.972	141.022	-	Y	-
141.022	164.026	-	-	Y
164.026	164.036	-	Y	-
164.036	164.071	-	-	Y
164.071	164.081	-	Y	-
164.081	164.891	-	-	Y
164.891	164.901	-	Y	-
164.901	164.928	-	-	Y
164.928	164.938	-	Y	-
164.938	165.130	-	-	Y
165.130	165.150	-	Y	-
165.150	166.102	-	-	Y
166.102	166.112	-	Y	-
166.112	167.015	-	-	Y
167.015	167.025	-	Y	-
167.025	167.042	-	-	Y
167.042	167.070	-	Y	-
167.070	167.400	-	-	Y
167.400	171.500	-	Y	-
171.500	174.000	-	-	Y
173.825	178.302	Y	-	-
178.200	178.307	-	-	Y
178.307	178.390	-	Y	-
178.390	180.759	-	-	Y
180.759	180.809	-	Y	-
180.809	188.524	-	-	Y
188.524	188.678	-	Y	-
188.678	188.735	-	-	Y
188.735	188.865	-	Y	-
188.865	206.064	-	-	Y
206.064	206.298	-	Y	-
206.298	217.806	-	-	Y

3.4. PIPELINE START-UP AND ANCHOR HANDLING OPERATIONS

Three (3) pipelay vessels were utilised to install the offshore pipeline in Danish territorial and EEZ waters. The actual pipelay vessel battery limits and pipelay direction (in Danish waters) are summarised in Table 3-6.

Table 3-6: Pipelay Vessel Battery Limits and Lay Direction (in Danish Waters)

KP		Pipelay Vessel	Pipelay Mode	Pipelay Direction
From	**To**			
0.000	19.500	Castoro 10	Moored	DK – PL
19.500	41.980 [1]	Castoro Sei	Moored	PL – DK
41.980	47.111	Castorone	DP	PL – DK
132.102	150.700	Castorone	DP	PL – DK
150.700	182.000	Castoro Sei	Moored	DK – PL
182.000	217.806	Castorone	DP	DK – PL

The pipeline was initiated via a start-up anchor located at KP150.700.

Pipelay vessels "Castoro Sei" and "Castoro 10" installed their assigned sections of the pipeline in moored pipelay mode. The anchors were positioned up to +/-1000m or +/-750m each side of the planned pipeline centreline for "Castoro Sei" and "Castoro 10" respectively. Specific anchor patterns were prepared at crossing locations and where confirmed or potential cultural heritage objects were identified.

Minor and localised physical disturbances of the seabed would have occurred at locations where the start-up anchor and vessel mooring anchors were placed, and where the anchor lines interacted with the seabed. It has not been feasible to consider the impact of the pipeline start-up anchor or pipelay vessel anchor handling operations within this assessment. However, the *"Environmental Impact Assessment – Baltic Sea – Denmark"* [Ref. /2/] concludes that:

> *"The impact from [...] anchors is assessed to be local and does not impact the general bathymetry of the Baltic Sea."*

4. ENVIRONMENTAL REPORTING: PHYSICAL LOSSES AND PHYSICAL DISTURBANCES OF THE SEABED

4.1. SEABED TOPOGRAPGHY

4.1.1. Methodology

The following methodology was used to assess the physical disturbances of the seabed, resulting from implementation of the Baltic Pipe Project, by considering changes in seabed topography.

<u>Qualitative Description of Observed Changes in Seabed Topography at Locations of Seabed Intervention:</u>

Physical losses and physical disturbances of the seabed primarily occur when seabed intervention works are undertaken.

The assessment is undertaken by providing a qualitative description of any observed changes in seabed topography at a selection of locations where seabed intervention has been undertaken. The locations are selected on the basis that they are representative of the different types and extents of seabed intervention work and the construction methodologies employed.

A detailed list of all seabed intervention locations in Danish waters is provided in Table 3-2. The following locations are selected for assessment.

Table 4-1: Selected Seabed Intervention Locations

Location	KP	Seabed Intervention				
		Pre-Lay Dredging	Concrete Mattresses	Pre-Lay Rock Installation	Post-Lay Rock Installation	Post-Lay Backfilling
A1	1.010	Y	-	-	Y	Y
A2	1.660	Temporary Spoil Storage Area				
A3	19.500	Y	-	-	Y	Y
A4	29.800	-	Y	-	Y	-
A5	167.050	-	-	-	Y	-
A6	176.000	Y	-	-	-	Y
A7	188.600	-	Y	Y	Y	-

At each of the selected locations, a cross sectional drawing is presented showing the seabed topography, obtained by multi-beam survey, prior to and following performance of the seabed intervention works. A description of any observed changes in seabed topography is provided along with an accompanying narrative of the seabed intervention works and the construction methodology employed.

Qualitative Description of Observed Changes in Seabed Topography at Locations Where Pipeline is Exposed on the Seabed:

The pipeline is exposed on the seabed at locations where seabed intervention has not been undertaken. Immediately after pipeline installation, the pipeline may have embed into the seabed due its self-weight. The magnitude of embedment along the pipeline route is linked to the seabed substrate type at the location concerned. The seabed topography will be permanently affected by the presence of the pipeline and the potential exists for the pipeline to act as a barrier to the flow of bottom currents. The long term impact on seabed topography is predicted to be insignificant and will only be known if further monitoring activities are undertaken in the future.

The assessment is undertaken by providing a qualitative description of any observed changes in seabed topography at a selection of locations where the pipeline is exposed on the seabed. The locations selected, which are representative of the four (4) seabed substrate types present along the pipeline route are identified in Table 4-2. Refer to Section 4.2.1 for an explanation of the classification system utilised.

Table 4-2: Selected Locations Where Pipeline is Exposed on the Seabed

Location	KP	Seabed Substrate Type
B1	165.500	Bedrock
B2	28.000	Hard Bottom
B3	135.000	Fine Grained Sediment
B4	181.000	Sand

It is understood that the soil conditions are likely to be variable within each seabed substrate type and the levels of embedment observed at other locations along the route may differ.

4.1.2. Assessment

The results of the assessment, considering the aforementioned methodology, are provided for each selected location below.

Foreach of the cross-sectional profile:

- The horizontal distance along the cross section, in metres, is indicated on the x-axis. 0m denoted the design centreline of the pipeline.
- The water depth, in metres, is indicated on the y-axis. 0m denotes the mean water level.

Location A1: KP1.010

Location A1 is in the vicinity of the micro-tunnel exit pit. The micro-tunnel exit pit is the end point of the 1000m long micro-tunnel that was bored under the Danish coastline from the landfall site. The exit pit, which is approximately 105m wide, was excavated for the recovery of the tunnel boring machine (TBM). The overall width of the exit pit was largely governed by the side slope geometry – which was an important consideration for slope stability and diver safety during the TBM recovery operation.

Minimal disturbance of the seabed is observed each side of the trench because all excavated material was placed at two (2) temporary spoil storage areas – located in water depths greater than seven (7) metres. The use of temporary spoil storage areas was part of the measures employed to minimise disturbance of the eel grass meadows in the vicinity of the micro-tunnel exit pit.

A shore pull-in operation was undertaken to pull the offshore pipeline through the micro-tunnel to the landfall site. Following pipeline installation, the trench was partially filled with rock material using a side stone dumping vessel (SSDV). Backfilling of the previously excavated soil material was primarily undertaken using split hopper barges. The split hopper barges transported spoil recovered from the temporary spoil storage areas back to the exit pit location – where the material was returned to the trench. Localised rectification work was undertaken using backhoe dredgers and grab dredgers.

The cross-sectional profile illustrated in Figure 4-1 indicates very close alignment between the pre-dredging and post-backfilling seabed profiles. The pre-dredging seabed profile is indicated with a black line and the post-backfilled seabed profile is indicated with a red line.

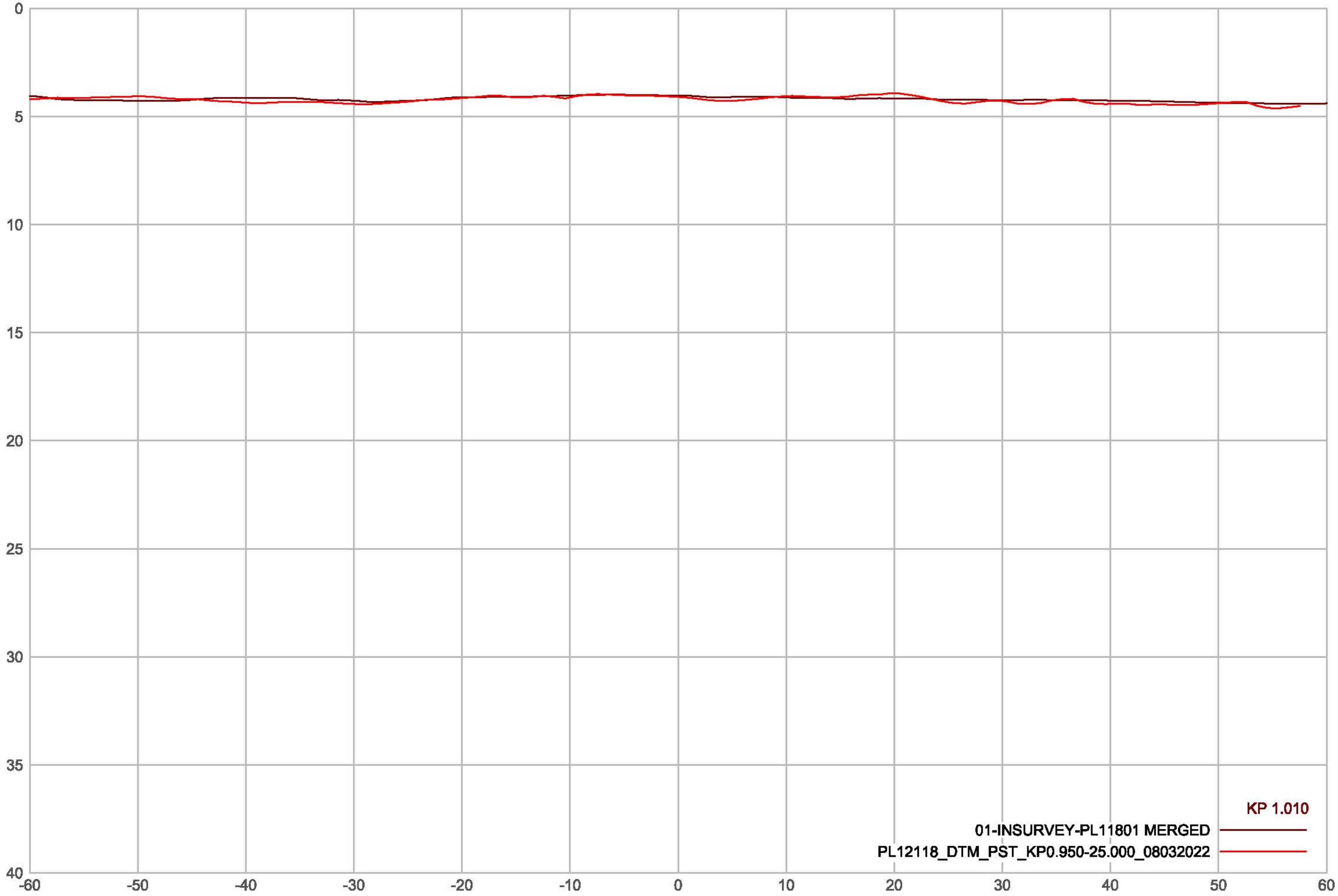


Figure 4-1: Cross-Sectional Profile at KP1.010

Location A2: KP1.660

Location A2 is the location of one (1) of two (2) temporary spoil storage areas. The width of the spoil storage area was approximately 100m. Material excavated from the pipeline trench during pre-lay dredging, with specific water depth and environmental constraints preventing side casting, was placed within the temporary spoil storage areas using split hopper barges.

During post-lay backfilling operations, the material was recovered from the temporary spoil storage areas by backhoe dredgers and grab dredgers and placed into split hopper barges. The split hopper barges transported the material back to the pipeline for placement into the trench.

The cross sectional profile is illustrated in Figure 4-2. The as-found seabed profile is indicated with a black line and the as-left seabed profile is indicated with a red line. Review of the profiles indicate that some of the original seabed may have been excavated whilst recovering the previously dumped spoil for the post-lay backfilling operation. This is to be expected considering the capability and accuracy of the equipment employed. It is also observed that the seabed elevation at the edges of the spoil storage area recorded in the as-left survey are greater than those obtained in the as-found survey. It is worth highlighting that sediment transport arising from environmental actions (i.e. from waves and currents) was observed during the period between pre-lay dredging and post-lay backfilling. This is likely to have resulted in some material within the spoil storage area migrating outside its boundary.

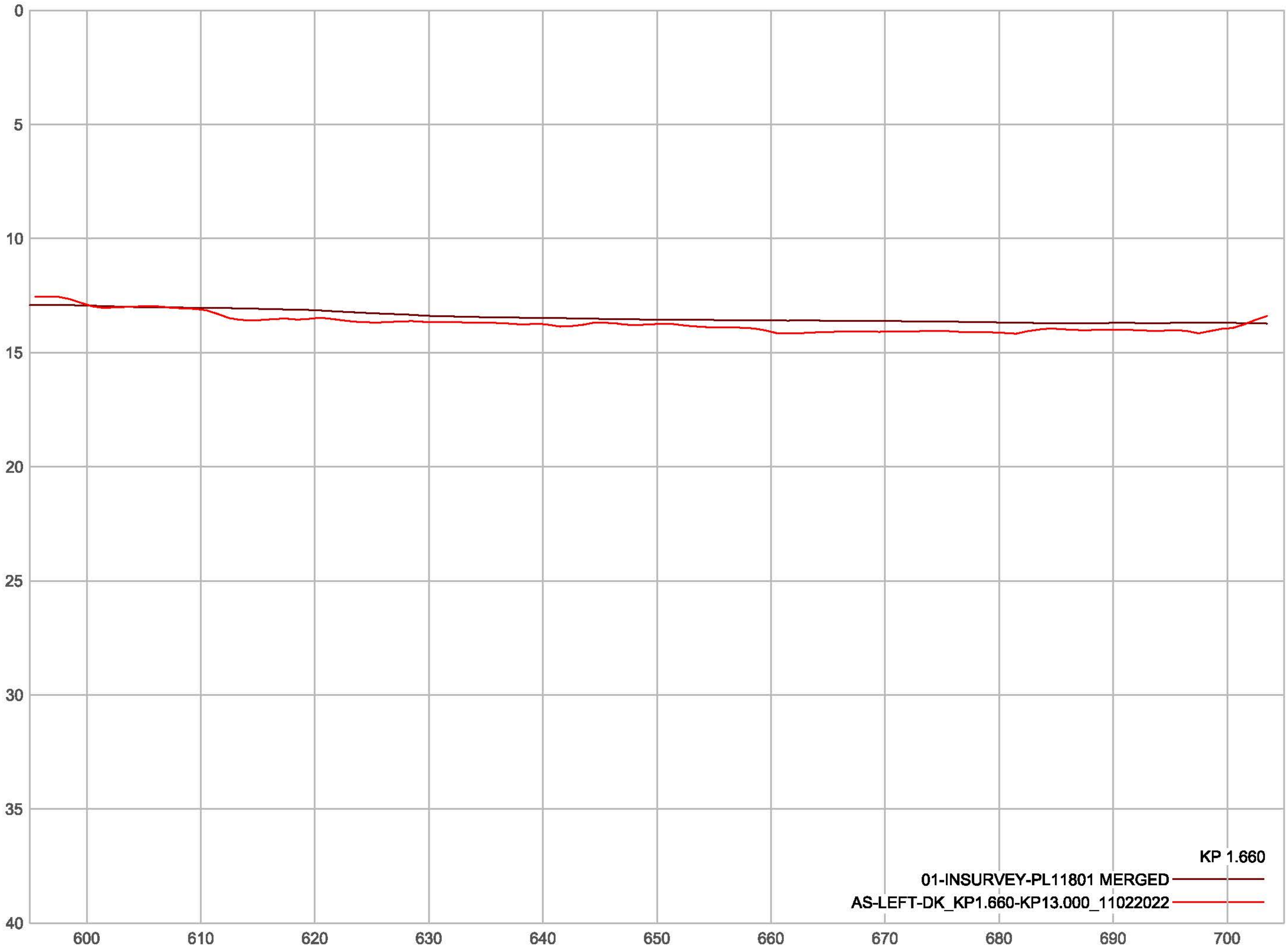


Figure 4-2: Cross-Sectional Profile at KP1.660

Location A3: KP19.500

Location A3 is the location of the pipeline above water tie-in. Prior to pipeline installation, a trapezoid shaped trench, with maximum width of approximately 40m, was dredged. The excavated material was side cast adjacent to the trench. Initially the section of pipeline installed from Poland was laid down within the trench. At a later date, the section of pipeline installed from Denmark was laid down within the trench with an offset of approximately 4m. The pipeline above water tie-in operation involved the recovery of the two (2) pipeline sections, laid in opposite directions, onboard pipelay vessel "Castoro 10" where they were welded together. Following the tie-in operation, the pipeline was lowered to the seabed – the excess length being managed by laying the pipeline in an "Omega" shape.

Rock was installed on the pipeline at three (3) locations within the trapezoid shaped trench. During post-lay backfilling operations, the previously side cast material was returned to the trench in such a manner that the minimum backfill requirements were achieved.

The above water tie-in arrangement and approximate location of the cross sectional profile is indicated in Figure 4-3.

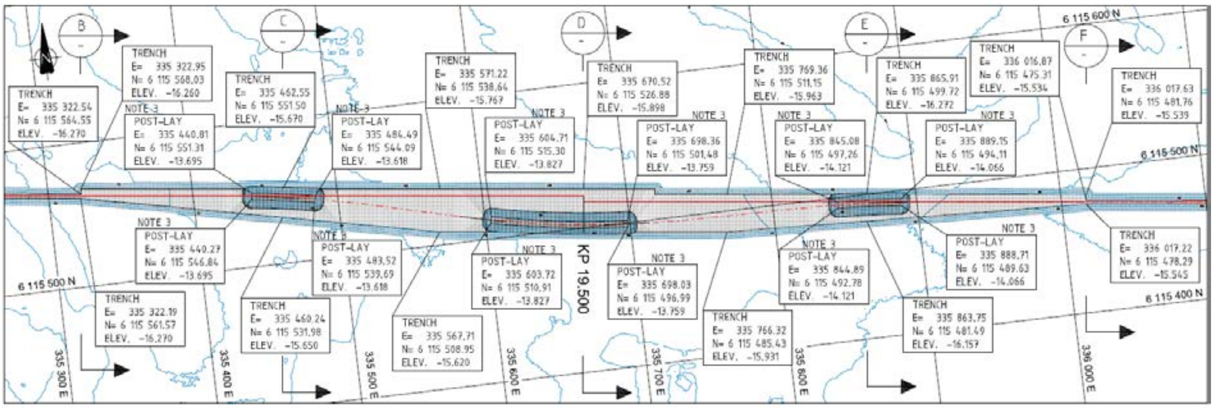


Figure 4-3: Above Water Tie-in Trench Configuration with Rock Installation Locations

The design cross-section at this location is indicated in Figure 4-4.

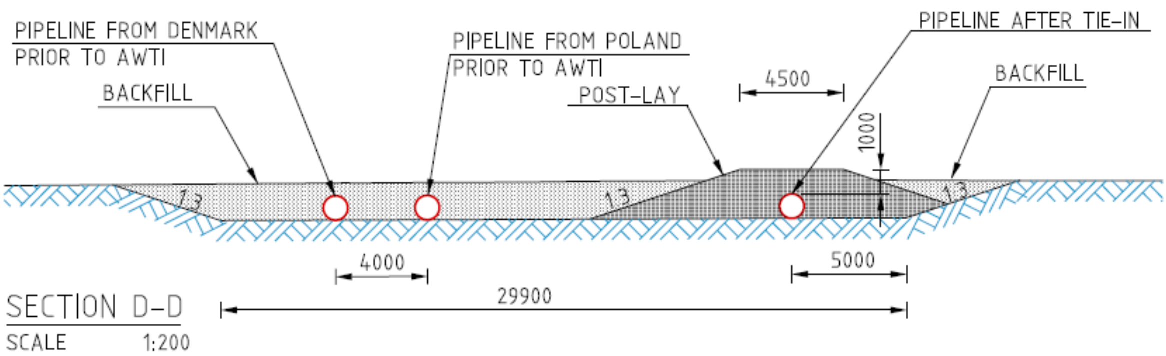


Figure 4-4: Configuration at Pipeline Above Water Tie-in

The cross sectional profile is illustrated in Figure 4-5. The pre-dredging seabed profile is indicated with a black line and the as-left seabed profile is indicated with a red line. Review of the profiles indicate that the as-left seabed elevation is greater than the pre-dredging elevation in the vicinity of the pipeline centre-line (0m on the horizontal axis) – in accordance with the design requirements. The as-left seabed elevation is marginally lower than the pre-dredging elevation across approximately 45m of the cross section (-52m to -7m on the horizontal axis).

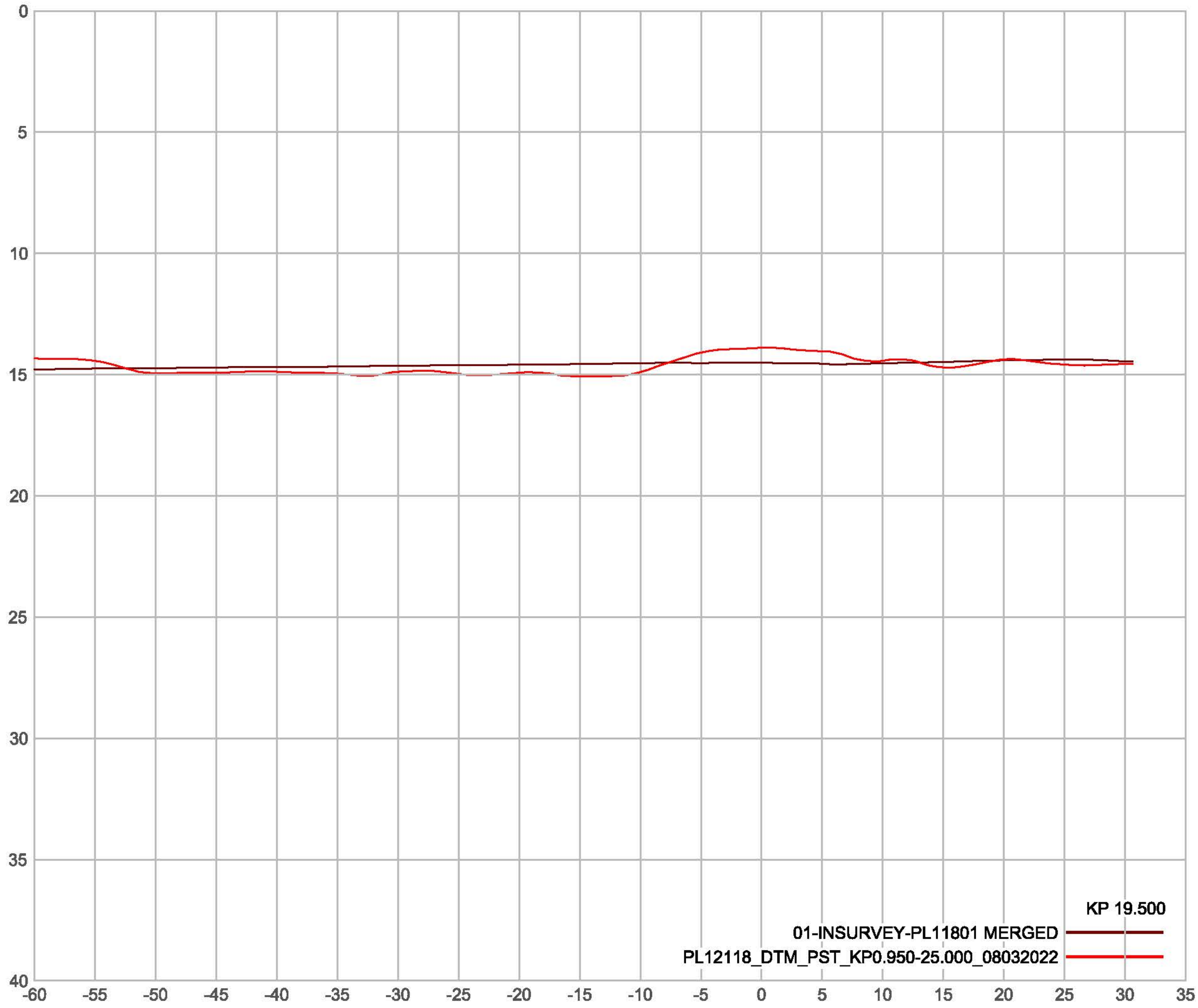


Figure 4-5: Cross Sectional Profile at KP19.500

Location A4: KP29.800

Location A4 is in the vicinity of the location where the Baltic Pipe offshore pipeline crosses the Kriegers Flak cable. The crossing arrangement and approximate location of the cross sectional profile is indicated in Figure 4-6.

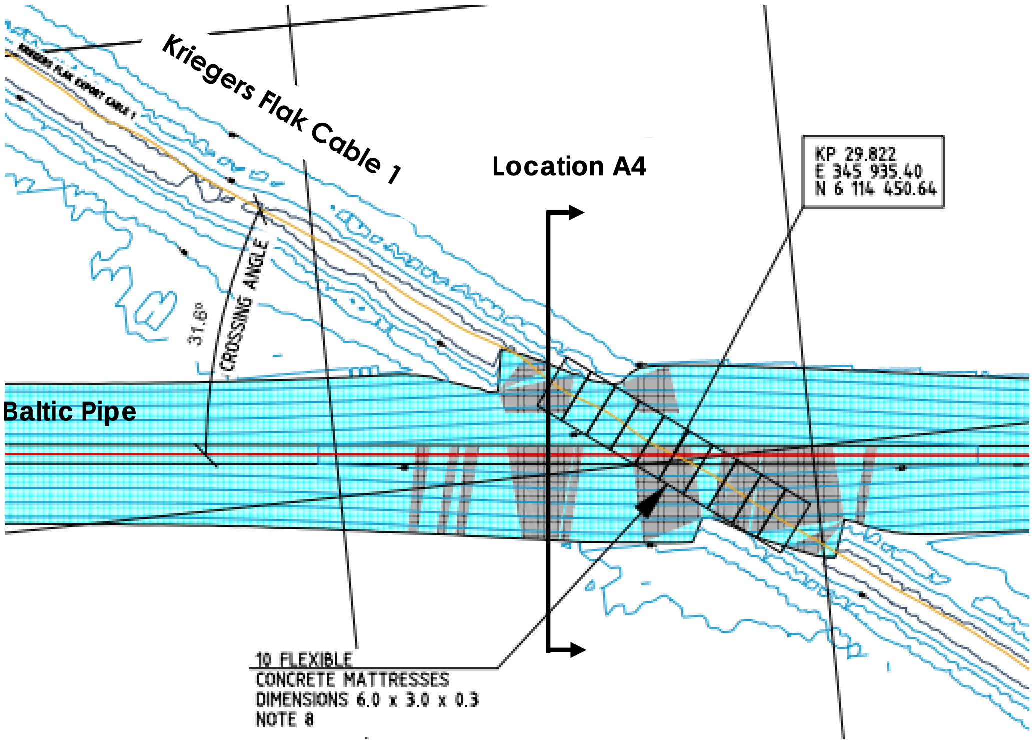


Figure 4-6: Kriegers Flak Cable Crossing

Prior to pipeline installation, concrete mattresses and a pre-lay rock carpet were installed over the existing asset – which is trenched and buried at this location. The rock was installed using a dynamically positioned fall pipe vessel (DPFPV).

The concrete mattresses and rock carpet provide protection to the cable during pipeline installation and operation. Following installation of the pipeline, post-lay rock installation was undertaken using DPFPV. The rock encompasses the concrete mattresses and pipeline at this location.

The cross sectional profile is illustrated in Figure 4-7. The as-found seabed profile is indicated with a black line and the post-rock installation seabed profile is indicated with a red line. It can be observed that the rock berm, which extends each side of the pipeline centreline (0m on horizontal axis), is approximately 16m in width and rises approximately 2.5m above the original seabed elevation.

The existing trenched and buried cable, converging towards the crossing location, is indicated by the "U" shaped configuration (-22m to -8m on the horizontal axis).

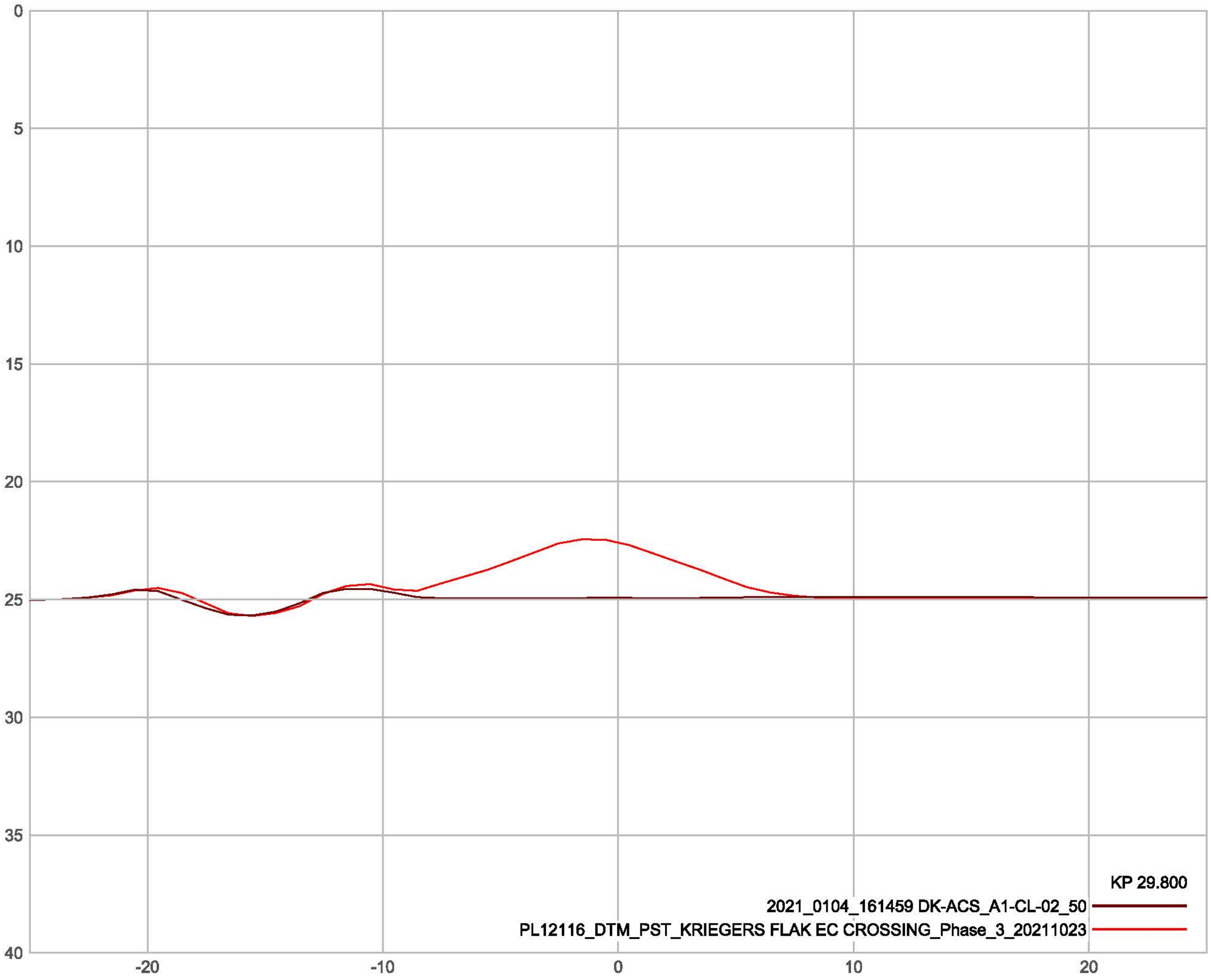


Figure 4-7: Cross Sectional profile at KP29.800

Location A5: KP167.050

Location A5 is a location where post-lay rock installation was undertaken for pipeline freespan support. The pipeline was initially installed on the natural seabed by pipelay vessel "Castoro Sei". During performance of on-bottom roughness analysis with the as-laid survey data, it was determined that spot rock installation was required for freespan support. Rock installation was undertaken using a DPFPV.

The cross sectional profile is illustrated in Figure 4-8. The as-found seabed profile is indicated with a black line and the post-rock installation seabed profile is indicated with a red line. It can be observed that the rock berm, which extends each side of the pipeline centreline (0m on horizontal axis), is approximately 25m in width and rises approximately 2m above the original seabed elevation.

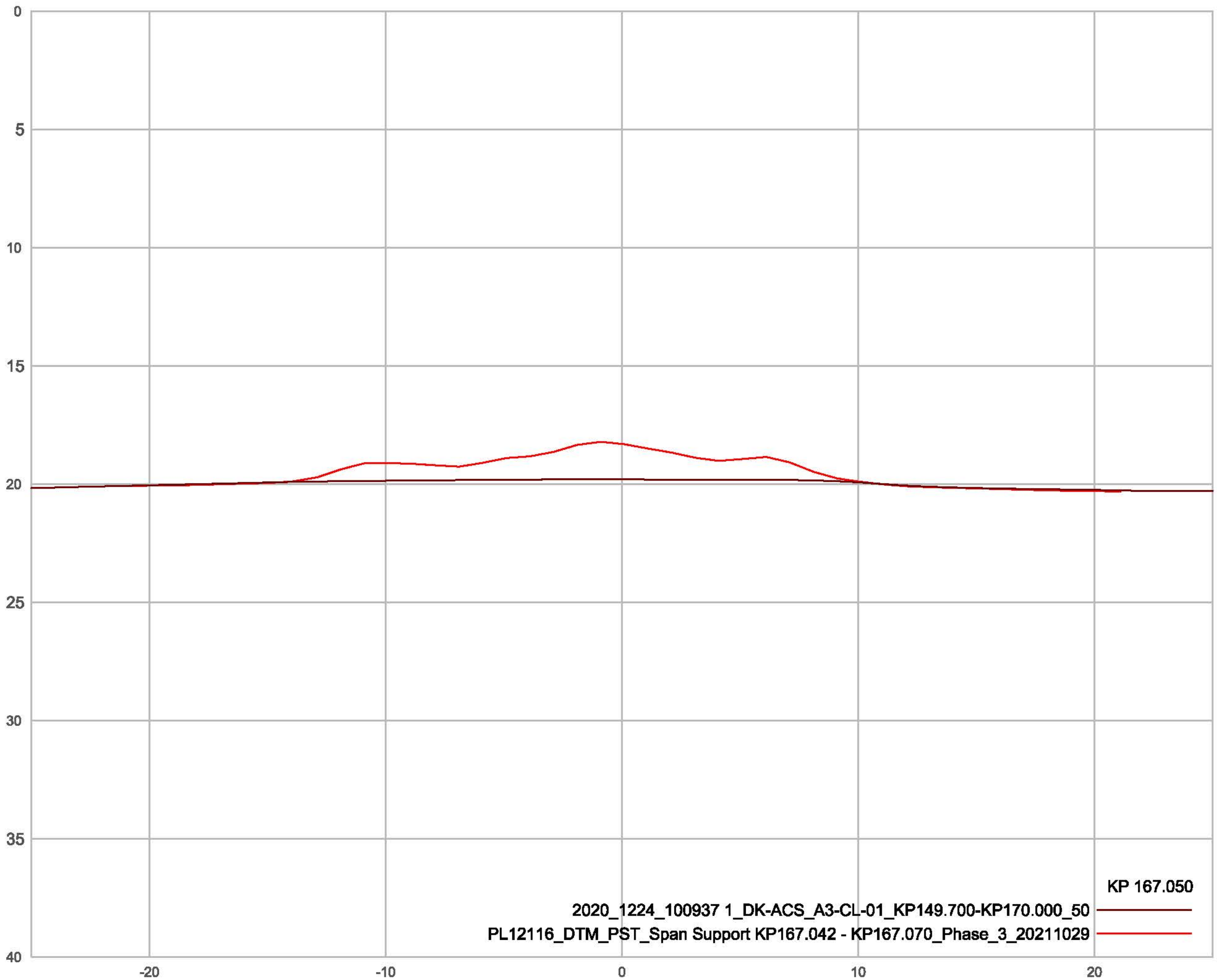


Figure 4-8: Cross Sectional Profile at KP167.050

Location A6: KP176.000

Location A6 is located south-west of Bornholm Island where the pipeline is installed within a trench. The trench was constructed prior to pipeline installation using primarily grab dredgers. The excavated material was side cast adjacent to the trench on the eastern side. Pipelay vessel "Castoro Sei" installed the pipeline within the trench.

During post-lay backfilling operations, the previously side cast material was returned to the trench using grab dredgers in such a manner that the minimum backfill requirements were achieved. The design configuration at this location is indicated in Figure 4-9.

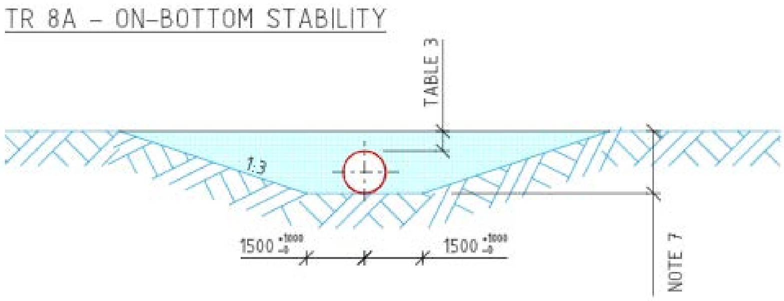


Figure 4-9: Trench Design

The cross sectional profile is illustrated in Figure 4-10. The pre-dredging seabed profile is indicated with a black line and the post-backfill seabed profile is indicated with a red line. Review of the profiles indicate that the post-backfill seabed elevation is marginally lower than the pre-dredging elevation at the location of the pipeline trench (-8m to 7m on the horizontal axis). The post-backfill seabed elevation is marginally higher than the pre-dredging elevation at the location of the spoil heap (-31m to -8m on the horizontal axis).

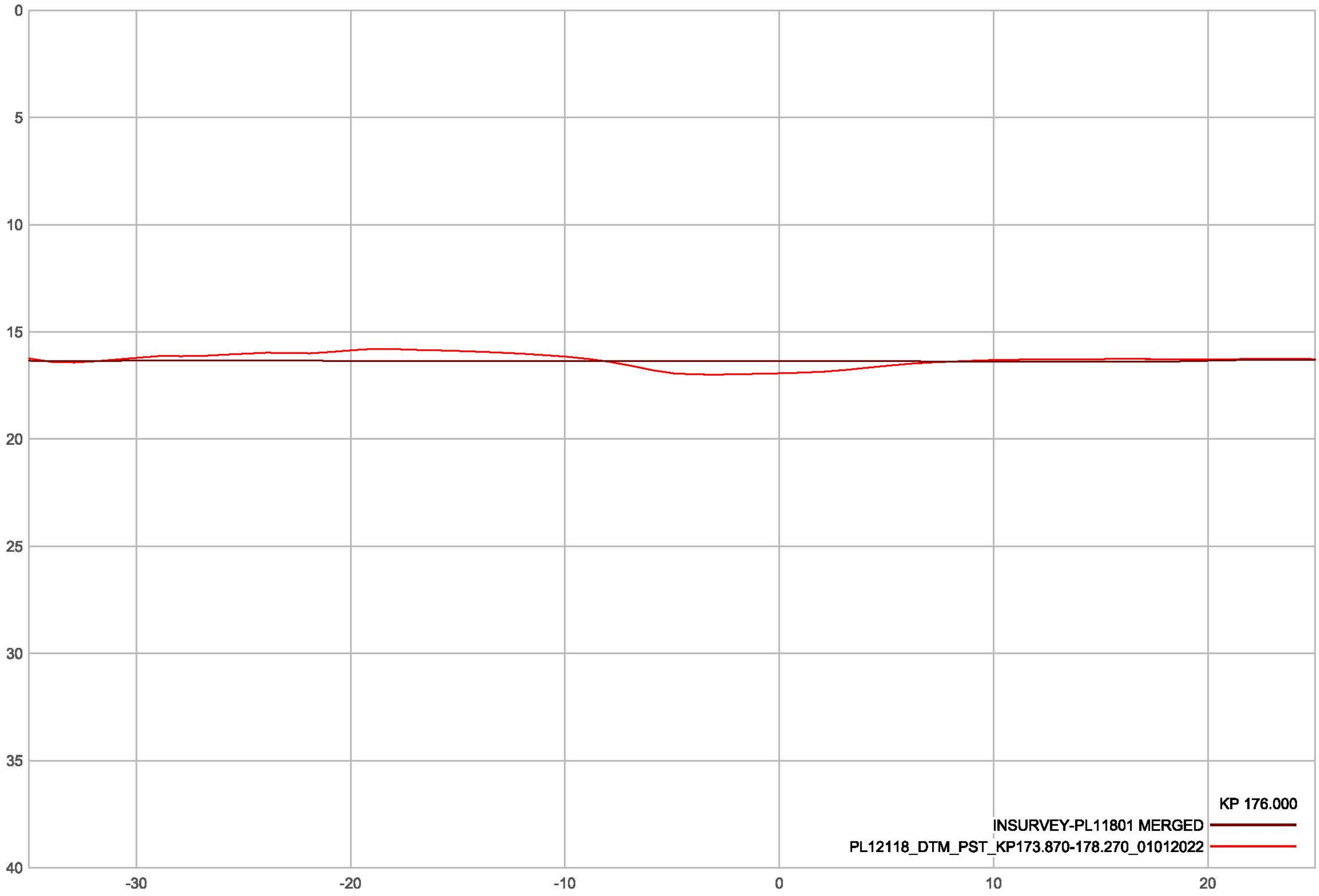


Figure 4-10: Cross Sectional Profile at KP176.000

Location A7: KP188.600

Location A4 is in the vicinity of the location where the Baltic Pipe offshore pipeline crosses the Nord Stream 1A pipeline. The crossing arrangement and approximate location of the cross sectional profile is indicated in Figure 4-11.

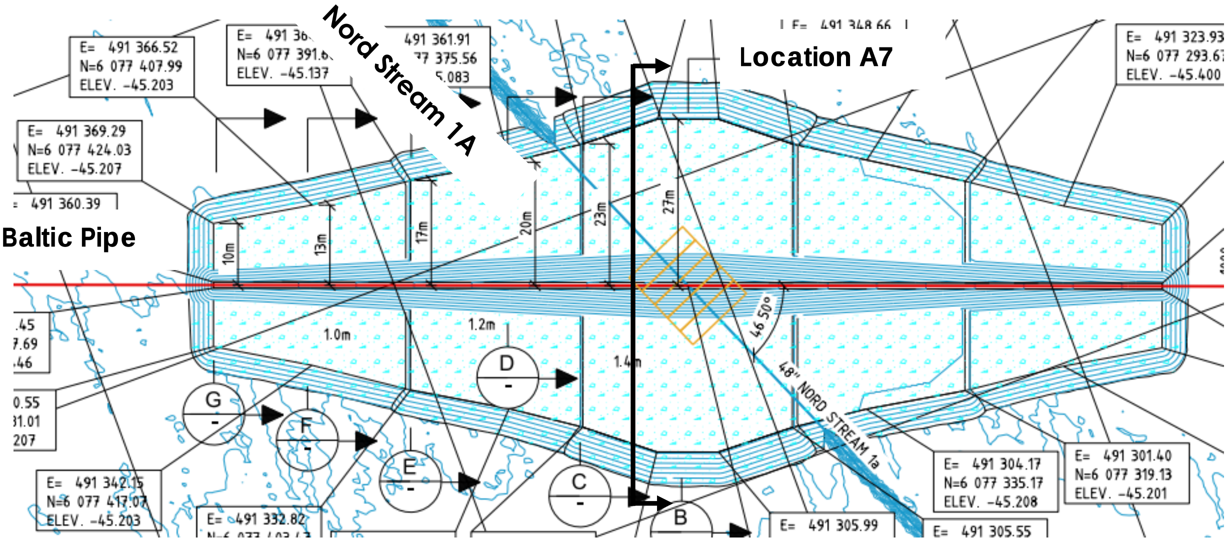


Figure 4-11: Nord Stream 1A Pipeline Crossing

The design cross-section is indicated in Figure 4-12.

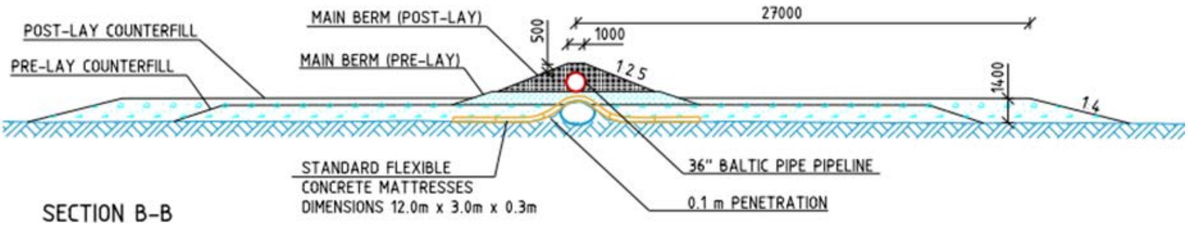


Figure 4-12: Nord Stream 1A Crossing Design

Prior to pipeline installation, concrete mattresses and a pre-lay rock carpet were installed over the Nord Stream 1A pipeline. The rock was installed using a dynamically positioned fall pipe vessel (DPFPV). The concrete mattresses and rock carpet provide protection to the pipelines during pipeline installation and operation. Following installation of the pipeline, post-lay rock installation was undertaken using DPFPV. The rock encompasses the concrete mattresses and both pipelines at this location.

The cross sectional profile is illustrated in Figure 4-13. The as-found seabed profile is indicated with a black line and the post-rock installation seabed profile is indicated with a red line. It can be observed that the rock berm, which extends each side of the pipeline centreline (0m on horizontal axis), is approximately 70m in width and rises approximately 3.5m above the natural seabed elevation at its highest point.

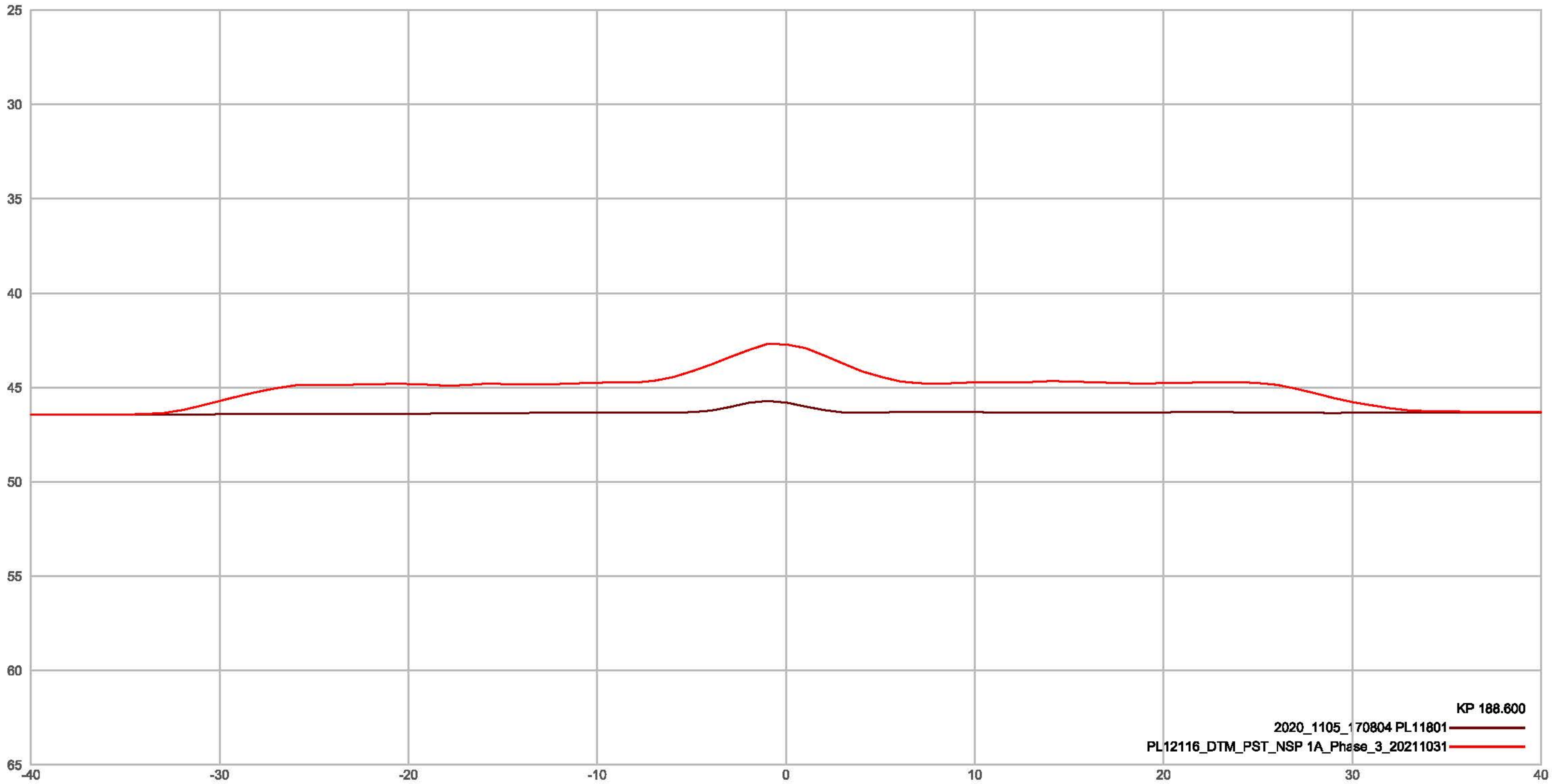


Figure 4-13: Cross Sectional Profile at KP188.600

Location B1 – B4: Pipeline Exposed on Seabed

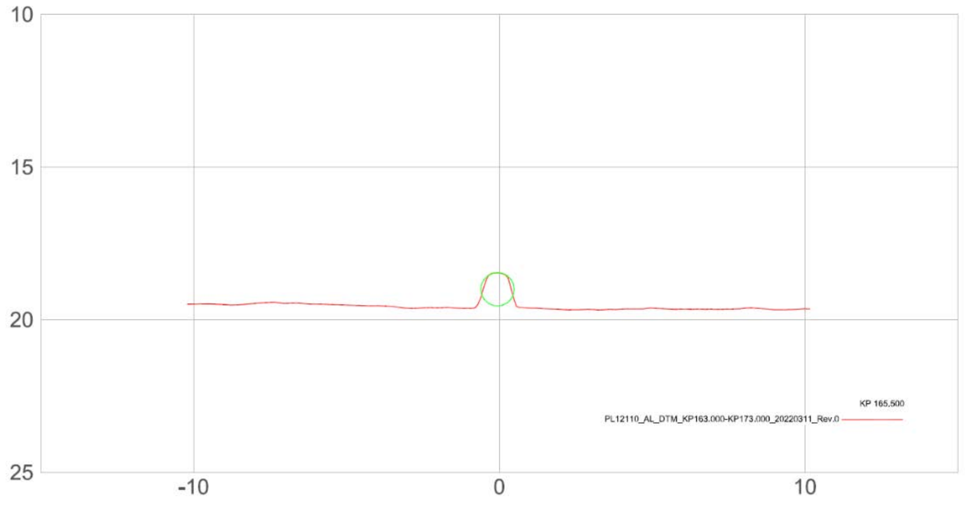
The pipeline configuration on the seabed at Locations B1 to B4 are presented in Figure 4-14. The magnitude of pipeline embedment at each location reflects the soil parameters at the location concerned.

No embedment is observed at the selected locations with Bedrock (Location B1) and Hard Bottom (Location B2) seabed substrate types.

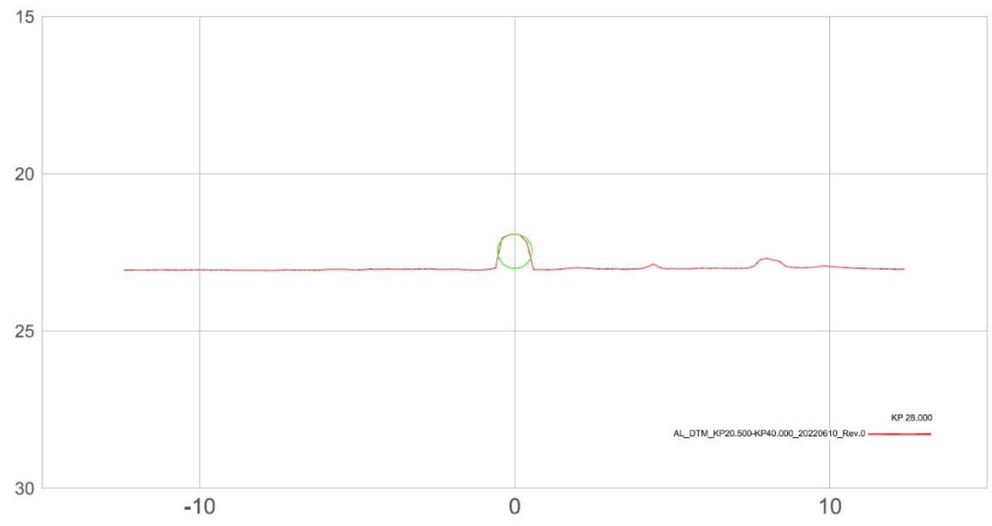
Minimal embedment is observed at the selected location with Sand (Location B4) seabed substrate type.

The pipeline is embedded to approximately half its diameter at the selected location with Fine Grained Sediment (Location B3) seabed substrate type.

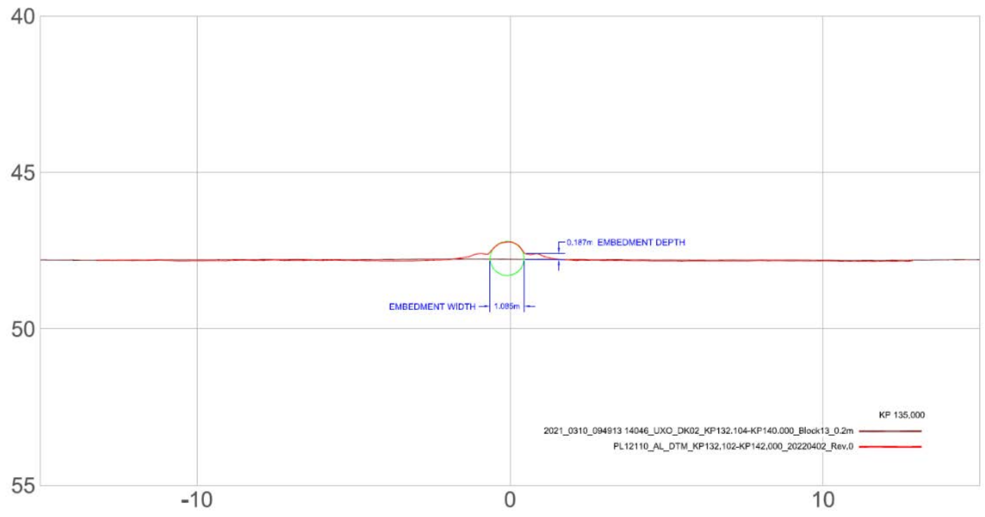
It is understood that the soil conditions are likely to be variable within each seabed substrate type and the levels of embedment at other locations along the route may differ.



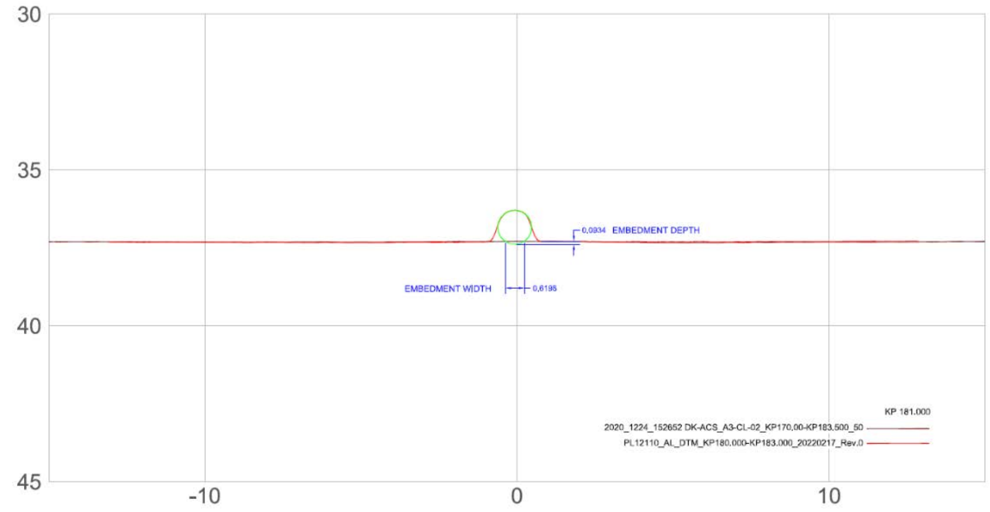
Location B1: KP165.500 (Bedrock)



Location B2: KP28.000 (Hard Bottom)



Location B3: KP135.000 (Fine Grained Sediment)



Location B4: KP181.000 (Sand)

Figure 4-14: Cross-Sectional Profiles at Locations B1 – B4

4.2. SEABED HABITAT TYPE

4.2.1. Methodology

The following methodology was used to assess the physical losses and physical disturbances of the seabed, with respect to seabed habitat type, resulting from implementation of the Baltic Pipe Project.

Overlay of Benthic Habitat Types on Pipeline Route Layout:

For the entire Baltic Sea region, sixty (60) different benthic habitat types have been identified – each of these habitat types reflect its specific combination of basic physical properties, i.e. substrate type, light availability and salinity.

The benthic habitat types defined in the *"Environmental Impact Assessment – Baltic Sea – Denmark"* [Ref. /2/], which originate from the BALANCE Project (https://balance-eu.org/) and the Danish marine substrate classification system, have been considered in this assessment.

The BALANCE Project data was downloaded, as GeoTiff files, from the HELCOM Map and Data Service (https://maps.helcom.fi/website/mapservice/index.html) and overlayed onto the route layout map.

The boundaries of each benthic habitat type were determined, in kilometre post (KP) notation, from the pipeline route layout map. In Danish waters, the pipeline crosses and therefore potentially impacts ten (10) benthic habitat types which are represented by four (4) substrate types. The benthic habitat types and their locations along the pipeline route are indicated in Table 4-3 and Table 4-4 respectively.

Table 4-3: Benthic Habitat Types Crossed by Pipeline Route

Substrate Type	Photic / Non-Photic Zone	Salinity (PSU)
Bedrock	Non-Photic	7.5 – 11
Hard Bottom	Non-Photic	7.5 – 11
Hard Bottom	Non-Photic	11 – 18
Hard Bottom	Photic	11 – 18
Fine Grained Sediment	Non-Photic	7.5 – 11
Fine Grained Sediment	Non-Photic	11 – 18
Fine Grained Sediment	Photic	11 – 18
Sand	Non-Photic	7.5 – 11
Sand	Non-Photic	11 – 18
Sand	Photic	11 – 18

Table 4-4: Location of Benthic Habitat Types Along Pipeline Route

KP		Substrate Type	Photic / Non-Photic Zone	Salinity (PSU)
Start	End			
0.951	1.174	Fine Grained Sediment	Photic	11 – 18
1.174	2.132	Hard Bottom	Photic	11 – 18
2.132	3.028	Fine Grained Sediment	Photic	11 – 18
3.028	3.979	Sand	Photic	11 – 18
3.979	9.494	Hard Bottom	Photic	11 – 18
9.494	10.930	Sand	Photic	11 – 18
10.930	11.135	Sand	Non-Photic	11 – 18
11.135	12.156	Hard Bottom	Non-Photic	11 – 18
12.156	18.429	Sand	Photic	11 – 18
18.429	21.048	Sand	Non-Photic	11 – 18
21.048	25.073	Hard Bottom	Non-Photic	11 – 18
25.073	29.290	Hard Bottom	Photic	11 – 18
29.290	29.692	Fine Grained Sediment	Photic	11 – 18
29.692	32.308	Fine Grained Sediment	Non-Photic	11 – 18
32.308	37.338	Hard Bottom	Non-Photic	11 – 18
37.338	47.111	Fine Grained Sediment	Non-Photic	11 – 18
132.102	148.741	Fine Grained Sediment	Non-Photic	11 – 18
148.741	155.129	Fine Grained Sediment	Non-Photic	7.5 – 11
155.129	165.068	Sand	Non-Photic	7.5 – 11
165.068	165.936	Bedrock	Non-Photic	7.5 – 11
165.936	166.958	Hard Bottom	Non-Photic	7.5 – 11
166.958	182.758	Sand	Non-Photic	7.5 – 11
182.758	185.237	Fine Grained Sediment	Non-Photic	7.5 – 11
185.237	186.445	Hard Bottom	Non-Photic	7.5 – 11
186.445	217.806	Fine Grained Sediment	Non-Photic	7.5 – 11

Determine Extent of Physical Losses and Physical Disturbances of the Seabed:

The pipeline was split into a number of discrete sections based on the benthic habitat type, the type and extend of seabed intervention and the resulting pipeline configuration.

For each discrete section, the following process was followed:

1. The pipeline configuration was used to assess whether a physical loss or physical disturbance was observed within the discrete pipeline section concerned:

Pipeline Configuration	Classification
Trench & Buried	Physical Disturbance
Rock Dumped	Physical Loss
Exposed on Seabed	Physical Loss

2. Where the pipeline is trenched and buried, the "footprint" of the physical disturbance was determined from the corresponding post-backfill survey chart:

Document Title	Ref.
Rohde Nielsen – Post Backfill Survey Charts (Denmark) – Area 1	[Ref. /5/]
Rohde Nielsen – Post Backfill Survey Charts (Denmark) – Area 2	[Ref. /6/]
Rohde Nielsen – Post Backfill Survey Charts (Denmark) – Area 3	[Ref. /7/]

3. Where the pipeline is rock dumped, the "footprint" of the physical loss was determined from the corresponding as-built drawing:

Document Title	Ref.
DEME – As-Built Drawing Danish Landfall Rock Placement	[Ref. /8/]
DEME – As-Built Drawing Lock Berm KP26.781 – Post-Lay	[Ref. /9/]
DEME – As-Built Drawing Lock Berm KP27.000 – Post-Lay	[Ref. /10/]
DEME – As-Built Drawing Kriegers Flak EC Crossing – Post-Lay	[Ref. /11/]
DEME – As-Built Drawing Lock Berm KP32.325 – Post-Lay	[Ref. /12/]
DEME – As-Built Drawing C-Lion Crossing – Post-Lay	[Ref. /13/]
DEME – As-Built Drawing Span Support KP164.026 – KP164.036	[Ref. /14/]
DEME – As-Built Drawing Span Support KP164.071 – KP164.081	[Ref. /15/]
DEME – As-Built Drawing Span Support KP164.891 – KP164.901	[Ref. /16/]
DEME – As-Built Drawing Span Support KP164.928 – KP164.938	[Ref. /17/]
DEME – As-Built Drawing Span Support KP165.130 – KP165.150	[Ref. /18/]
DEME – As-Built Drawing Span Support KP166.102 – KP166.112	[Ref. /19/]
DEME – As-Built Drawing Span Support KP167.015 – KP167.025	[Ref. /20/]
DEME – As-Built Drawing Span Support KP167.042 – KP167.070	[Ref. /21/]
DEME – As-Built Drawing – Post-Lay Rock Placement – Ronne Bank Stability Berm	[Ref. /22/]
DEME – As-Built Drawing Span Support KP178.333 – Post-Lay	[Ref. /23/]
DEME – As-Built Drawing Baltica Segment 3 Crossing – Post-Lay	[Ref. /24/]
DEME – As-Built Drawing Nord Stream 1A Crossing – Post-Lay	[Ref. /25/]
DEME – As-Built Drawing Nord Stream 1B Crossing – Post-Lay	[Ref. /26/]
DEME – As-Built Drawing Nord Stream 2 Crossing – Post-Lay	[Ref. /27/]

4. Where the pipeline is exposed on the seabed, the "footprint" of the physical loss was determined by multiplying the maximum concrete weight coated diameter of the pipeline by the length of the discrete pipeline section concerned.

The total extent of physical losses and physical disturbances for each impacted seabed habitat type along the pipeline route is calculated by summating the footprints determined in each discrete pipeline section.

4.2.2. Assessment

The “footprint” or extent of physical losses and physical disturbances of the seabed for each discrete pipeline section are reported in Table 4-5.

Table 4-5: Assessment of Physical Losses and Physical Disturbances of the Seabed

KP		Benthic Habitat Type			Seabed Intervention					Pipeline Configuration			Extent		
Start	End	Substrate Type	Photic / Non-Photic Zone	Salinity	Pre-Lay Dredging	Concrete Mattress	Pre-Lay Rock Installation	Post-Lay Rock Installation	Post-Lay Backfilling	Trenched & Buried	Rock Dumped	Exposed on Seabed	Physical Loss	Physical Disturbance	Reference
0.951	1.174	Fine Grained Sediment	Photic	11 - 18	Y	-	-	Y (1)	Y	Y	-	-		19083 m^2	[Ref. /5/]
1.174	2.132	Hard Bottom	Photic	11 - 18	Y	-	-	Y (1)	Y	Y	-	-		25468 m^2	
2.132	3.028	Fine Grained Sediment	Photic	11 - 18	Y	-	-	-	Y	Y	-	-		19556 m^2	
3.028	3.979	Sand	Photic	11 - 18	Y	-	-	-	Y	Y	-	-		19670 m^2	
3.979	9.494	Hard Bottom	Photic	11 - 18	Y	-	-	-	Y	Y	-	-		97700 m^2	
9.494	10.930	Sand	Photic	11 - 18	Y	-	-	-	Y	Y	-	-		22883 m^2	
10.930	11.135	Sand	Non-Photic	11 - 18	Y	-	-	-	Y	Y	-	-		3382 m^2	
11.135	12.156	Hard Bottom	Non-Photic	11 - 18	Y	-	-	-	Y	Y	-	-		14115 m^2	
12.156	18.429	Sand	Photic	11 - 18	Y	-	-	-	Y	Y	-	-		115288 m^2	
18.429	21.048	Sand	Non-Photic	11 - 18	Y	-	-	Y (1)	Y	Y	-	-		57296 m^2	
21.048	25.030	Hard Bottom	Non-Photic	11 - 18	Y	-	-	-	Y	Y	-	-		64200 m^2	[Ref. /6/]
25.030	25.073	Hard Bottom	Non-Photic	11 - 18	-	-	-	-	-	-	-	Y	49 m^2		-
25.073	26.781	Hard Bottom	Photic	11 - 18	-	-	-	-	-	-	-	Y	1964 m^2		
26.781	26.801	Hard Bottom	Photic	11 - 18	-	-	-	Y	-	-	Y	-	159 m^2		[Ref. /9/]
26.801	27.000	Hard Bottom	Photic	11 - 18	-	-	-	-	-	-	-	Y	229 m^2		-
27.000	27.300	Hard Bottom	Photic	11 - 18	-	-	-	Y	-	-	Y	-	4300 m^2		[Ref. /10/]
27.300	29.290	Hard Bottom	Photic	11 - 18	-	-	-	-	-	-	-	Y	2289 m^2		-
29.290	29.692	Fine Grained Sediment	Photic	11 - 18	-	-	-	-	-	-	-	Y	462 m^2		
29.692	29.747	Fine Grained Sediment	Non-Photic	11 - 18	-	-	-	-	-	-	-	Y	63 m^2		
29.747	30.250	Fine Grained Sediment	Non-Photic	11 - 18	-	Y (2)	-	Y	-	-	Y	-	7681 m^2		[Ref. /11/]
30.250	32.308	Fine Grained Sediment	Non-Photic	11 - 18	-	-	-	-	-	-	-	Y	2367 m^2		-
32.308	32.325	Hard Bottom	Non-Photic	11 - 18	-	-	-	-	-	-	-	Y	20 m^2		
32.325	32.625	Hard Bottom	Non-Photic	11 - 18	-	-	-	Y	-	-	Y	-	4386 m^2		[Ref. /12/]
32.625	37.338	Hard Bottom	Non-Photic	11 - 18	-	-	-	-	-	-	-	Y	5420 m^2		-
37.338	47.111	Fine Grained Sediment	Non-Photic	11 - 18	-	-	-	-	-	-	-	Y	11239 m^2		
132.102	140.972	Fine Grained Sediment	Non-Photic	11 - 18	-	-	-	-	-	-	-	Y	10201 m^2		-
140.972	141.022	Fine Grained Sediment	Non-Photic	11 - 18	-	Y (2)	-	Y	-	-	Y	-	571 m^2		[Ref. /13/]
141.022	148.741	Fine Grained Sediment	Non-Photic	11 - 18	-	-	-	-	-	-	-	Y	8877 m^2		-
148.741	155.129	Fine Grained Sediment	Non-Photic	7.5 - 11	-	-	-	-	-	-	-	Y	7346 m^2		
155.129	164.026	Sand	Non-Photic	7.5 - 11	-	-	-	-	-	-	-	Y	10232 m^2		
164.026	164.036	Sand	Non-Photic	7.5 - 11	-	-	-	Y	-	-	Y	-	100 m^2		[Ref. /14/]
164.036	164.071	Sand	Non-Photic	7.5 - 11	-	-	-	-	-	-	-	Y	40 m^2		-
164.071	164.081	Sand	Non-Photic	7.5 - 11	-	-	-	Y	-	-	Y	-	88 m^2		[Ref. /15/]
164.081	164.891	Sand	Non-Photic	7.5 - 11	-	-	-	-	-	-	-	Y	932 m^2		-
164.891	164.901	Sand	Non-Photic	7.5 - 11	-	-	-	Y	-	-	Y	-	106 m^2		[Ref. /16/]
164.901	164.928	Sand	Non-Photic	7.5 - 11	-	-	-	-	-	-	-	Y	31 m^2		-
164.928	164.938	Sand	Non-Photic	7.5 - 11	-	-	-	Y	-	-	Y	-	86 m^2		[Ref. /17/]
164.938	165.068	Sand	Non-Photic	7.5 - 11	-	-	-	-	-	-	-	Y	150 m^2		-
165.068	165.130	Bedrock	Non-Photic	7.5 - 11	-	-	-	-	-	-	-	Y	71 m^2		
165.130	165.150	Bedrock	Non-Photic	7.5 - 11	-	-	-	Y	-	-	Y	-	139 m^2		[Ref. /18/]
165.150	165.936	Bedrock	Non-Photic	7.5 - 11	-	-	-	-	-	-	-	Y	904 m^2		-
165.936	166.102	Hard Bottom	Non-Photic	7.5 - 11	-	-	-	-	-	-	-	Y	191 m^2		
166.102	166.112	Hard Bottom	Non-Photic	7.5 - 11	-	-	-	Y	-	-	Y	-	162 m^2		[Ref. /19/]
166.112	166.958	Hard Bottom	Non-Photic	7.5 - 11	-	-	-	-	-	-	-	Y	973 m^2		-
166.958	167.015	Sand	Non-Photic	7.5 - 11	-	-	-	-	-	-	-	Y	66 m^2		
167.015	167.025	Sand	Non-Photic	7.5 - 11	-	-	-	Y	-	-	Y	-	375 m^2		[Ref. /20/]

KP		Benthic Habitat Type			Seabed Intervention					Pipeline Configuration			Extent		
Start	End	Substrate Type	Photic / Non-Photic Zone	Salinity	Pre-Lay Dredging	Concrete Mattress	Pre-Lay Rock Installation	Post-Lay Rock Installation	Post-Lay Backfilling	Trenched & Buried	Rock Dumped	Exposed on Seabed	Physical Loss	Physical Disturbance	Reference
167.025	167.042	Sand	Non-Photic	7.5 - 11	-	-	-	-	-	-	-	Y	20 m^2		-
167.042	167.070	Sand	Non-Photic	7.5 - 11	-	-	-	Y	-	-	Y	-	791 m^2		[Ref. /21/]
167.070	167.400	Sand	Non-Photic	7.5 - 11	-	-	-	-	-	-	-	Y	380 m^2		-
167.400	171.500	Sand	Non-Photic	7.5 - 11	-	-	-	Y	-	-	Y	-	50842 m^2		[Ref. /22/]
171.500	173.825	Sand	Non-Photic	7.5 - 11	-	-	-	-	-	-	-	Y	2674 m^2		-
173.825	178.302	Sand	Non-Photic	7.5 - 11	Y	-	-	-	Y	Y	-	-		86655 m^2	[Ref. /6/]
178.302	178.307	Sand	Non-Photic	7.5 - 11	-	-	-	-	-	-	-	Y	6 m^2		-
178.307	178.390	Sand	Non-Photic	7.5 - 11	-	-	Y (2)	Y	-	-	Y	-	1404 m^2		[Ref. /23/]
178.390	180.759	Sand	Non-Photic	7.5 - 11	-	-	-	-	-	-	-	Y	2724 m^2		-
180.759	180.809	Sand	Non-Photic	7.5 - 11	-	Y (2)	-	Y	-	-	Y	-	536 m^2		[Ref. /24/]
180.809	182.758	Sand	Non-Photic	7.5 - 11	-	-	-	-	-	-	-	Y	2241 m^2		-
182.758	185.237	Fine Grained Sediment	Non-Photic	7.5 - 11	-	-	-	-	-	-	-	Y	2851 m^2		
185.237	186.445	Hard Bottom	Non-Photic	7.5 - 11	-	-	-	-	-	-	-	Y	1389 m^2		
186.445	188.524	Fine Grained Sediment	Non-Photic	7.5 - 11	-	-	-	-	-	-	-	Y	2391 m^2		
188.524	188.678	Fine Grained Sediment	Non-Photic	7.5 - 11	-	Y (2)	Y (2)	Y	-	-	Y	-	7674 m^2		[Ref. /25/]
188.678	188.735	Fine Grained Sediment	Non-Photic	7.5 - 11	-	-	-	-	-	-	-	Y	66 m^2		-
188.735	188.865	Fine Grained Sediment	Non-Photic	7.5 - 11	-	Y (2)	Y (2)	Y	-	-	Y	-	6017 m^2		[Ref. /26/]
188.865	206.064	Fine Grained Sediment	Non-Photic	7.5 - 11	-	-	-	-	-	-	-	Y	19779 m^2		-
206.064	206.298	Fine Grained Sediment	Non-Photic	7.5 - 11	-	Y (2)	Y (2)	Y	-	-	Y	-	35840 m^2		[Ref. /27/]
206.298	217.806	Fine Grained Sediment	Non-Photic	7.5 - 11	-	-	-	-	-	-	-	Y	13234 m^2		-
1.660	-	Hard Bottom	Photic	11 - 18	Temporary Spoil Storage Area #1									32670 m^2	[Ref. /5/]
13.000	-	Sand	Photic	11 - 18	Temporary Spoil Storage Area #2									46153 m^2	

Notes:

(1) Post-lay rock installation was undertaken within part of the reported KP range prior to undertaking post-lay backfilling. The extent of post-lay backfilling encompasses the areas of post-lay rock installation.

(2) Concrete mattresses and /or pre-lay rock installation was undertaken within part of the reported KP range prior to pipeline installation. The extent of post-lay rock installation encompasses the pre-lay seabed intervention works.

A summary of results per benthic habitat type is presented in Table 4-6.

Table 4-6: Physical Losses and Physical Disturbances of the Seabed

Benthic Habitat Type			Extent	
Substrate Type	**Photic / Non-Photic Zone**	**Salinity (PSU)**	**Physical Loss**	**Physical Disturbance**
Bedrock	Non-Photic	7.5 – 11	1114 m²	-
Hard Bottom	Non-Photic	7.5 – 11	2715 m²	-
Hard Bottom	Non-Photic	11 – 18	9875 m²	78315 m²
Hard Bottom	Photic	11 – 18	8941 m²	123168 m²
Fine Grained Sediment	Non-Photic	7.5 – 11	95198 m²	-
Fine Grained Sediment	Non-Photic	11 – 18	40999 m²	-
Fine Grained Sediment	Photic	11 – 18	462 m²	38639 m²
Sand	Non-Photic	7.5 – 11	73824 m²	86655 m²
Sand	Non-Photic	11 – 18	-	60678 m²
Sand	Photic	11 – 18	-	157841 m²
		Total	**233128 m²**	**545296 m²**
		Grand Total		**778424 m²**

The total combined extent of physical losses and physical disturbances of the seabed is assessed to be 778424 m². This comprises 233128 m² of physical losses and 545296 m² of physical disturbances.

4.3. COMPARISON WITH PREDICTIONS IN ENVIRONMENTAL IMPACT ASSESSMENT

The qualitative descriptions of observed changes in seabed topography at the selected locations demonstrate that the construction works have been undertaken in accordance with the design and using the methodologies considered in the *"Environmental Impact Assessment – Baltic Sea – Denmark"* [Ref. /2/].

Reference is also made to document *"Rohde Nielsen – Environmental Reporting: Restoration of the Seabed at Micro-Tunnel Exit – Denmark"* [Ref. /28/] which describes the steps that were taken during the performance of pre-lay dredging and post-lay backfilling in the vicinity of the micro-tunnel exit pit to minimise the impact on the eel grass meadows and ensure the restored seabed conditions create a habitat suitable for the re-establishment of eel grass.

Where the cross sectional profiles, at locations where the pipeline is trenched in water depths greater than seven (7) metres, indicate differences in seabed topography between the pre-dredging and post-backfilling condition the *"Environmental Impact Assessment – Baltic Sea – Denmark"* [Ref. /2/] states that:

> *"… the seabed height around the trench may vary from the surrounding seabed due to spoil heaps. However, artificial and natural backfilling will subsequently smoothen out the seabed bathymetry along the trenched pipeline sections."*

With regards to the extent of physical losses and physical disturbances of the seabed, the *"Environmental Impact Assessment – Baltic Sea – Denmark"* [Ref. /2/] predicted that:

> *"The physical loss and physical damage of the seabed during the construction phase along the Baltic Pipe route will be of a temporary nature and highly localised to the immediate footprint of the pipeline, which in Danish waters corresponds to a total occupied area of 0.15 km^2."*

The total area of physical losses and physical disturbances of the seabed, calculated according to the methodology presented in Section 4.2.1 and reported in Table 4-6, during project implementation was determined to be 778424m^2 (~0.78km^2). This is several times larger than the prediction within the *"Environmental Impact Assessment – Baltic Sea – Denmark"* [Ref. /2/]. The areas cannot be directly compared due to approved design changes following preparation of the *"Environmental Impact Assessment – Baltic Sea – Denmark"* [Ref. /2/].

Areas of physical disturbances of the seabed, which make up more than two thirds of this area, can be attributed to the pre-lay dredging, spoil storage and post-lay backfilling activities. Dredging of the pipeline was undertaken at specific locations along the route to ensure stability of the pipeline and to provide protection from interaction with marine traffic. The *"Environmental Impact Assessment – Baltic Sea – Denmark"* [Ref. /2/] states that:

> *"… impacts from physical disturbance of the seabed will not result in changes in the benthic habitat type, and therefore the intensity of the impacts on benthic communities from the construction work is assessed to be medium and the impact is considered minor and not significant."*

Areas of physical losses of the seabed correspond to areas where the pipeline is either exposed on the seabed or rock dumped. The *"Environmental Impact Assessment – Baltic Sea – Denmark"* [Ref. /2/] states that:

"The pipeline presence may on the one hand result in a loss of infauna seabed habitat within the project footprint. On the other hand, the introduction of the pipeline may represent a new hard substrate ("artificial reef") for sessile organisms and benthic macroalgae (within the photic zone).

Even though there will be a small negative impact from the pipeline due to the loss of soft seabed habitat, the introduced artificial reefs will change the existing habitats, with the potential for a minor degree of final positive impact. In conclusion, the impact of the presence of the pipeline on the local benthic communities is considered as not significant."

The potential impacts on benthic habitats, flora and fauna resulting from construction activities and operation of the pipeline within Danish waters are considered to be non-significant and will not have any transboundary impact.